NÁRODNÍ KOSMICKÝ PLÁN

2014 – 2019

NATIONAL SPACE PLAN

2014 – 2019

Ministerstvo dopravy

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Introduction by Deputy Minister of Transport

The space technologies significantly influence today's world. Since the second half of the 20th century, the space technologies have been gradually becoming the integral part of many sectors of human activities. The Czech Republic itself has a long tradition in space activities domain. It has been successfully continuing in this tradition with a number of initiatives and related activities started in recent years. The Czech Republic perceives the space activities as the opportunity especially for the growth of its national economy. Space activities are no longer only a scientific discipline but more importantly they are an economic discipline with enormous social, political, strategic and security dimensions. The involvement of any state in space activities determines its position within the international community of states, especially those in Europe and in the world which are the most technologically developed, and the position of its industry in the international economic competition, i.e. in the international competitive environment. Increasing its activities in the space domain, the Czech Republic is progressively trying to build its reputation as a strong and reliable partner in the field of both bilateral and multilateral international cooperation.

The accession of the Czech Republic to the European Space Agency (ESA) in 2008 has proved to be a crucial step for stimulation and implementation of the space activities of the Czech Republic. Czech companies, universities and research institutions have participated in more than 120 very technologically challenging ESA projects over the past 6 years of Czech membership in ESA so far. Many of the companies that entered to the space sector with unclear expectations are regularly bidding for ESA tenders now. Thanks to their participation in space programmes, they are improving their products, developing their technologies to higher levels and getting them ready for the market. Due to their involvement in the high level innovative activities, the companies are becoming more competitive in the field of their original expertise, not only in the space domain (e.g. supplies for commercial satellite systems) but especially outside of this domain.

After the accession of the Czech Republic to ESA, decision makers needed an appropriate strategic baseline to stimulate the further development of capacities and capabilities of Czech industry and academia and to maximize the return on public investment to space domain. For this reason, the National Space Plan was prepared, in close cooperation with ESA, with its effective period planned for the period 2010 – 2016. The National Space Plan was approved by Government of the Czech Republic in 2010.

Since the Czech Republic met all mid-term objectives of the National Space Plan from 2010 already in 2013, i.e. more than three years before the end of originally planned period, the Minister of Transport's Coordination Council for Space Activities, which was established in accordance with the Resolution of the Government of the Czech Republic No. 282 from April 20, 2011, decided on September 30, 2013 on the preparation of a new National Space Plan for the period 2014 – 2019. In order to fulfil this task a special working group led by the Ministry of Transport was established. The representatives of ministries, other authorities and experts from academic and industrial sector were involved in the work of the group. The preparation of the new National Space Plan was also closely coordinated with ESA.

The new National Space Plan for the period 2014 – 2019 was approved by the Government of the Czech Republic on October 27, 2014 by its Resolution No. 872. It is based on the achievements of the National Space Plan from 2010 and again represents a strategy upon which decision-makers should decide on future involvement of the Czech Republic in space activities. It is a plan of development of the Czech industry and academia and their integration into the international space community. Its main objective is to enhance the competitiveness of the Czech industry and to increase its technological and innovative level. According to its analyses the new National Space Plan defines recommendations concerning the level of support of Czech space activities, more specifically concerning funding and additional management optimization.

It is obvious that timely and duly implementation of the new National Space Plan will require an active execution of defined recommendations under the leadership of the Ministry of Transport. However, it should be noted that the real implementation of the new National Space Plan is directly dependent on nature and size of support determined by the Government of the Czech Republic.

Karel Dobeš
Deputy Minister of Transport

TABLE OF CONTENTS:

1 INTRODUCTION

1.1 PREAMBLE

The National Space Plan (NSP) represents the strategy of the Czech Republic in further development of capacities and capabilities of its industry and academia and in maximising the return of the public investment in space activities. Space activities are all industrial and scientific activities which lead to the use of possibilities and opportunities which space opens to society. Space activities covers areas as satellite navigation, satellite telecommunication, Earth observation, launchers, space situational awareness, microgravity, human space flights, space exploration, space science and applications and services connected with use of obtained data. NSP is addressed to policy/decision makers to decide, using its analyses and recommendations, on the level of support of the space activities in the Czech Republic, especially as far as the funding and the further optimisation of the management of this area are concerned.

The development of the Czech space sector is closely tied to European space policies and the strategies of the European Space Agency (ESA) and European Union (EU). The space sector and its activities are no longer merely the concern of science; it concerns a sector with immense economic, social, strategic and security potential which affects all domains of our lives.

Concurrently with the accession of the Czech Republic to ESA, a corresponding strong shift in the approach towards space activities had to take place in the Czech Republic. This was considerably conditioned and accelerated by the government decision to candidate the Czech Republic to host the European Global Navigation Satellite System Agency (GSA) and made possible by the very successful cooperation with ESA (Programme for European Co-operating States - PECS) that prepared the Czech Republic for ESA membership. It is also worthy to note that the bid for the GSA was very successful and therefore the GSA has its seat in the Czech Republic since September 2012.

1.2 PREMISES

The Czech Republic has had a long tradition in utilization of space for scientific purposes. Several scientific payloads and sensors were developed, as well as small scientific satellites. These activities, taking into account the different economic and social context, were implemented mostly in scientific institutions with small industrial involvement and little economic consideration or sustainability.

In the last 25 years the Czech Republic has undertaken enormous political, economic and social changes. In the same period the economic development of the Czech Republic has been remarkable even if, at this stage, its competitiveness is mainly based on the relatively low cost of its economy. OECD[1] shows some weaknesses mainly associated with weak links between its industry and academia (science) and low level of patents by academia. Eurostat[2] statistics show a high level of high technological content of its exports (16.4% in 2012), above the median of the European Union (15.6%) and higher even than Germany. On the other hand the Czech Republic has a low number of patents (approx. 18 patents per million inhabitants in 2012) that is around 12 and 15 times smaller than Denmark and Germany, respectively. It should also be pointed out that, while this indicator has remained almost unchanged since 2007 in the Czech Republic, it has almost tripled in Poland in the same period. This data suggests that the products manufactured in the Czech Republic have an intellectual propriety outside of the country and other European economies may pose serious competitive threats. In the evolution of its economy it will be necessary to address this issue by increasing its added value.

