

**Ministry of Education, Science, Research and Sport of the
Slovak Republic**

A conceptual framework of space activities in the Slovak Republic



For years 2020+

CONTENTS

1.	Introduction	2
2.	The state of space activities in the Slovak Republic and in Europe.....	3
2.1	The state of space activities in Europe	3
2.1.1	The Space Strategy for Europe	4
2.1.2	Overview of space programs in Europe	5
2.2	The state of space activities in the Slovak Republic	10
2.2.1	Governance of space activities.....	10
2.2.2	Academic sphere	13
2.2.3	Industrial sphere	15
2.2.4	Third sector	17
3.	Cooperation of the Slovak Republic with the ESA.....	18
3.1	Analysis of potential future cooperation of the Slovak Republic with the ESA	19
3.2	Financing the cooperation of the Slovak Republic with the ESA	21
3.2.1	Financing space activities in the Slovak Republic.....	22
4.	Development of Slovak space activities in the context of RIS3.....	24
5.	Slovak space activities and their future development	26
6.	Goals and possible measurable indicators of space activities development in the Slovak Republic.....	34
7.	Annexes.....	35
	Annex 1 – An overview of human activities in SPACE and their contributions for quality of life	36
	Annex 2 – More detailed information on the European Space Agency	37
	Annex 3 – Overview of financing of ESA programs by neighbouring states	38
	Annex 4 – List of optional ESA programs	40
	Annex 5 – Glossary of definitions and abbreviations	42

1. INTRODUCTION

The intention of this Conceptual Framework of Space Activities in the Slovak Republic (hereinafter the “conceptual framework”) is to summarize the state of space activities in the Slovak Republic as well as in the context of cooperation within the EU and with the European Space Agency (hereinafter the “ESA” – see www.esa.int) and to identify the main objectives of the development of Slovak space activities in line with the Space Strategy for Europe (hereinafter the “SSE”)¹.

The conceptual framework responds to the fact that adopting the SSE on the level of the European Union (hereinafter the “EU”) it is necessary that each EU Member State, and thus also the Slovak Republic, has a strategic document that will be prepared in line with the ESS. The harmonization of space policy is likewise necessary across the countries of Europe with the aim of remaining globally competitive in the area of the space. The ambition of the Slovak Republic after completing the 2nd phase of cooperation with the ESA is to become a full member of the ESA.

The conceptual framework covers two main time horizons:

- a) to year 2020: when the main priority of Slovakia in the field of space activities, the PECS program (Plan for European Cooperating States), is completed, as well as a decision on the form of the next phase of cooperation with the ESA;
- b) long-term, i.e. without limitations: where Slovakia’s intention is to successfully establish itself as a quality supplier of solutions in the field of space activities on both the European and worldwide level. For this purpose relevant areas (so-called “niches” – areas not covered by the market with potential for Slovak space industry) need to be identified and sustainable financing for Slovak space activities needs to be guaranteed.

The bases of the conceptual framework are the following:

- A) The exploration and exploitation of space are for mankind generally, and for Slovak citizens specifically, very beneficial activities. The results of these activities continuously contribute to human knowledge and to improving quality of life. Annex 1 provides a more detailed analysis of this subject.
- B) Europe is a major player in the world in this field: it implements globally strategic programs in the scope of leading EU space programs (Galileo/EGNOS, Copernicus) and makes available highly valuable technical expertise and technologies and human capacity within the ESA, which is a space actor of global importance (it has the second largest budget in the world after America’s NASA). For more, see Chapter “2.1 The state of space activities in Europe”. The ESA is an important partner for Slovakia and for the development of its space activities.
- C) Slovakia has a very long tradition in the field of space activities (dating from the time of the Soviet INTERKOSMOS program) as well as recent successes of worldwide importance are as following:
 - a Slovak cosmonaut (Col. Ivan Bella, 1999) spent seven-days on the Russian orbital station MIR during research mission Štefánik;
 - a professional technical participation in the historical first landing on a comet in the ESA Rosetta mission in 2014 (Ing. J. Baláž, PhD., IEP SAS, Košice);
 - its own satellite, completely designed and made in Slovakia, launched into Earth’s orbit in the summer of 2017 (the project “skCUBE”, the civic society SOSA).
- D) Slovakia has great potential in the field of space activities. This is based primarily on long-term traditional Slovak research and development (hereinafter “R&D”) – e.g. IT, the development of new

¹ The words “cosmic” and “space” used in the document are used as synonyms.

materials, biomedicine, and others – and partially on the results of the first three Slovak PECS calls (data from 2018).

A biannual report on selected results in space research in Slovakia, as well as associated activities and plans for the future is prepared by the Slovak National Committee COSPAR² and thus shares in the development of space activities with scientists from around the world in the given segment. Additional results can also be read in the publication the ESTMP³ (European Space Technology Master Plan 2017, pg. 157).

2. THE STATE OF SPACE ACTIVITIES IN THE SLOVAK REPUBLIC AND IN EUROPE

Space has become the domain of many countries of the world. The USA, Europe, Russia, China, Japan, India and others play the most important role in this regard.

The United Nations (UN), which represents the only global institution dedicated to the peaceful use of outer space, has a special place on the world stage in the area of the space exploration and exploitation. The UN Committee on the Peaceful Uses of Outer Space (COPUOS), based in Vienna, plays an important role in the development of international cooperation in space. The UN Office for Outer Space Affairs (UNOOSA) acts as the secretariat for COPUOS and is responsible for implementation of the international space commitments arising from the international space law, including the maintenance of the United Nations Register of Objects Launched into Outer Space. The Slovak Republic is a signatory of 4 of the 5 UN treaties on outer space (Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies; Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space; Convention on International Liability for Damage Caused by Space Objects; and the Convention on Registration of Objects Launched into Outer Space).

The United Nations General Assembly (UNGA) each year adopts several resolutions on the use of outer space, which are the subject of negotiations in the 1st and 4th UNGA committees. The military aspects of use of outer space are mainly dealt with in the Geneva Conference on Disarmament, which is an independent international organisation. The outputs and recommendations of the Conference on Disarmament are discussed in the UNGA.

The Slovak Republic supports the development of non-legally binding UN documents (e.g. Space Debris Mitigation Guidelines and transparency and confidence-building measures between member states in the field of use of outer space). It also supports initiatives aimed at enhancing the responsible behaviour of states in their space activities. Delegates of the Slovak Republic actively participate in the meetings of UNGA committees, COPUOS meetings (including Scientific and Technical Subcommittee and Legal Subcommittee), as well as in the meetings of the Conference on Disarmament in Geneva.

2.1 THE STATE OF SPACE ACTIVITIES IN EUROPE

Europe from a global point of view is a very important actor in space activities. Aside from the European Space Agency, the European Union itself has an abundant space program, published in 2016 a Space Strategy for Europe (SSE), from which we quote:

² The reports are available in Slovak at <http://nccospar.saske.sk>

³ The European Space Technology Master Plan 2017 is available at the address http://www.esa.int/Our_Activities/Space_Engineering_Technology/Europe_s_Master_Plan_for_space_technology_by_ESA_and_the_EU

“Europe — the Member States, the European Space Agency (ESA), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and the EU — has achieved many successes in space with breakthrough technologies and exploration missions, such as ESA's Rosetta mission, unique Earth observation and meteorology capabilities, such as Meteosat, and world-leading commercial telecommunications and launch systems with the Ariane family and Vega. Europe represents today the second largest public space budget in the world⁴ with programmes and facilities spanning different European countries. Between 2014-2020, the EU invests over EUR 12 billion in space activities. It owns world class space systems, with Copernicus for Earth observation and EGNOS and Galileo for satellite navigation and geo-positioning.”⁵

Europe as a whole is an important global player in space. It has a strong and competitive space industry, especially in the field of satellites, launchers and related services. The European space industry employs more than 230,000 people and generates added value estimated at 46 to 54 billion euros. Europe also produces one-third of the world's satellites (data from 2016).⁶

2.1.1 THE SPACE STRATEGY FOR EUROPE

The SSE was released as a Communication of the European Commission (hereinafter the “EC”)⁷ to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on 26 October 2016. The document responds to growing global competitiveness, the ever higher measure of engagement of the private sector and significant technological changes. The EC proposes a whole line of measures with the aim of enabling Europeans to use as best as possible the advantages that space has to offer, to create the right environment for the growth of new businesses in the field of space, to strengthen the position of Europe in this area and to increase its share in world markets. Starting from current initiatives, the EC is beginning to work on complex EU services related to the awareness of the situation in space for the protection of critical space infrastructures, from space debris, the space weather and cyber-attacks.

In the Joint Statement on Shared Vision and Goals for the Future of Europe in space, signed on 26 October 2016, the EU and the ESA agreed on the following: “Today's challenges for the space sector are characterized by changing paradigms and new user needs, an increasing number of space faring countries and new private actors, as well as increasing reliance on space. The space sector is becoming more diverse and complex. As both competition and cooperation are intensifying, Europe needs to shape its future position in the sector.”

The SSE was adopted with respect to the strategic importance of the space sector for the EU and its response to the rapidly changing global environment. Space activities contribute to many of the EU's policies and strategic priorities. They may play a key role in effectively addressing new challenges, such as climate change, sustainable development, border control, maritime surveillance and the security of EU citizens. New priorities of the EU lead to new ways of developing this program. With the development of EU space systems there is a need to tighten security requirements.

The Space strategy for Europe has **four main goals**, which are further divided into eight sub-goals:

1. Maximizing the benefits of space for society and the EU economy
 - a. Encouraging the uptake of space services and data
 - b. Advancing the EU space programs and meeting new user needs
2. Fostering a globally competitive and innovative European space sector

⁴ The sum of the consolidated space budget (EU Member States, ESA and EUMETSAT) was estimated at 7 billion euros in 2015

⁵ <http://data.consilium.europa.eu/doc/document/ST-13758-2016-INIT/sk/pdf>

⁶ <http://ec.europa.eu/docsroom/documents/19442>

⁷ <http://ec.europa.eu/docsroom/documents/19442>

- a. Supporting research and innovation and development of skills
 - b. Fostering entrepreneurship and new business opportunities
3. Reinforcing Europe's autonomy in accessing and using space in a secure and safe environment
 - a. Maintaining Europe's autonomous access to space
 - b. Ensuring access to the radio frequency spectrum
 - c. Ensuring the protection and resilience of critical European space infrastructure
 - d. Reinforcing synergies between civil and security space activities
4. Strengthening Europe's role as a global actor and promoting international cooperation

The conclusion of SSE briefly but very concisely justifies why the participation of Europe in the space sector is essential:

"The potential of space for Europe and the world is enormous. Europe faces huge global challenges which require global responses. Europe must contribute to this collective responsibility. Any Member State can do this alone. The EU, alongside its Member States and ESA, must act as a global stakeholder to promote and preserve the use of space for future generations. The EU cannot afford to fall behind in this domain. It must remain in the first rank, building on Europe's talents and expertise, capitalising on its investments and anticipating the opportunities of tomorrow."

2.1.2 OVERVIEW OF SPACE PROGRAMS IN EUROPE

Space programs in Europe can from an institutional point of view be divided into:

1. **EU programs**, which implement mainly programs of strategic importance (e.g. so-called "orbital infrastructure") with the aim of strengthening the position of the EU in the field of space on a global measure;
2. **ESA programs**, which implement in particular R&D, exploratory as well as commercial programs based on the interests of Member States and connected to industry.

The largest contributor to the ESA budget is the EU, since the EU does not make available its own capacities for the development, launching and operation of satellites; therefore, its strategic space programs are carried out through the ESA. Countries which are not EU Member States are also associated in the ESA, while in contrast, some EU Member States (including Slovakia) are not yet full members of the ESA.

I. Strategic programs of the EU:

"The proposal for a Regulation of the European Parliament and of the Council establishing the Space Program of the Union and the European Union Agency for the Space Program" (hereinafter the "Regulation") is one of the measures following up on the SSE of 2016. All EU activities in this highly strategic area are merged in a fully integrated space program which covers the systems Copernicus, Galileo/EGNOS, SSA/SST and the new initiative GovSatCom. This will ensure a coherent framework for future investments, offering greater visibility and flexibility. Improving efficiency will ultimately help to launch new services based on space technologies that all EU citizens will benefit from.