In this frame, space-related activities can be seen as a unique tool to influence economic development by creating virtuous examples and best-practices to be used in other sectors of the economy. The need to

[1] OECD Science, Technology and Industry Outlook 2012 – ISBN: 978-92-64-17039-1, OECD 2012, p. 272-273.

[2] EUROSTAT, Patent Applications to the European Patent Office (EPO) - Number of applications per million inhabitants, http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tsc00032&plugin=1 and High-tech exports – Exports of high technology products as a share of total exports, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=htec_si_exp4&lang=en.

retain and absorb the intellectual capital that is created in its academia and industry is an essential requirement to ensure the "return-on-investment" of the public investments.

Space is an area of economic activity with the highest potential for innovation[3] and represents a springboard to drive Czech economy's competitiveness. For EU, space is a political and economic challenge that can strengthen the position of EU in the global economy.

Currently the Czech Republic does not have any national space programme and therefore it participates as a Member State in space activities of ESA, EU and EUMETSAT. It is funding these space activities on average (2010-2014) per year around €28 million (see Figure 1). The majority of this investment the Czech Republic has not been able to influence so far since EU and EUMETSAT do not guarantee the geographical return of their Member States contributions. The Czech Republic mandatorily contributes to EU and EUMETSAT space activities on the grounds of its membership in these international organisations. The contributions of the Czech Republic to EU and EUMETSAT space activities will be increasing significantly in the next years.

[mil. €]	ESA (TOTAL)	Mandatory	Optional	EU (TOTAL)*	Galileo	Copernicus	FP7/H2020**	EUMETSAT	TOTAL
2010	10.15	5.79	4.36	11.29	8.72	1.27	1.31	1.78	23.22
2011	10.43	5.91	4.52	12.92	10.00	2.36	0.55	1.83	25.18
2012	11.36	7.62	3.74	10.88	7.38	3.11	0.40	2.50	24.74
2013	14.39	7.86	6.53	9.08	4.65	3.92	0.50	2.39	25.86
2014	13.88	7.86	6.02	22.69	16.38	4.32	1.99	2.53	39.10
2015	14.04	8.09	5.95	20.20	11.41	6.66	2.18	3.67	27.91
2016	14.25	8.09	6.16	21.25	11.41	6.95	2.89	4.44	39.94
2017	13.71	8.09	5.62	21.56	11.41	7.26	2.89	5.01	40.28
2018	12.20	7.50	4.70	21.97	11.41	7.65	2.89	5.08	39.25
2019	11.10	7.50	3.60	24.74	11.41	10.44	2.89	5.34	41.18

* The Czech Republic contribution to EU budget represents approx 1,2% of the total EU budget. SST programme will be funded by Galileo, Copernicus, H2020

** Excluding Copernicus (treated separately)

*** Budget for Galileo, SST and partially Horizont 2020 in 2015-2019 are set as annual average amounts.

Figure 1: Level of contributions of the Czech Republic to space activities [mil. €]. Source: MT

While there is no guarantee regarding the return of the contributions to the EU and EUMETSAT, the contribution to ESA has a guarantee of 95% return of the funds contributed (minus the ESA costs to implement, technically follow-up and monitor the activities).

ESA is the main tool for the Czech Republic to influence and develop space activities and participate in space projects. It is in ESA that currently almost all European space-related R&D leading to prototypes and operational systems are carried out. These systems are then commercialised by the industry that participated in those activities and exploited by other European organisations (e.g. EU, EUMETSAT).

What can be observed in the contributions of the Czech Republic to the EU (Space) and EUMETSAT is that little is returned in the form of contracts or expenditures in the Czech Republic due to lack of ready capabilities of its industry to compete in these activities. The return of these contributions has been slowly increasing due to the participation of Czech industry in ESA activities where they develop the technologies and products necessary to win contracts in the EU and EUMETSAT. Especially ESA optional programmes play the key role in further development of Czech capacities and capabilities. However this increase in the return in these contributions is constrained by the time and the funds necessary to create essential industrial capacities and capabilities. Without the increase of the contribution to ESA optional programmes, there is extremely low chance that the investments of the Czech Republic to EU and EUMETSAT space activities will draw back ever in contracts (in both cases the significant indirect return is assumed as far as the accessibility of data and information is concerned).

Science missions (funded only through ESA's mandatory contributions) have little recurrence (as an example, an X-ray or Infra-red space telescope, as may be expected, occurs only around every 20 to 25 years). ESA Member States and their industry can only afford these science missions only if most of the required technologies are already available. These technologies are developed and created first through some of the

[3] Space is an area of economic activity with the highest potential for innovation due to the demanding environment of outer space to which the technologies have to be adjusted and due to technology push from cutting-edge technologies that are characteristic for preparation and implementation of technologically demanding space missions. Ultimately the companies take advantage of knowledge and experience gained during space technologies development in their core business, which stimulates new innovations outside space sector.

ESA mandatory activities (Technology Research Programme – TRP) and mostly through targeted ESA optional programmes that also need to the industrialisation and commercialisation of the developments through the optional programmes that lead to economic sustainability in the global market. On the other hand ESA's science missions have also important long-term benefits involving the scientific communities of its Member States.

Another very pertinent issue that must be taken into account in this NSP is that from the date of accession to the ESA (2008) a special ESA transitional programme was implemented to create necessary capabilities in the Czech Republic for a successful Czech participation in ESA space activities. This programme is called Czech Industry Incentive Scheme (CIIS) and will end at the end of 2014. In this period the Czech Republic has enjoyed special support from ESA. The funds allocated to this special programme amount to 45% of the mandatory contributions of the Czech Republic to ESA.

This special programme has been very successful and was instrumental in achieving all mid-term objectives of the previous NSP three years before its target. During its lifetime the CIIS has allowed specific treatment targeted at the Czech Republic that will not be available after 2014.

This change after 2014 will require specific measures from the Czech Republic as to allow Czech industry to continue its development avoiding destruction of capabilities already created with substantial investment of time and money.

To ensure the continued development of space industry in the Czech Republic it will be necessary to double at least the contributions to ESA's optional programmes. This will also allow for substantial increase of the funds directly returned to the Czech Republic in the EU and EUMETSAT.

ESA is per se not a research organisation but, more than anything else, an agency for the industrial implementation of space projects. It is in this frame that it is a key player in space projects in Europe. Because of this role, ESA has a strong R&D programme supporting space projects and because of the high risks and costs associated with space, it uses systematically a Technological Readiness Level (TRL) approach to evaluate the readiness of the technologies developed for possible use in space missions. For this reason the R&D activities of ESA are very targeted and always involve industry at the higher levels of TRL that needs to bring these technologies to market. Academically led R&D is concentrated at the low levels of TRL where market or application considerations are not yet pertinent. This characteristic gives ESA's R&D a different nature to the one conventionally used in the Czech Republic where R&D is mainly the purview of academic institutions. Figure 2 illustrates the role of TRL and its relation to industry and academia.

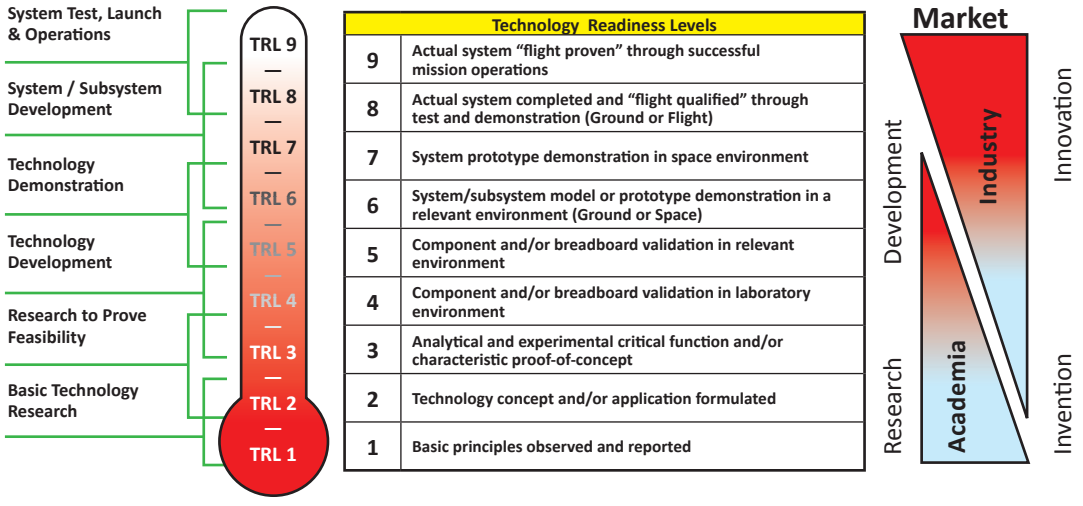

Figure 2: Technological Readiness Levels in the context of the roles of academia and industry. Source: ESA

It should also be noted, to avoid translation misunderstanding, that industry is not meant as production or manufacturing company, as it may be understood in Czech. Industry means in this case any company that undertakes any business.

1.3 POLITICAL AND ECONOMIC BENEFITS OF SPACE

Space activities are generally characterised by their high technological content, multi-disciplinarity, complexity, extreme visibility and often high cost. The two most important reasons why investment by the Czech or European tax-payer in space is of strategic importance are political and economic.

Political benefits

In the political domain space is of fundamental importance for the independence, security and prosperity of Europe. It is an enabling tool that gives decision-makers the ability to respond to critical challenges such as global climate change and global security.

Space technologies, products and services are an important part of everyday life. Weather forecasting, air traffic control, navigation, global communications and broadcasting – these and many other essential activities would be almost unthinkable today without satellite technology.

Modern weather forecast would be impossible without the satellite data that allow a global view of the Earth and its environment. Earth observation satellites are today an essential tool in the understanding of the physics and chemistry of the Earth's, atmosphere, land surfaces, oceans, geology and inner core.

In disaster forecasting, mitigation, management and assessment, satellite data play a fundamental role by providing the measurements for forecasting (e.g. storms) but also supplying the information to identify affected regions or infrastructure spared or destroyed (e.g. roads or bridges still open). It is also used to assess damage and to follow-up the recovery of the affected region (e.g. fires, floods, earthquakes, draughts).

Applications include systems for increasing the safety of air traffic and monitoring the movements of aircraft and authorized road vehicles at airports, safety measures for operating railroad transport, monitoring of the location of special consignments (e.g. oversized cargo, live animals, dangerous goods, valuable cargo), enhancing of road safety, improvement of logistics system functions, information gathering necessary for traffic control, systems for the control of domestic ship navigation and optimisation of water traffic.

Civilian protection and emergency response uses GNSS systems for localization of persons and assignment of resources for rescue operations of the highest priority, for localization of the area of emergency situations and catastrophes, for example contamination of the sea, chemical accidents, erosion processes, and alike.

Telecommunication satellites have been for many years one of the backbones of the global telecommunication infrastructure. Satellites broadcast the signals to our satellite TVs, transmit or receive, from our internet data to our phone calls, from data on the habits of wildlife to that from instruments in remote places. The internet revolution was a consequence of the communication revolution that space technologies made possible.

Satellite systems also enables the precise farming or effectively synchronise energy, IT or financial networks, etc.

Economic benefits

In the economic domain space brings a significant contribution to Europe's growth and employment and it provides indispensable enabling technologies and services for the knowledge society.

At this time of unprecedented economic challenges, space is proving to be an anchor of stability and a counterbalance to negative trends. Space-based services are having an increasing effect on our way of life. Competitiveness fosters growth. Increasing the competitiveness of the European space industry and operators on world markets, whether in infrastructures or services, and increasing the competitiveness of space-based services compared to ground-based services will contribute to growth in Europe.