The aim of the program is:

- to provide or contribute to the provision of high-quality, current and if necessary security data, information and services related to space, namely without interruption and if possible on the global level, and in this way satisfy the present and future needs and enable the fulfilment of the

political priorities of the Union, including those which are related to climate changes, security and defence,

- to maximize the social-economic benefits, among others, also by means of supporting the broadest possible use of data, information and services provided by the components of the program,
- to strengthen the security of the Union and its Member States as well as its freedom to act autonomously and strategically, especially in regard to evidence-based technologies and decision-making,
- to support the role of the Union on the international stage as one of the leading actors in the space sector and to reinforce its role in addressing the global challenges and supporting global initiatives, among others in the area of climate change and sustainable development.

The measures mentioned above are proposed with one main criterion, which is their practical implementation. They are designed in the interest of supporting partnerships between the European Commission, Member States, the ESA and the GSA⁸ and together with all other relevant agencies, such as EUMETSAT, stakeholders, industry, the research community and users community.

One of the cornerstones of success will be EU-ESA relations. With its technical expertise, experience, possibilities and knowledge, the ESA is an important partner on which the EC will continue to rely. During a mid-term assessment of EU space programs in 2017, the EC explored possible management improvements and simplification measures, for example, through a single partnership agreement in the financial framework with ESA, which would make valid rules more effective and would tighten transparency and accountability requirements.

With the Regulation, the EU provides a sufficiently large budget for space (16.2 billion euros for 2021-2027) that will enable it to carry out various planned activities, especially regarding the continuation and improvement of Galileo, EGNOS, Copernicus and SST, as well as launching the GovSatCom initiative.

In it the rules are stipulated for management of the program, and the relationships clarified between the individual actors involved and the role of these actors, in particular Member States, the European Commission and the European Union Agency for the Space Program, and the introducing of a single management system for all program components. It strengthens the role of the former European GNSS (GSA) Agency, since it expands the range of its security accreditation roles so as to include all program components, which is the reason for the change in the name of this agency, which will be the European Union Agency for the Space Program.

A/ Copernicus⁹

Copernicus, previously known as the Global Monitoring for Environment and Security (GMES), is an EU program that aims to achieve autonomous, multilevel operational infrastructure for Earth Observation. The ESA performed a large part of the program design. It mainly oversaw and co-financed the development of the Sentinel satellites (1, 2, 3, 4 and 5) and instruments for the MTG and MetOp-SG meteorological satellites EUMETSAT.

The aim is to use multisource data for obtaining timely and high-quality environmental information and ensuring an independent access to worldwide environmental and security information. The system provides all information on the environment through satellite technology, air and ground stations, and provides a comprehensive picture of Earth's "health". We can divide the Copernicus geo-spatial

⁸ Global Navigation Satellite System GNSS.

⁹ Taken from <https://www.enviroportal.sk/seis/copernicus-gio-land>

information services into six main subjects: the monitoring of land, oceans, emergency response to exceptional events, atmosphere monitoring, security monitoring and climate-change monitoring.

B/ Galileo and EGNOS¹⁰ (program/system of satellite navigation, telecommunication and positioning hardware)

Galileo is the global satellite navigation system of the European Union (GNSS). It is sometimes called the “European GPS”. Galileo offers exact information on position and time. This program is under civilian control and its data may be used for a wide scale of applications. It is autonomous but at the same time interoperable with existing satellite navigation systems. Galileo will consist of 30 satellites and ground infrastructure.

With 26 satellites (status as of 25 July 2018) on orbit and support infrastructure for ground communications Galileo at present offers for three extensive testing periods three initial services:

- Open service: a free mass-market service for placement, navigation and timing;
- Public regulated service: for users approved by the government, such as civil defence services, customs and police. This system is highly robust and encrypted in order to provide continuity of services for government users in emergency situations or crisis situations.
- Searching and emergency services: the contribution to Europe on organization of COSPAS-SARSAT, which is focused on international emergency beacons. Galileo data help search for these beacons and rescue people in need in every environment.

The aim of the **EGNOS** system is to improve the quality of open signals broadcast by existing global satellite navigation systems, in particular those transmitted by the Galileo system, for the purpose, among others, of air traffic management and air navigation services.

C/ Space Situational Awareness and Space Surveillance and Tracking systems (SSA, SST)

In line with the policy directions set by the EU Council, Europe needs to prepare for the transition to comprehensive acquisition of knowledge of the “space situational awareness” (SSA). The importance of safety in space and from space for the protection of space infrastructure from the risks of spreading space debris is steadily increasing. The EU began to address this problem by implementing the EU support framework for “Space Surveillance and Tracking” (SST), which now provides operational services based on pooling the capacities of Member States (MS). Services could be expanded to include the “monitoring of space weather” and “near-earth objects” (NEO).

D/ Governmental Satellite Communication (GovSatCom)

The EU Governmental Satellite Communication (GovSatCom) is an initiative at the interface of space, security and defence, and as such is a component of the SSE in the area of space and the European Defence Action Plan. This initiative should provide key competences – guaranteed access to secure satellite communications – to actors responsible for security in the EU and MS, both in national policies and during crises.

The GovSatCom system was identified as one of the elements of the European Union’s Global Strategy for Foreign and Security Policy of June 2016. GovSatCom should contribute to the EU’s response to hybrid threats and provide support for the EU Maritime Strategy and EU Arctic Policy.

¹⁰ Translated according to https://ec.europa.eu/growth/sectors/space/galileo_sk or <https://www.gsc-europa.eu>

GovSatCom is a program aimed at users with a strong security dimension. Cases for its use can be divided into three main groups: 1) crisis management, which may include civilian and military missions and operations in the scope of the Common Security and Defence Policy, natural and man-made disasters, humanitarian crises and maritime emergency situations; 2) surveillance, which may include border surveillance, surveillance in the frontier zone, surveillance of maritime borders, maritime surveillance and the monitoring of illicit trafficking; and 3) key infrastructures, which may include the diplomatic network, police communications, critical infrastructures (e.g. energy and transport infrastructures and water barriers) and space infrastructures.

E/ Autonomous access to space (launchers)

The European Union is the first European institutional customer for European launchers and therefore is a key player in industrial policy in terms of planned commercial models. In the coming 10 to 15 years, the EU plans to launch more than 30 satellites within its Galileo and Copernicus programs, carried especially on launchers made in Europe (Ariane 6 (FR) and Vega C (IT)). Launching services are already an important part of the implementation of the Copernicus and Galileo programs.

F/ Space research

A significant part of the Work Program of the EU Framework program for Research and Innovation **Horizon 2020 (H2020) for the years 2018-2020** is devoted to **space activities** and funded from the EU resources in the amount of **€ 709 million**. It promotes in this way the development of entrepreneurship and the entrepreneurial spirit, supports the needs for the development of space programs and puts emphasis on competitiveness in the field of technological development.

The EC also included support of space activities in a new EU Framework Program for Research and Innovation Horizon Europe, which will be implemented from 2021 – 2027.

The European Commission will work together with the EU High Representative for Foreign Affairs and Security Policy and the Member States to support international principles of responsible behaviour in outer space within the UN and other appropriate multilateral fora. The European Union should be a leader in resolving the problems caused by the increase in the number of space actors, space objects and the increase of space debris and do so in line with the UN treaties on outer space.

Further, the EC will use the EU space program to contribute to the international effort and also draw on their benefits through initiatives such as the Global Earth Observation System of Systems (GEOSS) and the Committee on Earth Observation Satellites (CEOS) under the Copernicus Program, or the Search and Rescue Initiative (COSPAS-SARSAT) under the Galileo system. The European Commission will also support the EU's neighbourhood and development policies, as it already does in Africa through the Copernicus program and EGNOS services. It will contribute to the international dialogue on space research with Member States and the ESA and will promote common European positions.

All in all, support of space activities is found in 3 programs in the scope of the proposal of a Multiannual Financial Framework for 2021 - 2027:

1. **Space program** represents the integration of existing systems – Galileo/EGNOS, Copernicus, SSA/SST and GovSatCom. The objective is to enable rationalization, better allowance for horizontal questions (e.g. security) and enable preservation of equality between the interests of R&D organizations and industry. A total of 16.2 bill. euros have been allocated to the program. The program enables better setting of the relations between MS, the EC and the ESA.
2. **EU Framework Program for Research and Innovation Horizon Europe** - divided into 4 parts. Space is a component of the proposed 2nd pillar.
3. **Program InvestEU** includes current instruments, such as EFSI, COSME and financial instruments.

II. Main programs of the ESA:

Aside from the fact that the ESA is a key supplier for all strategic EU programs (Copernicus, Galileo, SSA/SST, GovSatCom, launchers), it offers its Member States a wide range of research and development programs. The main programs are:

- **Telecommunications**– especially ARTES
- **Human spaceflight** – especially ELIPS as a partnership in the project of the International Space Station (ISS)
- **Scientific programs** (e.g. PRODEX)
- and others.

A comprehensive overview of ESA programs is given in Annex 2 – more detailed information on the European Space Agency.

2.2 THE STATE OF SPACE ACTIVITIES IN THE SLOVAK REPUBLIC

Slovakia has a very long tradition in space research, significant international achievements as well as considerable potential. It also has available high-quality human capital, a community of experts on the issues of space science, space law and space technology. This community is made up of the following actors:

- 1) decision sphere (government of the Slovak Republic, or respective ministries),
- 2) academic sphere (Slovak Academy of Sciences and universities)
- 3) industrial sphere (especially research and development organizations, mainly small and medium-sized enterprises)
- 4) third sector (civic and interest associations, non-governmental and non-profit organizations)

2.2.1 GOVERNANCE OF SPACE ACTIVITIES

Responsibility for space activities in Slovakia is divided among several ministries (see also Chapter 5. Slovak space activities and their future development):

1. Ministry of Education, Science, Research and Sport of the Slovak Republic (MŠVVaŠ SR) is responsible for cooperation of the Slovak Republic with the ESA and for implementation of the PECS program
2. Ministry of Transport and Construction of the Slovak Republic (MDV SR) is responsible for implementation of the Galileo/EGNOS, Public Regulated Service (PRS)
3. Ministry of the Environment of the Slovak Republic (MŽP SR) is the gestor of the Copernicus Program on the national level
4. The agenda of the GovSatCom program on the national level is in the competence of the Ministry of Interior of the Slovak Republic (MV SR)
5. Ministry of Foreign and European Affairs of the Slovak Republic (MZVaEZ SR) is responsible for international legal, security and political aspects of the use of outer space.

Overall, the involvement of respective ministries in context with a cross-cutting nature of space activities in Slovakia can be designed as follows:

	COPERNICUS	GALILEO / EGNOS	GOVSATCOM	SSA / SST
MV SR	X		X	X
MZVEZ SR			X	X
MŽP SR	X		X	X
MDV SR	X	X	X	
MO SR			X	X
MH SR	X	X	X	X
MF SR	X	X	X	X
UPVVI SR	X	X	X	X
MŠVVaŠ SR	X	X	X	X

The Minister of Education, Science, Research and Sport of the Slovak Republic has established an advisory body called the **Commission for Space Activities in the Slovak Republic**. This commission is made up of representatives of the relevant ministries and has its advisory bodies: the Scientific Council and the Chamber of Commerce.

The Commission for Space Activities in the Slovak Republic consists of representatives of the following institutions:

Commissions for Space Activities

- a) Ministry of Transport and Construction of the Slovak Republic,
- b) Ministry of Economy of the Slovak Republic,
- c) Ministry of Defence of the Slovak Republic,
- d) Ministry of Interior of the Slovak Republic,
- e) Ministry of Environment of the Slovak Republic,
- f) Ministry of Agriculture and Rural Development of the Slovak Republic,
- g) Ministry of Health of the Slovak Republic,
- h) Ministry of Foreign and European Affairs of the Slovak Republic,
- i) Office of the Deputy Prime Minister of the Slovak Republic for Investments and Informatization and
- j) national delegate for the framework program of the European Union for Research and Innovation.

Advisory authorities of the Commission:

A) Scientific Council:

- Slovak Academy of Sciences,
- Comenius University in Bratislava,
- Slovak University of Technology in Bratislava,
- University of Žilina in Žilina,
- Technical University of Košice,
- Pavol Jozef Šafárik University in Košice,
- Technical University in Zvolen.