One can, in principle, divide the economic impact in 2 different factors: the first one comes from the increase of revenues in industry stemming from increase of productivity or efficiency of the industrial processes, new ideas leading to new products or new markets; the second factor is related to societal impacts arising from increase in employment, savings due lives saved, better management or streamlining of societal infrastructure (e.g. weather, storm, flood forecast), information dissemination, etc.

Floods damages in the Czech Republic		
Year	Damages (bil. CZK)	GDP percentage
1997	62,6	3,3%
1998	1,8	0,1%
2000	3,8	0,2%
2001	1,0	0,0%
2002	73,3	2,9%
1006	6,2	0,2%
2009	8,5	0,2%
2010	15,0	0,4%
Total	**172,2**	

Figure 3: The table shows the impact on GDP induced by floods. Using of information provided by satellites contributes to better coordination of crisis management and rescue teams which helps to protect the property, save lives and reduce the impact of disasters in general. It is anticipated that the reduction of impacts could be in grade of percent. Source: Patria Finance

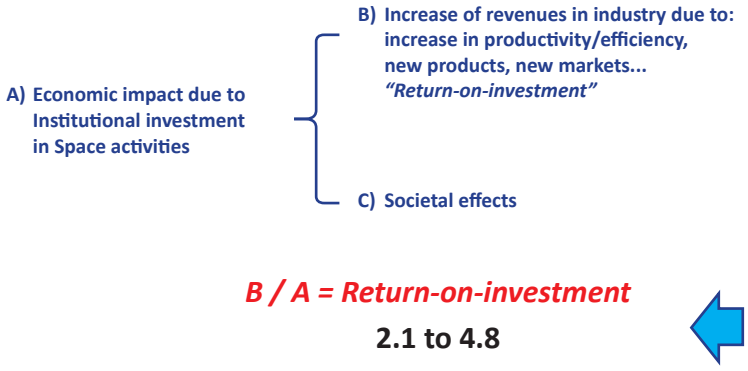

Figure 4: Space value chain. Source: OECD

The first factor can be seen as a return-on-investment of space activities of the public investment. This return-on-investment of space activities is higher than in most other sectors of economic activity.

Several independent studies have shown the increased revenues in the economy due to public investments in space activities. Considering only economic impacts without societal ones, for each €1 invested in space through ESA (more global data is difficult to obtain) Norway had an impact of €4.8 in the period from 1985 to 2012, Denmark of €4.5 in the period 2000-2007, Portugal of €2.2 in 2000-2009 and Canada of €2.07 in 2000-2009. This economic impact is recognised by the OECD in their "Space Economy at a Glance" reviews published in 2007 and 2011.

Because of the different methodological approaches used, it is difficult to perform comparisons between countries. However, the economic impact observed is also similar to those observed by the OECD on a global scale when considering the pyramid of economic value chain associated with space activities and the public investment. The multiplier effect in this case, not considering societal effects, is similar to the economic impact obtained with the previously discussed detailed studies. The "industrial effects" shown at the left of the figure 5 are those arising from increase of productivity and competitiveness in industry, cost savings and new concepts and ideas associated with space activities.

It should however be said that this multiplier effect cannot be obtained without industrial involvement (as by consequence public investment) in the different sectors of the pyramid. This is due to the fact that without knowledge and expertise in the upper part of the pyramid (space up-stream related to satellites, equipment, instruments, etc.) it is difficult to be successful in the lower part of the pyramid (down-stream) where the knowledge acquired in the up-stream is essential for competitive services and applications.

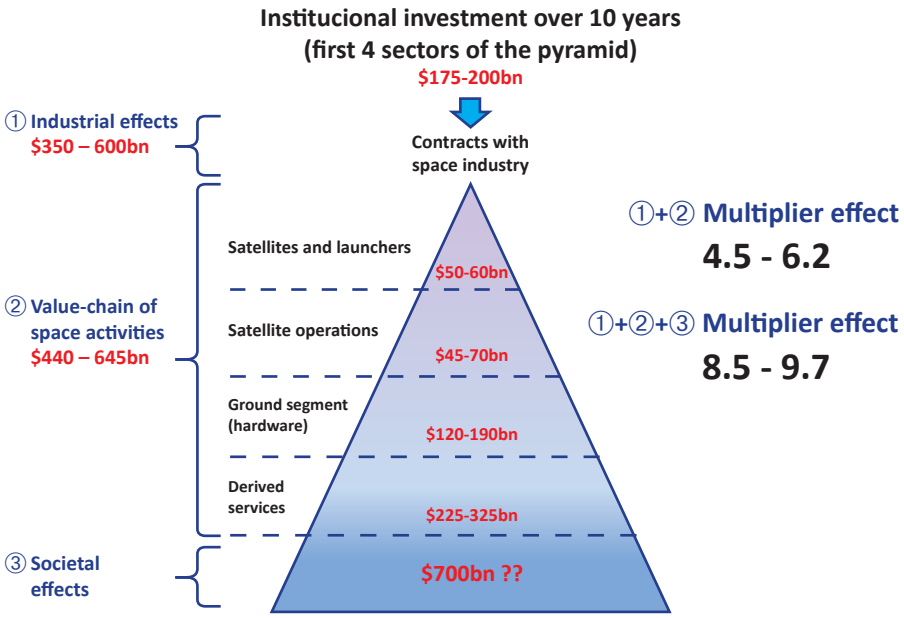

Figure 5: Space value chain. Source OECD

2 THE REVIEW OF THE NATIONAL SPACE PLAN APPROVED IN 2010

Historically first NSP was approved by the Committee for the EU at government level in May 2010 (2010 NSP).[4] The Ministry of Transport was responsible for elaborating and delivering the document to the Government. The document was prepared in cooperation with other Czech ministries, ESA, academia and industry.

In general the NSP represents the strategy of the Czech Republic in space. It specifies measures to be implemented in order to maximise the return of the public investments, further develop relevant capacities and capabilities of academia and industry and support the competitiveness of the economy of the Czech Republic.

The 2010 NSP identified long-term vision. In order to ensure that the Czech Republic is on the way to accomplish the vision the 2010 NSP defined the following mid-term objectives to be implemented by 2016:

- Czech investment in space has an appropriate return;
- The Czech Republic has the necessary competences (industrial, academic, project management) and infrastructures exist to sustain the long-term vision;
- The interaction between academia and industry exists and is well balanced;
- The Czech Republic has efficient and effective space coordination and recognizes space as a strategic element of national policy.

To evaluate whether the mid-term objectives were achieved by 2016 the following quantifiable evaluation criteria were set-up:

- An overall geo-return in ESA of at least 86%;
- Balanced participation of academia and industry in space projects with at least 80% of the budget spent in industry;
- A minimum of 1 Czech-owned sustainable space product is being supplied or about to be supplied;
- At least one sustainable commercial activity related to services or applications exploiting space;
- One on-going project, outside of ESA Space Science Programme, with an excellent example of cooperation/integration of academia/industry;
- The Czech Republic has a formalised structure supporting space activities.

The Czech Republic met all evaluation criteria of the 2010 NSP already in 2013, i.e. more than three years before the original deadline. The reasoning is the following:

1) ***An overall geo-return in ESA of at least 86%***

This evaluation criterion reflects the mid-term objective "Czech investment in space has an appropriate return". It was obvious that at the beginning of the membership of the Czech Republic in ESA when the 2010 NSP was being prepared, the main interest of the Czech Republic was to draw efficiently, sustainably and in an adequate rate the Czech contribution to ESA. According to ESA experience with new Member States the adequate rate of the geo-return was set at 86% with optimistic wish to achieve even higher geo-return rate.

Beyond this principle, the Czech Republic emphasized the need to maximize the return of public investments to space activities as a cross-sectional principle of the whole 2010 NSP. Since the membership in ESA brings the main opportunities for the Czech Republic in space and since the geo-return principle exists solely in ESA, the Czech participation in ESA activities and programmes have to be considered as a backbone for the calculation of the return of public investment in space in general.

According to actual ESA statistics the Czech Republic is achieving the geo-return at the level of 91% and taking into account recently approved or negotiated activities to be implemented by Czech entities, the increasing trend of the geo-return rate evolution can be expected.[5]

[4] Resolution of the Committee for the EU at government level, No 14, dated on May 3, 2010.

[5] ESA Report to Industrial Policy Evolution Working Group (IPE-WG) „Optional Programmes: Possible Evolution of Industrial Policy", February 2014.

2) ***Balanced participation of academia and industry in space projects with at least 80% of the budget spent in industry***

This evaluation criterion reflects the mid-term objective "The Czech Republic has the necessary competences (industrial, academic, project management) and infrastructures exist to sustain the long-term vision".

Just before the accession of the Czech Republic to ESA, the participation of academia in space projects was far higher that the participation of industry. However, ESA activities reflect very different distribution of funds between academia and industry. The usual participation of industry in ESA activities represents 90-95% of overall budget spending for ESA projects.

This evaluation criterion was of particular importance to achieve an optimised distribution of funding to maximize the ESA geo-return in the Czech Republic, considering as well the different roles of academia and industry (see Chapter 5).

Referring to the original significant disproportion and imbalance between the participation of academia and industry in space projects comparing with ESA practice, the objective to build industrial capacities and capabilities to be able to achieve the ratio of 80% of the budget spent in industry was rather optimistic at the time. In this context the implementation of the CIIS, an ESA transitional measure for adjusting the Czech entities to ESA rules and procedures, could be considered as a representative sample. In its Third call for project proposals issued at the beginning of 2013 the Czech-ESA Task Force recommended over 90% of the allocated budget for implementation of projects led by industry.

3) ***A minimum of 1 Czech-owned sustainable space product is being supplied or about to be supplied***

This evaluation criterion also reflects the mid-term objective "The Czech Republic has the necessary competences (industrial, academic, project management) and infrastructures exist to sustain the long-term vision".

The Czech Republic successfully applied the ESA model enabling the Czech entities to incubate their existing or potential capabilities and increase their global competitiveness. In spite of the conservativeness of space industry when involving new suppliers the Czech industry managed to participate in the purely commercial projects as in the case of a large delivery of mechanisms to deploy solar arrays of fleet of telecommunication satellites.

4) ***At least one sustainable commercial activity related to services or applications exploiting space***

This evaluation criterion also reflects the mid-term objective "The Czech Republic has the necessary competences (industrial, academic, project management) and infrastructures exist to sustain the long-term vision".

At the end of 2010 the Czech Republic succeeded in its candidature for the European GNSS Agency (GSA). The GSA relocated to Prague and started there its activities in September 2012. The R&D activities managed by GSA together with some downstream oriented activities in ESA help the Czech entities to increase their activities related to services or applications exploiting space systems data.

The Czech Republic actively supports new ideas to be commercialised and motivates Czech entities to be interconnect their businesses with space activities. As an outcome of this effort new services and applications based on satellite navigation, telecommunication and Earth observation are being created and introduced to relevant markets. The globally successful application is e.g. the geographic information assistant which is being used for coordination of staff in the field.

5) ***One on-going project, outside of ESA Space Science Programme, with an excellent example of cooperation/integration of academia/industry***

This evaluation criterion reflects the mid-term objective "The interaction between academia and industry exists and is well balanced".

As a past era legacy the Czech academia have had at its disposal state funded facilities in which it was able to implement activities that are only economically sustainable if done by industry. Since academia really used the facilities in this way and in practice competed with industry (in an era where this was not an issue or

concern), the development of industrial capacities and capabilities had not started before the Czech Republic acceded to ESA.

Nowadays, the Czech Republic promotes the active cooperation between academia and industry and need to use their capacities and capabilities in the usual way respecting their roles. The Czech Republic reflects the need into all decisions which it takes. This fact has already resulted in numerous examples of projects in which academia and industry cooperate together. An excellent example of this cooperation, respecting the natural roles of industry and academia is the SATRAM instrument (flying in PROBA-V). The respective project was led by industry with the full support of academia where the scientific background had been developed.

Recommendations

The Czech Republic should ensure that the participation of industry and academia in space projects reflects their natural missions and roles.