B) Chamber of Commerce:

- Association of Research and Development Industrial Organizations,
- Association of Slovak Scientific and Technological Societies,
- IT Association of Slovakia,
- Association of the Electrotechnical Industry of the Slovak Republic,
- Slovak AeroSpace Cluster,
- Cluster for Automation Technologies and Robotics AT+R

The 10 ministries that are involved in the space activities in the Slovak Republic (MZVaEZ SR, MF SR, MO SR, MV SR, MDV SR, MŽP SR, MH SR, MZ SR and MPRV SR) including the MŠVVaŠ SR, are aware of the importance of space for Slovakia and also its growing importance for society.

In the future, it will be necessary to find a suitable form of sustainable funding and cross-sectoral coordination of space activities in Slovakia, which would respect both the cross-cutting nature of space activities and address new space programs and EU challenges as well as new conditions of cooperation with the European Space Agency after 2020. In connection with this, governance from the position of a supra-ministerial authority of Slovakia is most probably needed. In the case the Slovak space activities are developing favourably and the Slovak Space Program is introduced, there would be a need to establish a space office or agency in the future, that may be entrusted with administration and coordination of space activities in Slovakia based upon the model of the German DLR or French CNES for example.

In connection with the development of the Slovak Space Program (at least in the fields of education, mobility, development of technological prototypes, etc.), it is necessary to concentrate on open areas – “niches” – where Slovak organizations can be competitive and sustainable. The ESA considers (from an evaluation of the first three Slovak PECS calls) as areas with high potential for cooperation following: of Earth Observation, which includes forestry, agriculture and other sectors associated with space activities, as well as education and training, where new projects for cooperation can be identified.

Adoption of national legislation (“Act on Space Activities”):

Every country that has ratified the United Nations treaties on outer space is responsible for compliance with them and their implementation towards the international community.

The Slovak Republic is accordingly to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies responsible for national activities in space, whether conducted by a governmental organization or non-governmental institution, and that activities are carried out in conformity with the provisions of this treaty. In line with the commitments of the Slovak Republic under the above-mentioned treaties, a government should designate a regulatory authority through its national legislation. The task of this authority will be to supervise the implementation of space activities in Slovakia (including the development of satellites) and to modify the rules for the carrying out of space activities (security measures, the conditions and procedure for registering space objects, terms of liability).

Currently, a temporary Register of Space Objects of the Slovak Republic has been established at the Ministry of Education, Science, Research and Sport of the Slovak Republic, for purpose of the launch of the first Slovak satellite, skCUBE. According to the Art. IV of the Convention on Registration of Objects Launched into Outer Space, the Slovak Republic notified the UN Secretary-General of the registration of the skCUBE satellite in the Register of Space Objects of the Slovak Republic.

The adopting of the Act on Space Activities in the Slovak Republic is an essential condition for the further development of the space activities in the country, including determining the competencies of state administration authorities. The Slovak Republic is a signatory of 4 of the 5 UN Treaties on outer space and supports the creation of non-legally binding UN instruments (for example e.g. Space Debris Mitigation Guidelines), including in the area of increasing transparency and building trust between states in the use of outer space, which increases the security and sustainability of space activities. The Slovak Republic also participates in the development of the international guidelines of the UN for the Long-term Sustainability of outer space activities and supports EU efforts to create an international regime of responsible behaviour in outer space.

Ministry of Foreign and European Affairs of the Slovak Republic provides the platform and initiates preparation of Slovak space legislation in cooperation with Ministry of Transport and Construction of the Slovak Republic Ministry of Economy of the Slovak Republic and Ministry of Education, Science, Research and Sport of the Slovak Republic.

2.2.2 ACADEMIC SPHERE

SLOVAK ACADEMY OF SCIENCES

Several institutes of the Slovak Academy of Sciences (SAS) take part in international space projects, such as the ESA Rosetta, BepiColobo, IMPRESS, or Radioastron, etc., while several Slovak universities have experience with foreign space projects. A brief overview of the activities of the SAS and Slovak Universities follows, and a more detailed overview can also be found in publications <http://nccospar.saske.sk/REPORT20162017> and the European Space Technology Master Plan 2017¹¹ on page 157.

[Institute of Experimental Physics SAS – Cosmic Physics Department](#) in Košice studies cosmic radiation, the solar wind and the Earth's magnetosphere with the use of satellite data and secures continuous measurements of cosmic radiation using the [neutron monitor at the high-mountain observatory on the Lomnický Peak](#). It is sharing in the manufacture of a new equipment [PICAM \(Planetary Ion CAMera\)](#) for research of planetary processes in the scope of a future space mission [ESA Bepi-Colombo](#), which is focused on the planet Mercury. [This department works in the scope of international cooperation on the JEM-EUSO telescope in the form of support analyses, which will be installed in the near future on the International Space Station ISS](#). The telescope is focused on ultraviolet radiation arising with the interaction of cosmic particles with the atmosphere of the Earth.

Currently they work on:

- the [DOK-M](#) particle spectrometer in cooperation with the Democritus University in Greece and the Institute of Space Research in Russia (IKI-RAN) for the Russian space mission RESONANCE, which will study the properties of the Earth's magnetosphere;
- the Neutral Atom Imaging System (NAIS) experiment for the Chinese mission MIT (Mesosphere-Ionosphere-Thermosphere) in cooperation with the Chinese National Space Centre (NSSC), Space Technology Ireland, Maynooth and the Swedish Institute of Space Physics IRF;
- the ASPECT-L particle spectrometer for the moon mission [Luna Glob](#) in cooperation with the Democritus University in Greece and the Institute of Space Research in Russia (IKI-RAN).

In the recent past this department participated in the development and construction of:

- the service system [ESS](#) aboard the space probe [ESA Rosetta](#) at comet 67P/Churyumov-Gerasimenko (in cooperation with the [Space Technologies Laboratory, National University of Ireland STIL- NUIM](#)), which enables communication between the main part of the probe, the orbiter and the landing module Philae;
- the experiment [NUADU \(NeUtral Atom Detection Unit\)](#), installed on the satellite [Double Star TC-2](#) (joint project of the [ESA](#) and [CNSA](#)), enabling the display of radiation of atoms in the Earth's magnetosphere ([in cooperation with the Space Technologies Laboratory, National University of Ireland STIL- NUIM](#));
- the detector for study of electrons [PEEL \(detector of Precipitating Energetic Electrons at high Latitude\)](#) in cooperation with the [Democritus University in Greece](#), as part of the mission HotPay-2 (project [Andoya Rocket Range](#) and [Arctic Lidar Observatory ALOMAR](#));
- the equipment of the [MEP \(Monitor of Energetic Particle\)](#) for the space mission [RadioAstron](#) in cooperation with the with the [Democritus University in Greece](#), and the [Institute of Cosmic Research in Russia](#) (IKI-RAN).

The [Geophysical Institute](#) of the Slovak Academy of Sciences in Bratislava and Hurbanovo deals with the study of space weather predominately in the scope of the program [COST Action ES0803 “Developing Space Weather Products and Services in Europe”](#) and by measuring the earthbound magnetic field.

¹¹ The European Space Technology Master Plan 2017 is available at:
[http://www.esa.int/Our_Activities/Space_Engineering_Technology/Europe s Master Plan for space technology by ESA and the EU](http://www.esa.int/Our_Activities/Space_Engineering_Technology/Europe_s_Master_Plan_for_space_technology_by_ESA_and_the_EU)

The [Astronomical Institute of the SAS](#) is focused on research of Solar physics, mainly by use of data from observation satellites [SOHO, TRACE, RHESSI](#), Hinode and SDO. [Its activities also cover study of the physics of stars using satellite data from the IUE, FUSE, Integral, Kepler and the HST.](#) This institute shared in the founding of the [Centre for cosmic research: the impacts of cosmic weather](#) in cooperation with the Institute of Experimental Physics of the SAS and Pavol Jozef Šafárik University in Košice.

The [Institute of Materials and Machine Mechanics](#) of the SAS takes part in the ESA project with the name Gravity dependence of CET in peritectic TiAl alloys (acronym GRADECET) in the scope of which it studies the influence of gravitation on the creation of structures in alloys of titanium and aluminium.

The [Geographical Institute](#) of the SAS in Bratislava participates in the URBAN Atlas Project with the aim of preparing maps of large cities in European countries with the use of satellite images and on the ESA PECS program.

The SAS publishes a detailed summary of its scientific work in the cosmic sector in a biannual Report on Space Research in Slovakia, which is published on the Web page <http://nccospar.saske.sk/>

UNIVERSITIES

Faculty of Mathematics, Physics and Informatics of Comenius University: [Department of Nuclear Physics and Biophysics at the Faculty of Mathematics, Physics and Informatics](#) of Comenius University in Bratislava focuses on the study of the interaction of cosmic radiation with material objects and chemical analysis of meteorites. This department has studied in the recent past fragments of the Rumanová, Košice and Chelyabinsk meteorites, which fell in the Urals after a massive and very clear explosion. Using its 70-cm telescope at the Astronomical and Geophysical Observatory in Modra, the [Department of Astronomy, Earth Physics and Meteorology](#) of the FMPI of Comenius University investigates the physical and dynamic characteristics of the space debris that threatens the space infrastructure. At the same time, it explores the population of small solar system bodies, meteoroids and asteroids, through the global network of the AMOS system fully developed in Slovakia.

The Faculty of Aeronautics of the Technical University of Košice – space technology and research (<http://web.tuke.sk/lf/index.php?name=41>), training of pilots, later astronauts (Mr. Bella and his substitute Mr. Fulier), the theoretical concept of a small satellite navigation system for the planet Mars.

The Faculty of Natural Sciences of the Pavol Jozef Šafárik University in Košice; the Faculty of Natural Sciences, Comenius University in Bratislava (measuring of cardiovascular rhythms in rodents under hypergravity conditions), the Department of Geodesy of the Slovak University of Technology in Bratislava (Radar interferometry, the InSAR, GOCE projects, Earth gravitational field measurements).

Žilina University successfully took part in the project of the first Slovak satellite, skCUBE, as well as in the PECS program.

The Slovak University of Technology in Bratislava obtained the most successful projects in the scope of the three Slovak PECS calls.

2.2.3 INDUSTRIAL SPHERE

Even though in the past Slovak space activities were mainly the domain of academic institutions, their further **development lies mainly in the ever more intensive involvement of Slovak industry**, research and development companies, which **will acquire know-how applicable in purely commercial space activities** by participating in ESA programs (outside of publicly subsidized schemes). **A long-term return on government investment in cooperation with ESA depends on the establishment of a solid space industry.**

Slovak companies have been involved in space activities in the past, though to a limited extent, especially in the development and construction of satellites and their components (whether in the ESA Rosetta or skCUBE and others), in software development and the like. However, participation of the Slovak Republic in the PECS program can enable further development of the Slovak space industry.

One positive factor is the presence of a well-developed engineering, electrical and, in particular, automotive (approximately 44% of total industrial production) industries, which represent a strong base of companies with the technological prerequisites for diversifying their activities in the direction of the space industry. Several Slovak technological companies that supply the automotive sector have already completed their first space projects.

In 2013, in preparation for the PECS program, **Ministry of Education, Science, Research and Sport** of the Slovak Republic run **an extensive survey of the potential** of industrial and research and development organisations in Slovakia for their participation in ESA programs, in which participated more than 80 such organizations. The survey was conducted in the form of an electronic questionnaire, in which respondents also stated their qualification in individual technological domains of space technologies according to ESA classification (the so-called “ESA technology tree”). The resulting processing of this survey is shown in Fig. 1. This **survey pointed to the relatively high readiness of Slovak R&D organizations for participation in ESA programs**, particularly in technologies focused on space software, on-board data systems, mechanisms and tribology, radiofrequency payloads and systems, materials and processes, and others. The selected organisations were then subject to a detailed expert evaluation by an ESA Delegation, which took place in May 2014. A total of 32 Slovak R&D organisations took part in this evaluation. Several workplaces presented their current activities in the field of space activities, some of which are directly suitable for implementation under the PECS program. **In its final report, the ESA delegation appreciated the high participation of Slovak R&D organisations and stated that Slovak R&D organisations have good potential for taking part in the PECS program.** They were based on the fact that several Slovak organisations are active in space activities and have either direct or indirect experience in implementing projects managed by the ESA.