6) ***The Czech Republic has a formalised structure supporting space activities.***

This evaluation criterion reflects the mid-term objective "The Czech Republic has efficient and effective space coordination and recognizes space as a strategic element of national policy".

The Government in 2010 realised that the current state of the space activities management in the Czech Republic is untenable. The space activities were unsystematically coordinated by the private non-profit Czech Space Office without clear mandate from state and despite of European or global trends, the Czech space activities were on purpose especially science oriented. The competence dispute between ministries and the need to change the official approach to space from purely scientific discipline to more industrial oriented discipline with huge economic, social, strategic and political potential resulted in the Government decision on formalised settings of space activities management in the Czech Republic.

In order to implement the 2010 NSP in a coordinated way, the Government entrusted the Ministry of Transport with the task to coordinate all space activities in the Czech Republic. For better transparency and involvement of all stakeholders both from public and private sector the Ministry of Transport established the Coordination Council for Space Activities and its permanent Working Groups (Scientific Activities, Industry and Applications, Security and International Affairs).

This formalised structure is the first step on way to establish a national space agency.

3 INSTITUTIONAL SETTING

3.1 NATIONAL

3.1.1 COORDINATION COUNCIL FOR SPACE ACTIVITIES

Following a joint proposal of the Ministry of Transport, Ministry of Industry and Trade, Ministry of Education, Youth and Sport and Ministry of the Environment, the Government of the Czech Republic on April 20, 2011 entrusted[6] the Ministry of Transport with the role of a coordinator of all space activities in the Czech Republic. At the same time it tasked the Ministry of Industry and Trade, Ministry of Education, Youth and Sport, Ministry of the Environment to cooperate with the Ministry of Transport. For the purpose of coordination, the Ministry of Transport established the Coordination Council for Space Activities which consists of high-level representatives of the Ministry of Transport, Ministry of Industry and Trade, Ministry of Education, Youth and Sport, Ministry of the Environment, Ministry of Foreign Affairs, Ministry of Defence and Office of Government of the Czech Republic. The Coordination Council has also established cross-sectional expert working groups as an interface with industry and academia – "Industry and Applications" and "Science Activities". The "Security and International Relations" Working Group deals with security and international aspects of space activities.

The Coordination Council is a body which helps the Ministry of Transport to coordinate all matters related to space activities of the Government of the Czech Republic.

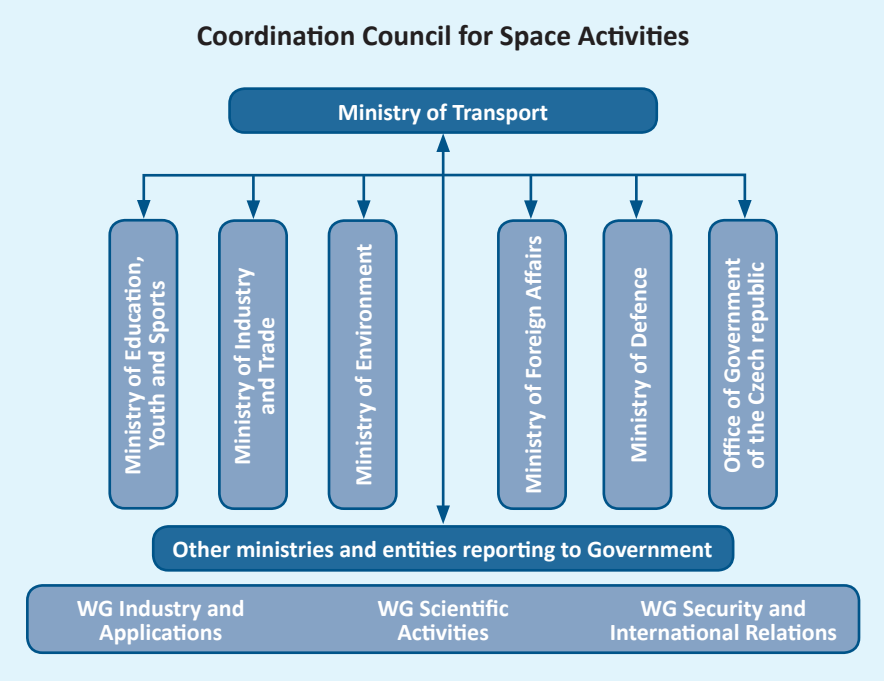

Figure 6: Structure of Coordination Council for Space Activities. Source: MT

Ministry of Transport

Beyond its coordination role, the Ministry of Transport (MT) is responsible for membership of the Czech Republic in ESA and provides the formal interface to ESA in the Czech Republic. Other governmental bodies contribute to activities of the Czech Republic in ESA according to their competences. The MT is also responsible for EU space issues; in particular the EU space policy and its programmes as e.g. Galileo programme. Together with the ME, the MT is responsible for Copernicus programme and co-represents the Czech Republic in Copernicus boards in the EU. The successful bid for the European GNSS Agency (GSA) seat has also been coordinated by the MT.

[6] Resolution of the Government of the Czech Republic, No. 282, dated on April 20, 2011.

The MT deals, together with Ministry of Foreign Affairs, with space matters in the United Nations (UN), especially as far as the COPUOS agenda is concerned, and is also involved in standardization process within the CEN/CENELEC.

The MT has been responsible for elaborating and delivering the 2010 NSP to the Government. As a continuation of the NSP, the MT prepared the National Space Implementation Plan, which the Government approved in August 2011.

The scope of responsibility of the MT covers all key aspects of the national space agenda, not solely those related directly to transport. Among others, it in cooperation with other governmental bodies protects and promotes public interests in space, ensures contacts with relevant international bodies or states, covers the participation of the Czech Republic in relevant space programmes, creates suitable environment for the Czech space industry and academia to facilitate their involvement in space activities, supports them and promotes their co-operation with leading space nations.

Ministry of Education, Youth and Sports

The Ministry of Education, Youth and Sports (MEYS) is the main governmental body responsible for R&D. It also supports R&D activities in ESA, EU and other international organisations. The MEYS manages several national programmes for support of R&D, including support for research infrastructures. The MEYS ensures also the international cooperation of the Czech Republic in R&D, including meetings with the EU bodies and institutions and the individual EU Member States active in R&D and the implementation of the EU funds for R&D. The MEYS also cooperates with MT on ESA matters. Several programmes for support of international cooperation in R&D are managed by the MEYS, such as INGO II, COST II and EUREKA. The MEYS is also responsible for coordination of Czech activities in Horizon 2020.

Ministry of Industry and Trade

The Ministry of Industry and Trade (MIT) is responsible for state industrial and trade policy and for support of business and industry in the Czech Republic. Further, it is also responsible for the electronic communications including the membership of the Czech Republic in ITSO, EUTELSAT IGO and Intersputnik and together with the Czech Telecommunications Office in the International Telecommunication Union (ITU). The MIT also cooperates with MT on ESA matters.

In the context of EU cohesion funds and MIT's research programmes, MIT implements projects aimed at developing advanced technologies, production, materials, information and control systems, etc. with a potential application in space. The MIT tasked its agencies Investment and Business Promotion Agency (CzechInvest) and Czech Trade Promotion Agency (CzechTrade) to provide relevant support to Czech space industry in developing their capacities and capabilities.

The CzechInvest supports small and medium-sized enterprises (SMEs), business infrastructure and innovations. It attracts foreign investments in the field of manufacturing, strategic services and technology centres. The CzechInvest covers the entire area of business support in the manufacturing industry, both from the EU and state budget funds.

The CzechTrade promotes international trade and cooperation between Czech and foreign companies. It helps Czech exporters to enter foreign markets and is a contact partner for foreign companies wishing to enter the Czech market and seeking business partners and suppliers.

Ministry of Environment

The Ministry of the Environment (ME) plays a crucial role in the involvement of the Czech Republic in GEO/GEOSS. The ME facilitates the involvement of the Czech Republic in the Copernicus programme. As far as the space segment of Copernicus is concerned, the MT cooperates with the ME. The ME leads the National Secretariat for GEO/Copernicus with the aim to coordinate all GEO/GEOSS and GMES/Copernicus related activities within the Czech Republic. The National Secretariat is composed of representatives from the ME, MT, CENIA, Czech Hydrometeorological Institute (CHMI), and MEYS.

The ME also charged its subordinated bodies CENIA and CHMI with certain tasks related to space activities.

The CENIA, Czech Environmental Information Agency has an important role regarding the support for spatial data, implementation of INSPIRE and Copernicus in the Czech Republic and has also an important role in

communication with the Czech users of the Copernicus data and information. It also represents the Czech Republic in the Copernicus boards in the EU.

The CHMI is responsible for data acquisition, processing, distribution, archiving of data and retrieved products from the meteorological satellites Meteosat, NOAA POES and MetOp, the representation of the Czech Republic in EUMETSAT, as well as scientific and technical research of the interpretation and use of satellite data in meteorology.

Ministry of Foreign Affairs

Ministry of Foreign Affairs (MFA) is responsible for Czech foreign policy. With regards to the space activities its main focus is on international cooperation and security related issues. The MFA also cooperates with MT on ESA matters.

MFA is responsible for the UN COPUOS and its subcommittees. The Czech Republic closely follows and contributes to International Code of Conduct for Outer Space Activities. Therefore the MFA participates in the work of the CODUN SPACE Working Party.

The MFA especially via its special envoy promotes collaboration in R&D related to space activities and supports participation of Czech entities at various international space forums and other collaborative events. Diplomacy assists in concluding of various intergovernmental agreements and memoranda and forging joint projects. It also provides its capabilities and infrastructure for networking, facilitation of contacts, gathering and transmitting information regarding space exploration and development of related technologies and establishing and exploring bilateral contacts and communication.

Ministry of Defence

The Ministry of Defence (MD) ensures defence of the Czech Republic and controls the Armed Forces of the Czech Republic. As the authority for ensuring the nation's defence, it contributes to the formation of a strategy for the military defence policy of the country, prepares a concept for operations planning and propounds necessary defence arrangements to the government and the Defence Council of the Czech Republic. Even though the MD does not have any activities and programmes directly related to space, it is responsible for national defence applied R&D and membership of the Czech Republic in the European Defence Agency (EDA) and the North Atlantic Treaty Organization (NATO) and covers the participation of the Czech Republic in cooperative space activities within both organizations.

Office of Government of the Czech Republic

The Office of the Government of the Czech Republic is the main national coordinator of European policies. It is also a seat of executive secretariat of governmental Research, Development and Innovation Council. The Research, Development and Innovation Council is an expert advisory body to the Government for Research, Development and Innovation that carries out preparation, monitoring and updates of National Research, Development and Innovation Policy of the Czech Republic for 2009 – 2015 with a perspective to 2020 and its constituent part, the National Priorities of Oriented Research, Experimental Development and Innovation.

Recommendations (to 3.1.1)

The establishment of the Coordination Council for Space Activities was a significant improvement of the situation as it was before 2011 by ensuring transparency and participation to all institutional stake-holders and this concept has shown its positive results so far. However, the Czech Republic should further optimize the way that the public sector approaches the area of space activities – in particular to eliminate current fragmentation of execution powers, increasing the effectiveness and efficiency of public administration and public expenditures, improving communication between public and private sector, and using synergies with other areas and concentrate the expertise. This is a point already recognised in 2010 NSP. Therefore another step forward should be taken and a public national space agency should be established.

3.1.2 PUBLIC SECTOR ENTITIES SUPPORTING THE SPACE ACTIVITIES GENERALLY OR INDIRECTLY

Ministry of Regional Development

Ministry of Regional Development (MRD) is responsible inter alia for the area of regional policy, respectively for balanced development of regions of the Czech Republic. MRD lays the role of the National Coordination Authority (NCO), which lays down a single framework for management and implementation of the assistance

granted from structural funds and the Cohesion Fund in the Czech Republic and secures the activities related to the EU cohesion policy in the Czech Republic, which is targeted on the reduction of disparities between the levels of development of various regions in the Czech Republic, and on convergence of the economic level of the Czech Republic with the EU.