The real potential of the Slovak industry for operating in the area of SPACE can also be seen in the results of the three Slovak PECS calls, in which 7 Slovak private companies were actively involved, in addition to the institutes of the SAS and university faculties (data from 2018). They are taking part in the development of space hardware, processing large data from the Copernicus project, the development of ground station software, the construction of a ground station network, processing data for the NATURA2000 projects and the development of equipment for stratospheric flights. **While in the first call only one project of seven successful projects was implemented by a private company, in the second call 4 projects of 8 were implemented by private companies.** Therefore, the potential for the Slovak industry can be seen in particular in the following areas of SPACE¹².

- 1) **ICT** – software systems and processing, especially of BIG DATA (Earth observation programs, especially the EU’s Copernicus), development of telecommunications equipment and systems (antenna systems, analysis and processing of radio signals, etc.).
- 2) **“space hardware”** – design, development and manufacture of mechanical, mechatronic and robotic equipment and systems intended for operation in the extreme conditions of free space and the Earth’s stratosphere.

¹² Potentially others, which will be active and in the future Slovak PECS calls (two to three additional calls are anticipated to year 2020).

- 3) **Biological systems** – research on the cultivating of biological systems (cell cultures, plants and animals) in the changed conditions of the environment (hyper- or hypo-gravitation, increased radiation, extreme temperature, and the like).

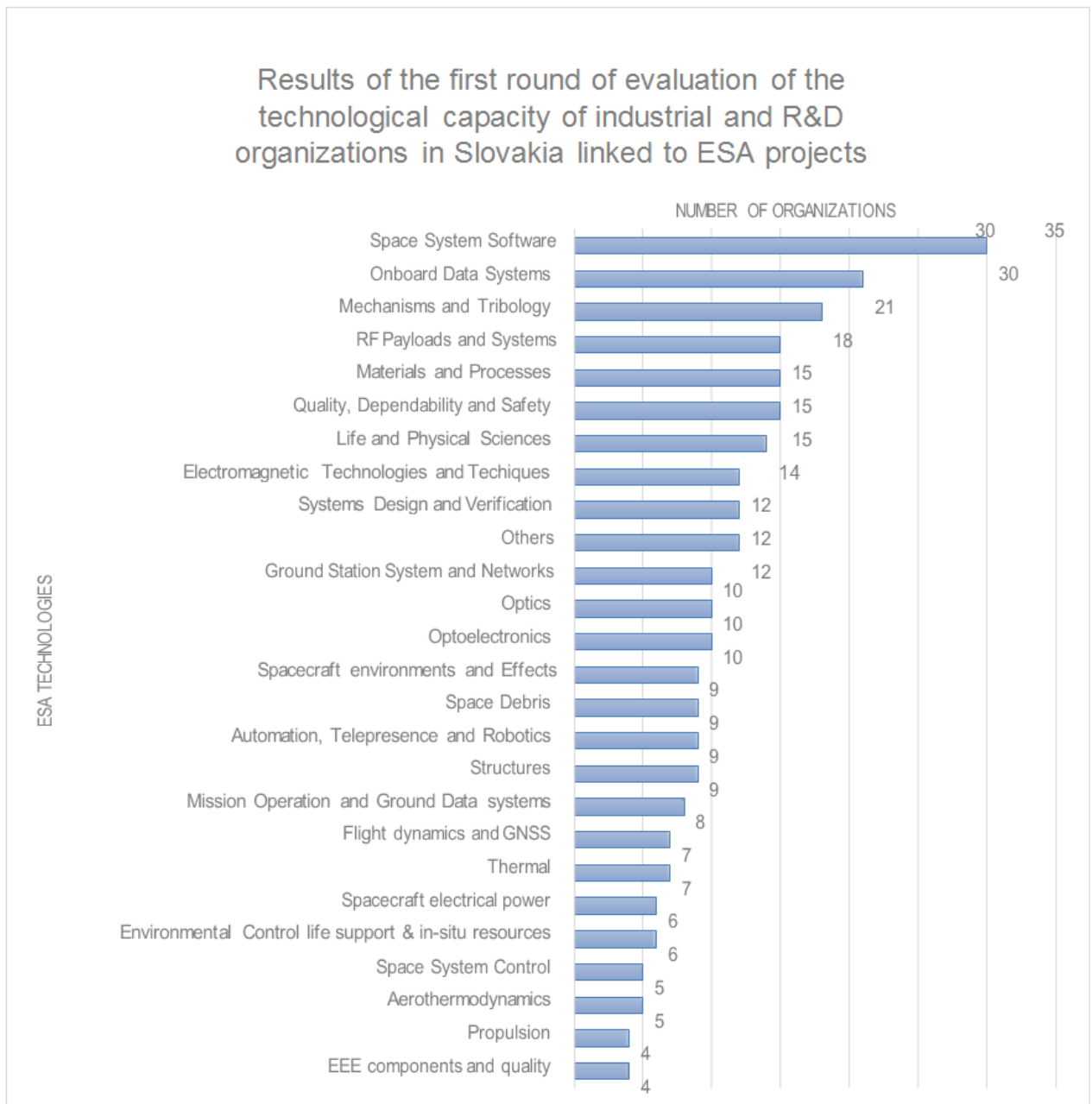


Fig. 1: Final processing of the first round of evaluation of the potential of industrial and research and development organizations in Slovakia for their participation in ESA programs. Source: Ministry of Education, Science, Research and Sport of the Slovak Republic

2.2.4 THIRD SECTOR

The ecosystem of actors of Slovak space activities is consisting also of the third sector subjects, for example: civic and interest associations. The following are worth mentioning in particular:

1. **The Slovak Organisation for Space Activities (SOSA)** is a civic association whose aim is to promote science, technology and space research in Slovakia, to disseminate information on space research and international projects in this field among domestic organizations and to facilitate their cooperation, boost Slovak industry, research and development of new technologies, as well as their practical use, to further focus on popularization activities (organizing conferences, seminars, workshops – training their own members as well as the general public).
2. **The Slovak Space Policy Association (SSPA)** is a non-governmental organization that deals with space policy. The main role of SSPA is to boost public discussion on issues concerning the use of outer space and its crucial impact on societal, economic, scientific, research and external relations of the Slovak Republic. The SSPA is the national contact point for the international organisation the Space Generation Advisory Council, for the European Space Law Centre at the ESA (ECSL) and a member of the regional think-tank network in the framework of the IRSEC Hub project.

3. COOPERATION OF THE SLOVAK REPUBLIC WITH THE ESA

A key element for long-term development of Slovak space activities is its cooperation with the ESA. In 2010 Slovakia signed the first "Cooperation Agreement" with the ESA as a framework document that enables the first contact of Slovak experts with those from the ESA, participation in common seminars and the like. In 2015, Slovakia signed a "European Cooperating State Agreement" (hereinafter a "ECS") and entered the ESA PECS program (Plan for European Cooperating States), and committed to allocate approximately 7.5 million euros for the period 2015 – 2020 for funding Slovak space projects, under the organisational supervision of the ESA. The European Cooperating State Agreement is valid till 2020, and after Slovakia should decide upon future form of further cooperation with the ESA. It will depend mainly on the readiness of the Slovak space industry and the results of the Final "PECS Country Report" after completion of a 5-year PECS contract. The following options will come into consideration:

- 1) To renew a 5-year cycle of PECS program (as an "ECS")
- 2) To become an "associate member" of the ESA
- 3) To become a full ESA Member State

Overview table of the individual variants:

	ECS	Associate Member	Member State
Legal basis	European Cooperating State Agreement	On the basis of Article XIV.3 "Cooperation" of ESA Convention	Accession to ESA Convention, Article XXII "Accession"
Participation in ESA's programmes and activities	Participation only in the PECS program	Participation in basic activities executed from the General Budget, excluding the Technology Research Program (TRP). Possibility to participate in optional programs (subject to unanimous approval of the respective Participating States).	Participation in mandatory activities and possibility to participate in optional programmes.
Financial contributions	5 million euros according to economic conditions from 2001	Obligatory contributions to mandatory activities + voluntary contributions to optional programs. No entrance fee.	Obligatory contributions to mandatory activities, by GDP of the state for the past 3 years, + voluntary contributions to optional programs + obligation to make a special payment after accession - entrance fee (related to the current value of the assets of the Agency).
Access to classified information	No	No	After ratification of a so-called Security Agreement.
Duration of status	5 years	5 years	Unlimited, in the first years supplemented by a transition period with a common group "Task Force" for better involvement of the country's industry to ESA activities.

3.1 ANALYSIS OF POTENTIAL FUTURE COOPERATION OF THE SLOVAK REPUBLIC WITH THE ESA

We herein present a brief SWOT analysis for all three variants of possible cooperation of Slovakia with the ESA after 2020, especially in the context of the Central European region¹³.

1) Variant "second PECS period"

Strengths	Weaknesses
<ul style="list-style-type: none"> Already well known process in Slovakia Financially undemanding More time for Slovak industry to gain experience, improve and adapt to the ESA standards More time for formulation of Slovak interests in the SPACE sector (selection of future optional programs). 	<ul style="list-style-type: none"> Limited options to contribute to the development of the ESA and its cooperation with the EU, of which Slovakia is a member state Limited access to information and ESA programs Labour market or job opportunities within the ESA are limited for Slovak experts, the same as possibilities for Slovak industry to apply for ESA tenders.
Opportunities	Threats
<ul style="list-style-type: none"> participation in PECS calls return of about 80- 85% of Slovak contribution to Slovak PECS projects. 	<ul style="list-style-type: none"> Slovakia lagging behind in the scope of Central European Region.

2) Variant "Associate Member"

Strengths	Weaknesses
<ul style="list-style-type: none"> Access to mandatory and optional ESA programs on the basis of a decision of the ESA Council. 	<ul style="list-style-type: none"> increased administrative demand Conditioned access to ESA information and programs Slovak citizens will be further disqualified from jobs at the ESA.
Opportunities	Threats
<ul style="list-style-type: none"> Need for qualified Slovak representatives to a limited number of ESA committees. Involvement of Slovakia in supply chains for strategic European projects and infrastructures (Galileo, Copernicus, SSA). Catching up of trends in Central Europe. 	<ul style="list-style-type: none"> Geo-return of Slovak contribution is not guaranteed, whether in the field of mandatory or optional ESA programs. this requires a degree of preparedness/readiness and competitiveness of the Slovak space industry.

3) Variant "Member State"

Strengths	Weaknesses
<ul style="list-style-type: none"> Access to mandatory and optional ESA programs. Full access to ESA information and programs. 	<ul style="list-style-type: none"> New processes for responsible ministry Higher financial demand.
Opportunities	Threats
<ul style="list-style-type: none"> Involvement of Slovakia in supply chains for strategic European projects and infrastructure (Galileo, Copernicus, SSA) Catching up of trends in Central Europe. 	<ul style="list-style-type: none"> Lack of qualified representatives for Slovakia to the many ESA committees (1 officer of MŠVVŠ SR is currently responsible for the space agenda). Problematic geo-return of the Slovak contribution.

¹³ In the scope of this chapter we consider the Central European region the following states: Austria, Czech Republic, Poland and Hungary. These countries, (except of Slovakia) are already full members of the ESA.

We also present an overview of current activities of the European Space Agency with opportunities for Slovakia:

Activity	Main Activity	Current Subjects	Opportunities for Slovakia
SCI (Science)	8 ongoing and 9 missions in preparation	A limited number of prime contractors; more demanding for the involvement of smaller countries; Overpricing and delays of the ExoMars mission	Development of scientific instruments, processing of scientific data
HRE (Human spaceflight and robotic exploration)	Operation of ISS station, solar system exploration, 2 prepared robotic missions	Determining roles for Europe after the end of ISS operations	Limited: biology, physiology
TEC (Technical and quality management)	Own R&D activities, development and maintenance of testing facilities, support of spin-offs	Harmonization of R&D activities across Europe, continuation of the mission e-deorbit and the AIM mission, implementation of Newspace	Many opportunities including PECS
OPS (Operations)	Mission operations control, Missions analysis, SSA	Development of operational model, space debris, implementation of SSA	Software for the ground segment, SSA projects
NAV (Galileo etc.) – satellite navigation	Development of Galileo flotilla, future of Galileo and EGNOS	Implementation of the Galileo system, relations with EU, consequences of Brexit	Many opportunities, including H2020/GSA calls
TIA (Telecommunications & Integrated applications)	New programs development Support (SmallGEO, EDRS, Electra, ARTES 3-4), development of innovative applications for end users	Importance of new applications, development of new PPP projects (Pioneer, GovSatCom, ...), new ARTES programs	Many opportunities including PECS or IAP
LAU (Launchers)	Development and qualification of European launchers, including the ground segment	Commercialization costs, new models of development, international competition	Very limited
EOP (Earth observation programs)	Earth Sciences and meteorology; global monitoring through Copernicus	Continuity of services, data distribution , limited resources for new missions for monitoring climatic parameters, consequences of Brexit	Many opportunities, including national distribution points

3.2 FINANCING THE COOPERATION OF THE SLOVAK REPUBLIC WITH THE ESA

The forms of future cooperation of Slovakia with the ESA can be divided, in terms of financial costs, into the following three basic types:

- A) **participation in the PECS program**, in which the given state is contractually committed to pay a fixed amount of 1 million euros annually (based on economic conditions from 2001) for a period of five years. After accounting for international inflation, Slovakia for the period 2016 – 2020 committed to pay to the ESA approximately 7.5 million euros. This amount will be subtracted from certain expenses/administrative costs of the ESA used for financing Slovak PECS projects.
- B) **full membership** of the Slovak Republic in the ESA, the financial contribution of the country is made up of two parts:
 - 1) **obligatory contribution** – to fund mandatory activities (especially scientific, educational and mobility programs, as well as agency running costs. The level of this contribution is derived from a country's GDP; for Slovakia the amount is expected to be **about 3 million euros annually**.
 - 2) **voluntary contribution** – all other specialized programs that cover other ESA activities, such as design, development and construction of satellites and launchers, launching of satellites into orbit and monitoring them, etc. Given the large number of these programs, each country selects independently the programs to take part in, as well as the amount of the contribution to the given program. On the basis of roughly 5-year cycles, the ESA then assesses the so-called "Geographic return coefficient" (the "Geo-return"), which is the ratio of funds invested from a given country to those obtained in supply tenders and projects. The aim of the ESA is to maintain this coefficient for each country at about 1 over the long term period, thus, to balance the investment and contract ratio for the given country. Any development of the Slovak space industry, and thus also the long-term return on Slovak investment, rests specifically in the appropriate selection of optional programs. Of special interest in this regard are, for example, strategic programs, such as Copernicus, Galileo and SSA, or the ARTES telecommunications programs and others. For the primary needs of the Slovak Republic, the amount of the optional contribution can be expected to be **approximately up to 5 million euros annually**.

The obligatory and voluntary contributions together make up **the total contribution of the Slovak Republic to the ESA budget in the full-membership phase**, and its value can be estimated at **about 8 million euros per year**. For a comparison, neighbouring countries are financing much larger amounts – see also "Annex 2 - More detailed information on the European Space Agency", the section "Annex 3 – Overview of financing of ESA programs by neighbouring states".

- C) A certain intermediate stage is so called **associate membership**, when a country is obligated to pay part of the obligatory contribution for the ESA's core activities and, moreover, has the opportunity to apply for optional programs, if approved by the Member States. It can be assumed that the cost of associate membership is **about 3 million euros annually**, depending on the number of optional programs.

We recommend considering the option of financing the contribution to the ESA (or part of it) through the European structural funds.

3.2.1 FINANCING SPACE ACTIVITIES IN THE SLOVAK REPUBLIC

SLOVAK PROJECTS IN THE ESA PECS PROGRAM:

The Slovak Republic is cooperating with the ESA until 2020 in the form of participation in the PECS program.

In the second phase of its five-year cooperation with ESA, Slovakia is involved in the Plan for European Cooperating States in the form of PECS projects. Slovakia has participated (data from 2018) in three PECS calls, with a total number of 22 successful projects funded from the budget of the Ministry of Education, Science, Research and Sport of the Slovak Republic in the total amount of 4.05 million euros. From December 2018 to February 2019, the fourth call was launched for the submitting of PECS projects.

Slovak participation in PECS projects

2016	2017	2018	TOTAL
1.34 mil. euros	1.35 mil. euros	1.36 mil. euros	4.05 il. euros

We offer a brief analysis of the successful projects from 4 PESC calls:

A) by type of organisation:

While in the first call only 1 of 7 successful projects was from the business sector, in the second and third calls there were up to 6 successful projects from the business sector out of a total of 15 successful projects. After the assessment of 4 PECS calls in 2019, 12 of the total 29 projects were from the business sector. From this, we anticipate development towards industry, which is the goal of Slovak cooperation with ESA.

B) by type of activity:

Out of 29 projects from the four PECS calls, 17 were mainly focused on R&D activities, i.e. technological demonstrations, industrial processes and their qualifications, which lead to products such as hardware or software. From this, further development towards satellite data (navigation, Earth observation) and space surveillance and tracking – space debris mitigation – can be anticipated.

The amount and sources of funding after 2020 will depend especially on the form that cooperation with ESA takes. The individual options were analysed in Chapter “3.1 Analysis of potential future cooperation of the Slovak Republic with the ESA”. However, given the highly **cross-cutting nature** of space activities and particularly the growing dominance of the business sector in this field, it’s indispensable to guarantee either **multi-source financing** (i.e. from the budgets of other ministries involved) or financing **directly from the budget of the Ministry of Finance of the Slovak Republic**.

Additional sources of financing may be, for some selected ESA programs, the **private investments** of involved business stakeholders, as some ESA programs (e.g. ARTES) are conceived as so-called “PPP programs”, where industry invests the same amount as the ESA.

Any financing of cooperation between Slovakia and the ESA must be sustainable (in the framework of cooperation till 2020, this cooperation is based on an international preferential presidential agreement between Slovakia and the ESA).

SLOVAK PROJECTS WITHIN H2020 (EU):

Slovak participation in EU projects:

Call	Title	Participant	Contribution in euros
H2020 Galileo 2014	CaBiAvi	Žilina University in Žilina/VÚD,a.s.	197,846 90,435
H2020 EO 2016	E2MC	KAJO, s.r.o.	77,300
H2020 INFRADEV 2016-2017	PRE-EST	Astronomic Institute SAS	18,750
H2020 COMPET 2014	COSMOS	SCSTI SR (CVTI SR)	37,500
TOTAL			421,831

To date, a total of 1798 project proposals have applied for funding from Horizon 2020 (hereinafter “H2020”), and 281 of them have been successful. There were 32 proposals with Slovak participation, which means below average success of 9% in the scope of H2020. The Slovak element is thus represented in 1.78% of project proposals and only in 1.06% of supported projects.

The poor success of Slovakia under the H2020 program is a cyclical problem, because it can discourage potential participants. The absence of successful examples makes it nearly impossible to transfer know-how within Slovakia. Therefore, it's necessary to support the involvement of Slovak teams in consortia, which may lead to the project proposal submission in the H2020 program.

During the ongoing seven-year period, 2014-2020, the European Commission counts on the distribution of 1.479 billion euros in the subject area of Space. Together with information and communication technologies, nanotechnologies, modern materials, biotechnologies, and modern manufacturing and processing, it is ranked into the second pillar of the H2020, titled Industrial Leadership.

The H2020 space budget for the following 3 years (2019-2021) will be nearly 616 million euros. The allocated sum will always be increased year-on-year. While in 2014 the EC planned to support projects worth not quite 168 million euros, by 2020 this will be more than 228 million euros. This trend will not change even in the context of the United Kingdom's expected withdraw from the European Union and should also be transferred to the 9th Framework Program (Horizon Europe) after 2020.

A major part of the work program is development of applications for systems that will be deployed in space by the ESA. Emphasis here is placed on making these services available to EU citizens. From a practical point of view, this means a financially undemanding effort at breakthrough research and massive digitization, which also represents an opportunity for Slovak IT companies without experience in the SPACE sector.

Space activities may also be financed from other chapters of the H2020 program. One of them is the competition within the so-called European Innovation Council (EIC) prize for “Low Cost Space Launch”. Up to 10 million euros will be awarded, and the solution needs to be submitted by the end of 2020. A more traditional additional source of Horizon 2020 funding is the support of small and medium-sized enterprises (SME), the so-called “SME Instrument”.

4. DEVELOPMENT OF SLOVAK SPACE ACTIVITIES IN THE CONTEXT OF RIS3

A document “Through Knowledge towards Prosperity – Research and Innovation Strategy for Smart Specialization of the Slovak Republic” (hereinafter referred to as “RIS3”) was adopted by the Slovak Government as a Government Resolution No. 665 from 13 November 2013. This document identifies strategic and partial objectives as well as dozens of measures to achieve them. An analysis of the potential of cooperation between Slovakia and the ESA showed that their closer cooperation will directly fulfil several RIS3 measures, thus contribute to the achievement of the RIS3 Vision, all its strategic objectives and some partial objectives. These were defined as follows:

RIS3 Vision:

“To drive a structural change in the Slovak economy towards growth based on increasing innovation capability and R&D excellence to promote self-sustaining growth in incomes, employment and standard of living.”

Strategic objectives of RIS3:

1. *Deepening integration and embeddedness of key major industries increasing local value added through the cooperation of the local supply chains and turning local supply chains into embedded clusters.*
2. *Increased contribution of research to the economic growth via global excellence and local relevance.*
3. *Creating a dynamic, open and inclusive innovative society as one of the preconditions for the increase in the standard of living.*
4. *Improving the quality of human resources for an innovative Slovakia.*

Partial objectives of RIS3, fulfilment of which the cooperation of Slovakia with the ESA may contribute to:

- *To raise the number of companies moving to a higher level of the supply chain of multinational companies.*
- *To support the creation of international teams.*
- *To support the building of research and innovation capacities in Slovak enterprises.*
- *To create for businesses, especially SMEs, the conditions needed to increase their innovation performance.*
- *To increase the employability of secondary school and university graduates.*
- *To improve the interconnection of the education system with practice.*

Slovak cooperation with the ESA within the PECS period will also be in line with the established research, development and technological priorities of RIS3. Given the broad range of individual ESA programs, Slovakia will focus its research and development priorities particularly on:

- **Materials research and nanotechnology**, where in cooperation with the ESA, Slovakia can focus on research on special materials, lightweight construction materials and composites.
- **Information and communication technologies**, where it will be possible to focus on information and communication systems, including systems for controlling technological process, as well as services of “Data mining” and big data processing.
- and to a large scale in the field of **Biomedicine and biotechnology**, where it will be possible to focus on heart diseases, the vascular system and brain, endocrine and metabolic disorders, infectious diseases and allergies, as this research is being executed in the ESA under a human spaceflight program.

In the case of the technological priorities of Slovakia, it will be possible to focus Slovak cooperation with ESA on:

- **progressive industrial technologies**, specifically automation, controlling, robotics, as well as technologies for shaping, machining and joining of new metallic and non-metallic materials and composites, which are to be used, e.g. in the construction of flight and ground components, especially, for example, for materials and structures of launchers, cryogenic engines, IXV-re-entry (return) systems and the like.
- **efficient use of energy sources**, with respect to the development of new and more efficient photovoltaic cells for satellites and spacecraft.
- **Progressive technologies for agriculture and the environment**, focusing especially on the use of land and monitoring the state of forests and forest fires, since precision agriculture and forestry are a path to more efficient and competitive agriculture, which cannot be achieved without support for scientific research and methods and means of remote sensing of the Earth (hereinafter referred to as “remote sensing”).

Slovak cooperation with the ESA lays the foundations and creates an excellent environment for the implementation of the common priority “**Employment for Young People in Changing Conditions**”, as the ESA has a developed educational program that supports the direct involvement of university graduates in practice.

5. SLOVAK SPACE ACTIVITIES AND THEIR FUTURE DEVELOPMENT

The space activities of the Slovak Republic have a highly cross-sectoral character and fall under the competences of several ministries.

1. Ministry of Economy of the Slovak Republic

The Ministry of Economy of the Slovak Republic, as the authority responsible for industry, the support of small and medium-sized enterprises, a strategy of creation and support of the business environment, internal trade, foreign trade and innovation, is aware of the need to adopt a comprehensive strategy that defines the priorities of Slovakia as well as a method for meeting them. It is important to focus on support for the competitiveness of the Slovak economy in the space industry. According to the Space Strategy for Europe, the European space industry employs more than 230,000 people. In 2014, it had an estimated worth of 46-54 billion euros. It can therefore be said that it is of great importance for the economy of both the European Union and the Slovak Republic. The trend is towards increasingly intensive involvement of the private sector. Slovakia can build on its strong industrial tradition and dynamic technological developments, particularly in the spheres of automation, artificial intelligence, micro- and optoelectronics, sensing technology and many others. Businesses in Slovakia have great potential for working in the space industry, joining networks of supply companies and providing solutions in the fields of navigation, satellite communications, space systems and other areas. One of the main objectives of a common Space Strategy for the Slovak Republic should therefore be the creation of a suitable environment for the involvement of Slovak industry, including small and medium-sized enterprises in the European or global space industry. At the same time, Slovakia should continue to be actively engaged in the creation of the European Space Policy itself and in the preparation and implementation of EU strategic projects in this area in order to defend the interests of industrial sectors in Slovakia. This also relates to cooperation on the European level, whether on the level of state authorities, interest associations or businesses. Already at this stage of Slovakia's ESA membership, however, it's necessary to improve the conditions for the involvement of Slovak businesses in the ESA supply chain and its tenders.

The Slovak Investment and Trade Development Agency ("SARIO"), as an institution operating under the auspices of the Ministry of Economy of the Slovak Republic, actively seeks high-tech investment projects and helps in their implementation, while supporting the internationalization of Slovak high-tech firms. In regard to the process of sectoral diversification and qualitative growth of the Slovak economy as well as to the great potential of the Slovak engineering and automotive industry, the space sector is one of the potential areas. In this context, SARIO is systematically working on two key activities:

- Increasing the attractiveness and readiness of the Slovak investment environment for the space sector by identifying its strengths and weaknesses from the investor's point of view and by building a network of sectorally relevant Slovak companies with the potential to be involved in supply chains.
- Direct support for the involvement of Slovak companies working in the aerospace industry in international supply chains through so-called *sourcing* projects. At the same time, in 2017 a pilot project of SARIO innovation services was launched, the aim of which is to stimulate the growth of intelligent industry, which cooperates with several Slovak companies working to expand, in terms of capacity and technology, their scope to the space industry.

SARIO is also currently preparing an integrated publication on the Slovak aerospace industry, which will be freely available in English and will serve as a primary source of information on the sector for potential investors and partners of Slovak companies.

2. Ministry of Defence of the Slovak Republic

From the viewpoint of civilian, commercial, security and defence policy objectives, space capabilities are strategically important. The Ministry of Defence of the Slovak Republic is currently participating in selected activities associated with the use of outer space. Services for determining positioning via Galileo projects are fully exploited, and the strategic potential of these systems as well as their civilian character are emphasized. Within the EU, Slovakia participates in financing of the EU Satellite Centre. To a certain extent, the NATO - Alliance Ground Surveillance (AGS) project, which the Ministry of Defence has been involved with for a long time, is related to the use of outer space. In the area of the use of outer space, the Ministry of Defence of the Slovak Republic will in the medium and long term promote:

- the monitoring and surveillance of territory to maintain security and stability in the Slovak Republic, as well as NATO and EU Member States;
- the monitoring and surveillance of territory, or the Earth's surface for the prevention and resolving of local and regional conflicts and mitigating their consequences, suppressing threats that affect the security of the Slovak Republic.

3. Ministry of Foreign and European Affairs of the Slovak Republic

As part of its space policy, the Ministry of Foreign and European Affairs of the Slovak Republic focuses especially on the foreign policy and security aspects of the use of outer space, space law and promoting international cooperation in science, innovation and industry. In January 2017, an informal working group, called Task Force Space, for which the state secretary Lukáš Parížek was responsible, was set up at the Ministry of Foreign and European Affairs of the Slovak Republic for the purpose of intra-ministerial coordination of the space agenda.

The basic foreign policy framework for Slovak space policy is represented by UN treaties on outer space, the Space Strategy for Europe and the Joint EU-ESA Declaration of 26 October 2016, as well as the EU Global Strategy for Foreign and Security Policy. While the Copernicus and Galileo satellite programs are, in principle, civilian programs, their services can also be used for security purposes; a specific example from the recent past is the use of satellite imagery to monitor unregulated human migration and control the external borders of the Schengen Area. The EU SATCEN satellite centre supports the activities of the EEAS in a variety of areas, including disaster relief, humanitarian aid, and domestic and international crisis management. The program of space surveillance and tracking – SST – represents a special added value for EU security.

In recent years, EU space policy has placed increased emphasis specifically on the foreign policy and security aspects of space. This is also evidenced by the creation of the EEAS Special Envoy for Space in 2015. Several recent documents, including the EU Global Strategy for Foreign and Security Policy of the European Union (EUGS), the Joint Framework on Countering Hybrid Threats as a joint communication of EEAS and COM and the European Parliament Resolution on space capabilities for European security and defence emphasize the importance of space for guaranteeing EU security.

The strategic aims of the ministry are the following:

- to provide a platform for the adoption of the Act on Space Activities of the Slovak Republic and the establishment of a regulatory authority to perform supervision over the implementation of space activities in the Slovak Republic;
- to promote systematic inter-ministerial coordination and communication, especially with those ministries that are responsible for individual areas of space policy of the Slovak Republic;
- to support a unified presentation of Slovakia's positions in the field of space policy at international forums, including the EU, ESA and UN;

- to actively participate in meetings of selected EU committees dealing with the space policy agenda (e.g. CODUN SPACE), at meetings of relevant UN committees, including the UN Committee on the Peaceful Uses of Outer Space (UN COPUOS) and meetings of the International Relations Committee (IRC) within the European Space Agency (ESA);
- to participate in the creation of European space policy, especially in foreign policy and security issues (especially in cooperation with the Ministry of Education, Science, Research and Sport of the Slovak Republic, the Ministry of Defence of the Slovak Republic, the Ministry of Interior of the Slovak Republic and the Ministry of Transport and Construction of the Slovak Republic)
- and others.

4. Ministry of Transport and Construction of the Slovak Republic

The Ministry of Transport and Construction of the Slovak Republic is entrusted on the basis of resolution of the Government of the Slovak Republic No. 579 of 16 June 2004, in cooperation with other ministries, the National Security Authority and the Regulatory Authority for Electronic Communications and Postal Services, to ensure the implementation of the "Agreement on the Support, Provision and Use of Galileo and GPS Satellite Navigation Systems and Related Applications". A component of ensuring the implementation of this agreement also includes the preparation and building of the technical and administrative structures needed to secure the activities of the European satellite navigation system Galileo and the passing of the necessary legislation.

The services of the Galileo system are of particular importance, namely the basic open service for general use and the public regulated service, which is intended for important users selected by the state, mainly the security services. These services are also a source of accurate time signals used for synchronization, control and operation of networks. The use of a public regulated service is also significant from the viewpoint of protecting critical infrastructure.

Pursuant to Act No. 351/2011 Coll. on Electronic Communications, as amended, the Ministry of Transport and Construction of the Slovak Republic, in cooperation with the National Security Authority and the Regulatory Authority for Electronic Communications and Postal Services, fulfils the function of the Office for Public Regulated Service which is provided by the GNSS established under the Galileo program.

The priorities of Ministry of Transport and Construction of the Slovak Republic in the field of global navigation satellite systems are:

- promotion of European GNSS programs and support for the potential participation of Slovak subjects in these programs in the interest of stimulating industry as well as the user segment for the development and production of systems, equipment and applications utilizing the services of the Galileo and EGNOS systems,
- ensuring the administrative conditions for the use of the public regulated service of the Galileo system in state institutions, security and rescue services, and in ensuring critical state infrastructure.

Development of use of satellite navigation represents a huge benefit for the economy. Such socio-economic benefits can be divided into three main categories: direct benefits from the growth of the space market, direct benefits from the consumer market for GNSS-based applications and services, and indirect benefits from the penetration of new applications into other industries or from transfer technologies to other sectors. Thus, new market opportunities in other sectors are created and industrial productivity is increased.

5. Ministry of Environment of the Slovak Republic

The Ministry of Environment of the Slovak Republic is responsible for the Copernicus Program agenda at the national level. In order to coordinate the agenda of the program, the Ministry has established a National Working Group for Copernicus.

Although the Copernicus program entered into full operation in 2014 and provides data and services on the status of the environment free of charge, it is relatively unknown in Slovakia and its data is underused. Therefore, it is necessary to significantly raise the awareness of both the lay and professional public about this program and its services.

For this purpose the Ministry of Environment of the Slovak Republic takes the following steps:

- 1.) Creation of Copernicus Information Web page on the Ministry of Environment web sites. The page will contain basic information about the Copernicus program, information and links to Copernicus services as well as current information relating to the Copernicus program in Slovakia and the EU.
- 2.) Creation of a mailing list of users to distribute information and know-how related to the Copernicus program, projects and its data and services. Following organizations would be addressed in order to create a members base for this group: MŠVVŠ SR, MV SR, MPRV SR, MDV SR, Commission for Space Activities in the Slovak Republic and the member organisations of the Copernicus Academy. A contact form will then be subsequently published on the Copernicus website, with the option of subscribing to the public email group.
- 3.) Creation of a page with information about Copernicus program activities in Slovakia on Facebook and publishing information about the Copernicus program for the general public in a popular form. Linking to existing Copernicus program pages for easy redistribution of previously published information.
- 4.) A proposal to report on two popular science books: "Slovakia Through the Eyes of Satellites" (2010) and "Changing Slovakia Through the Eyes of Satellites" (2012), published by Veda (Science). These publications describe the acquisition of various characteristics of Slovakia through satellite remote sensing approaches.

For improving access to the satellite data of the Copernicus program, the Ministry of Environment of the Slovak Republic will establish a national node "Copernicus collaborative ground segment" on the Government Cloud infrastructure, through which users, after free registration, will be able to download satellite images from the program. This node will be a national distribution node and will act as a "Mirror" site for data published on the ESA Scientific data HUB for the Slovak Republic.

6. Ministry of Agriculture and Rural Development of the Slovak Republic

Space exploration and exploitation are leaders in development of sophisticated technologies in various sectors, including agriculture. This agenda is under the auspices of the Ministry of Agriculture and Rural Development of the Slovak Republic. Information and communication systems and satellite sensing technologies have the greatest importance for agriculture. The organisations of the Ministry of Agriculture have more than 30 years of experience with their use, and this forms the basis for further development of applications based on space technologies.

The use of space technologies or information technologies in the field of agriculture has become an integral part of the control system of subsidy measures related to the EU “Common Agricultural Policy”. Eligibility check for subsidies in agriculture is one of the basic elements of the Integrated Administration and Control System (IACS) in the agricultural sector, which began its operation in Slovakia in 2004. One of the main means of control in this system is through the use of remote sensing data (DZP), which is at present on the qualitative side analogous to the approach used in other EU countries. The National Agricultural and Food Centre – Soil Science and Conservation Research Institute (hereinafter referred to as “NPPC - VÚPOP”), as a user, has available remote sensing data in the form of images and uses image processing for visualizing or controlling of selected subsidy incentives, especially verification of declared areas of agricultural parcels and land use as well as cultivation practices on agricultural land.

Remote sensing data represent at the NPPC - VÚPOP an extensive source of information contributing to the objective evaluation of selected parameters of soil surface layer. At present they are used to detect and assess the local occurrence of some soil degradation processes (particularly soil erosion) and the landscape (e.g. the occurrence of floods and other catastrophic situations).

Estimates of crop yield, biomass production and the temperature and moisture of the Earth’s surface based on analysis of remote sensing data and modelling of biophysical parameters have become standard in the agricultural sector. With gradual development of better spatial images with the use of other informational layers, it will be possible to derive other associated phenomena, not only the weather but also the climatic conditions usable for agriculture management.

In forestry, it is beneficial for the ministry to monitor and support the effective implementation of the results from those EU and ESA programs that are directly associated with the responsible organisation (ČMS Lesy – the National Forest Centre Zvolen) which provides an overview of spatial and temporal changes in the state of the forest in relation to anthropogenic and natural stress factors. The aim is to integrate satellite technologies into the monitoring of forests and to use them in STALES applications: www.nlcsk.sk/stales and SATLESYS: www.nlcsk.sk/satlesys that are focused on assessing forest damage and continuously measuring production characteristic wood biomass (NPP and GPP) on forest land. Research activities will further focus on:

- Mapping and Assessment of Ecosystems and their Services (MAES) and assessing the status of agricultural biotopes and forest habitats. The intention is to integrate the existing spectrum of data with terrestrial surveys using remote sensing data and to propose new methods and procedures of MAES.
- The balance of greenhouse gases (GHG) in the agriculture and forestry sector: Land Use, Land-use Change and Forestry (LULUCF) . The intention is to use remote sensing data to satisfy GHG balances.
- Quantification of changes in land cover within CORINE and Copernicus Land Monitoring Services. The intention is to participate in both European projects, particularly in the validation of their outputs.
- the FLEGT/EUTR Directive – aims to design new methods and procedures for the identification and quantification of wood biomass in forested and non-forested land with the use of radar data (Sentinel 2).

The NPPC - VÚPOP develops and conducts similar research activities focused on the use of satellite technologies for agricultural soil and agricultural land. These concern the balance of greenhouse gases, the Mapping and Assessment of Ecosystems and their Services (MAES) and the assessing of agricultural biotope status and quantification of land cover changes within the CORINE and Copernicus Land Monitoring Services – the verification of permanent grassland.

7. Ministry of Interior of the Slovak Republic

The security services and rescue system:

In the field of use of space services, the Ministry of Interior of the Slovak Republic is aware of importance of use of the Public Regulated Service (PRS) of the Galileo/EGNOS satellite navigation system that due to increased robustness and encryption provide a continuity of services not only in emergency but also in crisis situations. Critical communication of authorized users of ministry is required, especially between the components of civil protection, an integrated rescue system and the Slovak police force.

Critical communication is essential for efficient maintaining of public order and civil protection. Reliable governmental satellite service (GovSatCom) can be identified in the mid-term as an alternative solution of critical communications to the current terrestrial communication networks operated by the Ministry of Interior of the Slovak Republic.

Availability of use of the GovSatCom satellite services is an advantage, especially during the crises and disasters, when the terrestrial communication infrastructure is damaged, unavailable or unreliable. The geographical and spatial independence of use of GovSatCom enables cooperation of the intervening forces in difficult terrains and independently of national borders.

Civil Protection and Crisis Management:

The Ministry of Interior of the Slovak Republic is the central body of state administration for civil protection and integrated rescue system and besides is responsible for the execution of tasks related to state management in crisis situations during peace and in a state of war, or in the area of critical infrastructure protection and humanitarian aid. These tasks are performed by the crisis management division.

The Crisis Management Division is a member of the National Copernicus Working Group and is the competent national authority within the EU Civil Protection Mechanism. It is currently also an authorized user of Copernicus Crisis Management services. In the Rapid mapping regime at times of emergencies or crisis situations, Slovakia may request through Copernicus satellite imagery and obtain satellite data within hours to days of sending a request to the Emergency Response Coordination Centre (ERCC) of the Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO).

The service of the Copernicus Crisis Management program provides early warning and monitoring of floods, fires and droughts, and also includes prevention. The crisis management division may, via support mode, request satellite imagery to update territorial information, assess threats, prepare and plan for unpredictable events (pre-event situational maps), or to obtain information to recover and evaluate impacts and changes in an area's vulnerability.

The Ministry of Interior of the Slovak Republic cooperates with the Ministry of Transport and Construction of the Slovak Republic in the area of public regulated services within the Galileo program (GNSS) for positioning and time.

The Ministry of Interior of the Slovak Republic will use SST services from the SSA program in the scope of the EU Civil Protection Mechanism. Information on the uncontrolled entry of space objects and their estimated time and location are needed for early warning and other civil protection measures.

Cooperation, communication and coordination of civil and crisis management actors at national and European level are important for ensuring protection of the population, as is support for systems that provide timely and accurate information to help in decision-making throughout a crisis management cycle from prevention, preparedness, response and recovery. Environmental monitoring by a combination of terrestrial and satellite observation offers the opportunity to detect threats early and to warn the population. Rapid satellite mapping

and accurate location-based satellite services help to effectively manage a crisis situation and to deploy the most appropriate measures to mitigate the consequences.

8. Ministry of Culture of the Slovak Republic

The Ministry of Culture of the Slovak Republic, through the Act on Cultural and Educational Activities (189/2015 Coll.), manages regional observatories and planetariums, which are dedicated to educational activities in the field of space activities.

9. Ministry of Health of the Slovak Republic

The Ministry of Health of the Slovak Republic is the authority responsible for health care and health protection of the population in the Slovak Republic. In terms of space exploration and use, it is important to focus on research on the effects of cosmic rays on the health of people who are sent into space. Cosmic radiation and its impact on spacecraft crew members is currently not investigated sufficiently. The subject of research will be the monitoring of radiation load and its influence on markers of exposure, its effect and individual sensitivity in a professionally exposed group of people on board of spacecraft. The level of exposure in spacecraft and in open space depends on solar activity, geomagnetic position, altitude and the duration of flight and time spent in space. A part of the research will be an assessment of the effects of cosmic radiation on markers, determining the impact of doses received on markers of genetic stability, DNA repair and immune markers, and finding out whether antioxidant defences can modify the effect of exposure on markers of genetic stability markers and immunity. The results of the research will provide the footing for optimizing radiation exposure and for making recommendations to reduce the health risks for those sent into space.

10. Ministry of Education, Science, Research and Sport of the Slovak Republic

The Ministry of Education, Science, Research and Sport of the Slovak Republic (hereinafter referred to as the “MŠVVaŠ SR”) is, under Act No. 172/2005 Coll. on the Organisation of State Support for Research and Development, the central state authority of the Slovak Republic for science and technology.

The Ministry, as the authority responsible for the organisation of state support for research and development, ensures the participation of representatives of the Slovak Republic in international research and development organisations and ensures the fulfilment of tasks in the fields of science and technology, which follow from the international obligations of Slovakia and its membership in international organisations.

On the basis of an agreement between the European Space Agency (ESA) on cooperation in space research and the use of space for peaceful purposes, the MŠVVaŠ SR was entrusted with implementation of the agreement and coordination of activities and cooperation with the ESA.

Responsibility for the coordination of Slovakia’s space activities in the fields of science, research, education and popularization rests in the science and technology division of the MŠVVaŠ SR. This division ensures coordination of activities of the central state administration authorities and the Slovak Academy of Sciences in the area of science and technology, including space policy. The Department of Strategies and European Affairs in Science and Technology within the division coordinates Slovak space policy in the field of science and technology in relation to the EU and the ESA. The MŠVVaŠ SR takes part in international cooperation on space policies at the following levels:

A) European Union

- Political participation of representatives of the MŠVVaŠ SR in Working Party of the Council of the EU for Competitiveness(Research and Space).
- Participation of experts from the MŠVVaŠ SR in expert groups of the European Commission (EC).

B) European Space Agency (ESA)

- The political participation of MŠVVaŠ SR representatives in the Council of the ESA and IRC-PECS committees.
- The participation of MŠVVaŠ SR experts in selected program committees (PB-EO, PB-NAV).

C) United Nations Organisation – COPUOS (UN Committee for the Peaceful Uses of Outer Space)

- The participation of MŠVVaŠ SR experts in Legal subcommittee and Scientific and Technical subcommittee of the COPUOS.

The MŠVVaŠ SR is co-responsible for the development of space activities in Slovakia, including the cooperation of Slovakia with the ESA. An inter-ministerial Commission for Space Activities in Slovakia was established for this purpose.

6. GOALS AND POSSIBLE MEASURABLE INDICATORS OF SPACE ACTIVITIES DEVELOPMENT IN THE SLOVAK REPUBLIC

Primary goal:

To achieve such knowledge, research and production level of Slovak companies to be competitive in the space sector.

Secondary goals:

- ✓ To increase research and innovation capabilities of R&D organisations in Slovakia.
- ✓ To ensure the efficient use of contributions from the state budget allocated for Slovak cooperation with the ESA.
- ✓ To enable Slovak organisations to obtain know-how applicable in commercial space industries (e.g. telecommunications, navigation, etc.) as well as in other sectors in the form of innovative goods and services through participation in research and development space programs
- ✓ To increase the participation of Slovak organisations in supply chains and international consortia and networks.
- ✓ To include space activities in school educational programs and general awareness-raising activities in order to stimulate interest in space activities.
- ✓ To support programs that will strengthen the security of Slovakia - GovSatCom, Galileo (PRS).
- ✓ To actively participate in the shaping of the European space policy and to have a unified approach and positions of the Slovak Republic at international forums.

Proposed measurable indicators:

- ✓ Total number of PECS projects submitted and implemented within PECS calls at a level comparable with other PECS countries.
- ✓ Total number of EU projects submitted and implemented at a level comparable to the EU Member States.
- ✓ Total amount of financial contributions within the PECS projects.
- ✓ Total amount of financial contributions within the EU framework programme (space) projects.
- ✓ Number of support activities focused on space research (activities/participants).
- ✓ Number of jobs created and maintained in R&D organisations.
- ✓ Return on investment, which can be divided into:
 - **Direct** – that is the ratio of expenditure to funding the cooperation with the ESA –the individual sums for supporting Slovak PECS projects.
 - **Indirect** - increase in turnover or profit from companies involved in ESA cooperation from activities associated with space technologies
(<https://ufm.dk/en/publications/2008/evaluation-of-danish-industrial-activities-in-the-european-space-agency-esa>)
- ✓ The number of visitors at events for the public or the number of students involved in school science activities related to space activities.

List of annexes:

Annex 1 – Overview of human activities in SPACE and their contributions for quality of life

Annex 2 – More detailed information on the European Space Agency

Annex 3 – Overview of financing of ESA programs by neighbouring states

Annex 4 – List of optional ESA programs

Annex 5 – Glossary of definitions and abbreviations

ANNEX 1 – AN OVERVIEW OF HUMAN ACTIVITIES IN SPACE AND THEIR CONTRIBUTIONS FOR QUALITY OF LIFE

The exploration and use of space continues to bring new knowledge, the transfer of which to everyday life is continuously improving the quality of life for people on Earth. This knowledge can be divided into the following categories:

- A) **Earth Observation Program**, (in particular the Copernicus Program in Europe): Observation of the planet and individual countries from orbit enables the monitoring of environmental quality, forest health, the state of watercourses and oceans. It is used in monitoring development and planning of urbanization, as well as in predicting crop yields; it is an integral part of weather forecasting and also contributes to the physical security of citizens (migration crisis, natural disasters, and the like). The monitoring of the Earth's surroundings, including its orbit, i.e. especially the monitoring of space debris and near-Earth asteroids that may, for example, endanger existing satellite networks could be put in this category.
- B) **Satellite Navigation program** (known as GPS, in Europe the Galileo program in particular). The function of navigation satellite systems is essentially two-fold:
 - distribution of ultra-accurate time (synchronization of energetic, financial and other transactions),
 - positioning, navigation services for air, sea and land transport, as well as every day and leisure purposes (today a part of every smartphone).
- C) **Telecommunication services** – mediation of signals for telephones, TV, the Internet,...
- D) **Human health research** – studies of long-term stays of people in a state of weightlessness, especially musculoskeletal, dietary and others, have a significant impact on routine medicine for humans.
- E) **Solar System Exploration** – in addition to fundamental scientific research of celestial bodies (such as the Moon, other planets of our Solar System), this activity also has potential future economic impacts (e.g. in the form of asteroid-mining, etc.).
- F) **Scientific knowledge** – scientific research is one of the basic manifestations of human civilization. Space is primarily a place for the development of physics (astronomy, astrophysics, cosmology, material engineering,...), but also biology, chemistry and other scientific disciplines.

ANNEX 2 – MORE DETAILED INFORMATION ON THE EUROPEAN SPACE AGENCY

The European Space Agency (ESA) is an intergovernmental organisation established in 1975 for the purpose of space exploration and the development of space technologies for peaceful purposes. Alongside NASA in the USA, or ROSKOSMOS in Russia, it is one of the most important space agencies in the world.

Among ESA's main activities are:

1. Scientific research activities in the field of fundamental physics, astronomy and astrophysics, solar system research, etc.
2. Educational activities through a rich program focused on grammar school and university students.
3. Technological developments in the fields of telecommunications, satellite navigation, remote sensing of the Earth, launchers, manned spaceflight, engineering and operational activities and others.

The ESA was **established in 1975** by signing an intergovernmental "Convention for the establishment of a European Space Agency". ESA's **headquarters is in Paris** and has several establishments and facilities: in Spain (The European Space Astronomy Centre - ESAC), in the Netherlands (The European Space Research and Technology Centre - ESTEC), in Italy (ESA's centre for Earth observation - ESRIN) and in Germany (The European Space Operations Centre - ESOC and The European Astronaut Centre - EAC). The ESA has its Cosmodrome - Guiana Space Centre in French Guiana in South America in Kourou.

In 2018, the ESA was made up of **22 Member States** (Belgium, Czech Republic, Denmark, Estonia, Finland, France, Hungary, Germany, Austria, Greece, Ireland, Luxembourg, Italy, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland and the United Kingdom), which make up their ESA budget of **nearly 6 billion EUR per year**. Other European countries are at different stages of preparation for membership. Canada and Slovenia are associate members of the ESA.

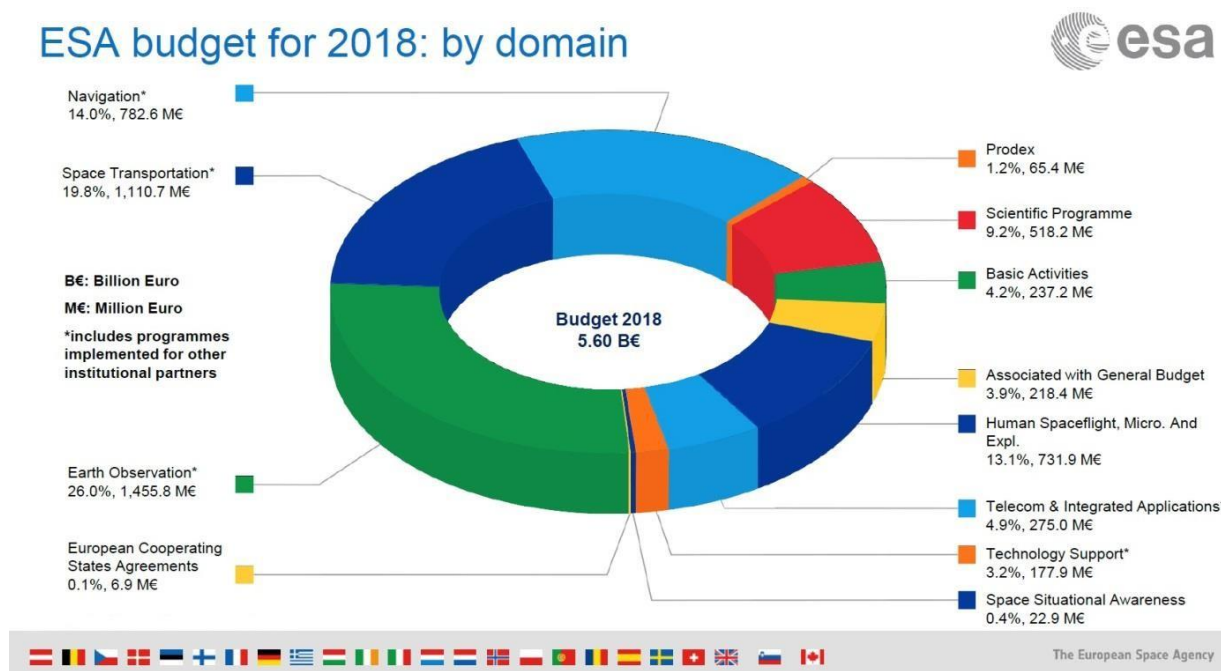


Fig. 2: ESA budget for 2018 (source www.esa.int)

The ESA is headed by a **Director-General**; since 2015 this is Dr. Johann-Dietrich Wörner. The vision of the ESA Director-General on Europe in space and the role and development of the European Space Agency is the so-called “**Space 4.0**”. We can characterize the first space period, Space 1.0, as the period when astronomy began to evolve. The second period, Space 2.0, is the period when states began to compete with each other in space, culminating in an American landing on the Moon. The Space 3.0 represents the period of mutual cooperation of countries on the project of the International Space Station (ISS). Space 4.0 represents the development of space sector in a new era, which abandons the idea of space only for certain states and is developed through the interaction between governments, the private sector, academia and industry. This concept, actively and publicly promoted by the ESA Director-General, advances the modern perception of space activities through economic indicators, the growing importance of the private sector, or the so-called NewSpace indicators.

ANNEX 3 – OVERVIEW OF FINANCING OF ESA PROGRAMS BY NEIGHBOURING STATES

Even though the ESA has already 22 member states, for the Slovak Republic it is useful to know especially about the activities of neighbouring countries, because the establishment of possible partnerships of Slovak R&D organisations is more probably in this group of states.

In this chapter we therefore provide an overview¹⁴ on the membership and financing of the ESA’s mandatory and optional programs for Austria, Czech Republic, Poland and Hungary.¹⁵

Austria became a full member of the ESA as early as 1986, but before was an Associate Member for 7 years. The PECS program was not established until 2001; therefore Austria did not participate in it.

The **Czech Republic** completed the PECS program in 2004-2008 and subsequently became a full member of the ESA.

Hungary completed the PECS program twice (the only one to do so thus far) in 2003-2008 and in 2008-2014. It became a full member of the ESA in 2015.

Poland joined the PECS program in 2008 and became a full member of the ESA in 2012.

¹⁴ Source: <http://www.czechspaceportal.cz/2-sekce/evropska-kosmicka-agentura/volitelne-programy-esa-s-ucasti-cr> , <https://www.ffg.at/en/services/austrian-esa-participation>

¹⁵ Ukraine is not a member of the ESA.

Overview of the participation of neighbouring states of Slovakia in ESA programs

	Austria¹⁶	Poland	Czech Republic¹⁷	Hungary
Member since	1986	2012	2008	2015
Annual contribution (2018) [in mil. EUR]	47.4	34.6	32.5	6.2
Annual contribution per capita [in EUR]	5.3	0.9	3.0	0.6
Optional programs the state takes part in	<p>General budget Science GSC-Kourou EO</p> <p>Telecom + IAP Navigation</p> <p>Security Technology & Exploration</p> <p>Launchers HSE/M</p>		<p>EOEP-5 Earth Watch – InCubed ARTES Future Preparations</p> <p>ARTES Core Competitiveness</p> <p>Govsatcom Precursor Iris 2.2</p> <p>IAP - Integrated Applications Promotion</p> <p>NAVISP</p> <p>Vega Element, Vega C Sub- element</p> <p>FLPP-3</p> <p>European Exploration Envelope Programme SciSpacE</p> <p>SSA P3</p> <p>GSTP</p> <p>PRODEX</p>	<p>GSTP PRODEX E3P (Human) SSA</p> <p>EO Launchers</p>

ANNEX 4 – LIST OF OPTIONAL ESA PROGRAMS

I. **Space transportation:**

AVD/Ariane 6 development AVD/ P120C development AVD/Vega C development AVD/Vega E
VECEP Step 1
Space Rider (PRIDE) Step 1 Space Rider Step 2.1
AVD/ Launchers Evolution (Demonstrator + LLL) LEAP Ariane Classical & MCO (2013-2016)
LEAP Ariane Classical & MCO (2017-end of A5 exploitation) LEAP Ariane Supplementary (2013-2016)
LEAP Ariane Supplementary (2017-2019)
Ariane 5 Exploitation Others (ARTA, Slice 13, ACEP) LEAP Vega Classical & MCO (2013-2016)
LEAP Vega Classical & MCO (2017-2019) LEAP Vega Supplementary (2015-2016) VERTA Periods 1 and 2
VERTA Period 3
FLPP Period 2 Step 1 and Step 2 SDT FLPP Period 3/NEO Core Component
FLPP Period 3/NEO Ultra Low Cost Engine Dem FLPP Period 3/NEO Lox-Methane

II. **Earth Observation:**

EOEP (including Period 2,3) EOEP 4
EOEP Period 5 EarthWatch - ALTIUS EarthWatch - InCubed
PROBA-V - Exploitation phase (Earth Watch) Climate Change Initiative
GMES Space Component GSC-3
MTG 1
MetOp-SG

III. **Human spaceflight and robotic exploration:**

MSTP-ERA Additional Contribution ISS Exploitation Ph. 2, 1st BFC
ISS Exploitation Ph. 2, 2nd BFC ISS Exploitation Ph. 2, 3rd BFC ELIPS (P1,P2,P3 (current e.c.))
ELIPS 4 Science Core (current e.c.)
ELIPS 4 Technology Component (current e.c.) Transportation Early Activities I Transportation Early Activities II
Aurora ExoMars
Mars Robotic Exploration Program (MREP-2) - Sub-element 1 Mars Robotic Exploration Program (MREP-2) - Sub-element 2 E3P - Period 1
ISS Exploitation ExoMars
Luna-Resource Lander SciSpacE
ExPeRT
Commercial Partnerships E3P Period 1 Contingency

IV. **Telecommunications and Integrated Applications:**

ARTES Core Competitiveness Future Preparation

Core Competitiveness ScyLight
ARTES Integrated Applications Promotion IAP
ARTES Private Public Partnership EDRS GlobeNet
Large Platform IRIS
SGEO
NeoSat SAT-AIS
Partner

V. Navigation:

European GNSS Evolution Program NAVISP - Period 1

VI. Technology:

GSTP 5

GSTP Element 1 "Develop" GSTP Element 2 "Make" GSTP Element 3 "Fly"

Precise Formation Flying Demonstration Component

VII. Space Situational Awareness:

SSA - Period 2 SSA - Period 3

VIII. Prodex:

PRODEX is an optional scientific program established to provide funding for the industrial development of scientific instruments or experiments proposed by institutes or universities that have been selected by the ESA for one of its programs in the various fields of space research (science, microgravity, Earth observation, etc.).

ANNEX 5 – GLOSSARY OF DEFINITIONS AND ABBREVIATIONS

For better understanding of the text, we present here some of the most commonly used phrases (and their abbreviations, if any), as are used in professional English and Slovak texts.

English abbreviation	Full wording in English	Slovak abbreviation	Full wording in Slovak
ARTES	Advanced Research in Telecommunications Systems		Pokročilý výskum v telekomunikačných systémoch (one of the primary ESA programs)
COPUOS	Committee on the Peaceful Uses of Outer Space		Výbor OSN pre mierové využívanie vesmíru
EC	European Commission	EK	Európska Komisia
ECS	European Cooperating State		Európsky spolupracujúci štát
ECSL	European Centre for Space Law		Európske centrum pre vesmírne právo
EGNOS	European Geostationary Navigation Overlay Service		Európska geostacionárna navigačná prekryvacia služba
ELIPS	European Programme for Life and Physical Sciences in Space		
EO	Earth Observation	DPZ	Diaľkové pozorovanie Zeme
ESA	European Space Agency		Európska vesmírna agentúra
EU	European Union	EÚ	Európska únia
GNSS	Global Navigation Satellite System		Globálny navigačný satelitný systém
GSA	European GNSS Agency		Agentúra pre európsky globálny navigačný satelitný systém
H2020	Horizon 2020 The EU Framework Programme for Research and Innovation	Horizont 2020	Rámcový program EÚ pre výskum a inovácie v období rokov 2014 – 2020
ISS	International Space Station		Medzinárodná vesmírna stanica
NEO	Near-Earth objects		Objekty v blízkosti Zeme
PRODEX	PROgramme de Développement d'Expériences scientifiques (Fr.)		Program vývoja vedeckých experimentov
RIS3	Research and innovation strategies for smart specialisation		Stratégia výskumu a inovácií pre inteligentnú špecializáciu Slovenskej republiky
SSA	Space Situational Awareness		Situačný prehľad v kozmickom priestore
SST	Space Surveillance and Tracking		Systém vesmírneho prehľadu a sledovania kozmických objektov
UNOOSA	United Nations Office for Outer Space Affairs		Úrad OSN pre mierové využívanie vesmíru
SSE	Space Strategy for Europe	EVS	Európska vesmírna stratégia / Stratégia pre Európu v oblasti kozmického priestoru
	Horizon Europe	Horizont Európa	Rámcový program EÚ pre výskum a inovácie na roky 2021 - 2027
	Ministry of Education, Science, Research and Sport of the Slovak Republic	MŠVVaŠ SR	Ministerstvo školstva, vedy, výskumu a športu Slovenskej republiky
	National Agriculture and Food Centre – Soil Science and Conservation Research Institute	NPPC-VÚPOP	Národné poľnohospodárske a potravinárske centrum – Výskumný ústav pôdoznanectva a ochrany pôdy
	Slovak Investment and Trade Development Agency	SARIO	Slovenská agentúra pre rozvoj investícií a obchodu