Ministry of the Interior

The Ministry of the Interior (MI) is responsible for home affairs, in particular for public order, fire protection, territorial structure of the Czech Republic, etc. The MI is the main state user of space applications in the Czech Republic. It is also responsible for security R&D.

Ministry of Agriculture

The Ministry of Agriculture (MA) is responsible especially for agriculture, water management, food industry, forest management and animal welfare. The Ministry of Agriculture manages R&D for the entire agricultural sector.

Czech Telecommunication Office

The Czech Telecommunication Office (CTO) is responsible for market regulation in the area of electronic communications and postal services. CTO is responsible for radio spectrum management, sets the conditions of use of radio spectrum and supervises compliance with the conditions, ensuring the national and international frequency coordination (especially for the ground segment of satellite services). CTO is also responsible for preparation of harmonisation of the conditions of the use of the radio spectrum within the EU and implementation of EU harmonisation measures. The CTO represents the Czech Republic in the International Telecommunications Union (ITU) together with the MIT.

Czech Office for Surveying, Mapping and Cadastre

Czech Office for Surveying, Mapping and Cadastre (ČÚZK) has built and is responsible for operation of the Czech network of GPS stations (CZEPOS) which provides data from global navigation and positioning satellite systems (GNSS) and following services based on them useable in a number of applications and technologies in different branches, especially in land surveying, GIS and navigation, for tracking of vehicles, ships or aircrafts, for searching and rescue activities, etc.

National Security Authority

National Security Authority (NSA) has overall competences in the area of the protection of classified information and security clearance. The NSA is also responsible for implementation of the Public Regulated Service (PRS) of Galileo in the Czech Republic and represents the Czech Republic in Copernicus and GNSS security boards in the EU.

Czech Science Foundation

Czech Science Foundation (GA CR) is an organizational unit of the state providing support of basic (frontier) research on a competitive basis and promotes international cooperation in basic research.

The main function of the GA CR is to provide, on the basis of public tenders, financial support for research projects submitted by individuals or organizations. The GA CR supports all disciplines of basic research. The evaluation system is based on peer review system and a bottom-up principle, i.e. the topics of projects are determined by applicants.

Technology Agency of the Czech Republic

The Technology Agency of the Czech Republic (TA CR) is an organizational unit of the state providing targeted support of R&D through the preparation and implementation of programmes of applied research, experimental development and innovation.

The TA CR also provides consultancy to researchers and users of project results especially in the legal and financial field and in the field of protection of intellectual property.

Czech-Moravian Guarantee and Development Bank

The Czech-Moravian Guarantee and Development Bank (CMZR Bank) is the only promotional bank in the Czech Republic entrusted with the administration of funds disbursed within the programmes of assistance launched by the Government to help the development of SMEs using financial resources from national or EU

funds for guarantees and loans. Its stakeholders are MIT, Ministry of Finance (MF) and Ministry for Regional Development (MRD).

Export Guarantee and Insurance Corporation

Export Guarantee and Insurance Corporation (EGAP) is a credit insurance corporation insuring credit connected with exports of goods and services from the Czech Republic against political and commercial risks uninsurable by commercial insurance. The Czech Republic exercises its shareholder rights through the MF, MIT, MFA and MA.

3.2 INTERNATIONAL

3.2.1 ORGANIZATIONS DIRECTLY INVOLVED IN SPACE ACTIVITIES

These organisations implement their own space missions and activities. They are usually oriented to upstream and midstream activities but they also support in different measure the downstream segment. They usually own their satellite systems and often operate also these systems.

Upstream covers all areas directly pertinent or supporting satellites, launchers, satellite operations and ground-segment, midstream represents components and technologies for support space missions utilization and downstream refers to industrial activities which use the space infrastructure and space based data to provide tools and services for general users.

3.2.1.1 European Space Agency

Mission

ESA was established in 1975 as an intergovernmental organisation with the mission to provide for and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems.

ESA elaborates and implements its long term space policy through its programmes and its industrial policy. ESA coordinates and supports the global competitiveness of European industry by coordinating European and national space programmes and through its programmes, by maintaining and developing space technology and encouraging the rationalisation and development of an industrial structure appropriate to market requirements.

The activities of ESA are financed via its Member States and Canada as associate Member State. ESA activities are also financed by third parties for specific programmes, e.g. EUMETSAT.

Governance

ESA is governed through the ESA Council as the highest delegate body of representatives of the Member States. For the purpose of drawing up and supervising individual programmes, the Council set up the Science Programme Committee and Programme Boards (Member States representatives). The Council set up some committees to give advice on administrative and financial matters, industrial policy, security and international relations. The chief executive and legal representative of ESA the Director General, who is appointed by the Council in four-year terms. The execution of ESA activities is entrusted to Directorates responsible for individual themes or domains.

Activities

ESA activities are performed within programmes of two different types:

Mandatory activities

- Participation and contribution of each Member State is obligatory and proportional to its GDP.
- **Includes** the agency's basic activities as studies on future projects, technology research, shared technical investments, information systems and training programmes and they are organized mainly through the Science Programme, the Technology Research Programme, the General Studies Programme and ESA's technical and operational infrastructure.

Optional programmes

- Each Member State may participate in and may contribute according to its own interests and financial resources.
- **Includes** space domains like Earth observation, satellite navigation, telecommunication, launchers, human spaceflights, microgravity, exploration, technology development, etc. including the development of space applications.
- ESA Member States see in the optional programmes an opportunity to pursue their national strategies in a targeted and more controlled manner than in the mandatory activities.

Details of the different programmes are discussed in Chapter 6.

Typically more than ¾ of the contributions to ESA's budget is dedicated to optional programmes (in 2014 the percentage was 75%).[7] Especially the optional programmes help the Member States to build their industrial capacities and capabilities to be able to implement mandatory activities and to be competitive worldwide.

In 2014, Member States committed to ESA a total of €4.102 billion divided through its different programmes and domains as shown in Figure 7.

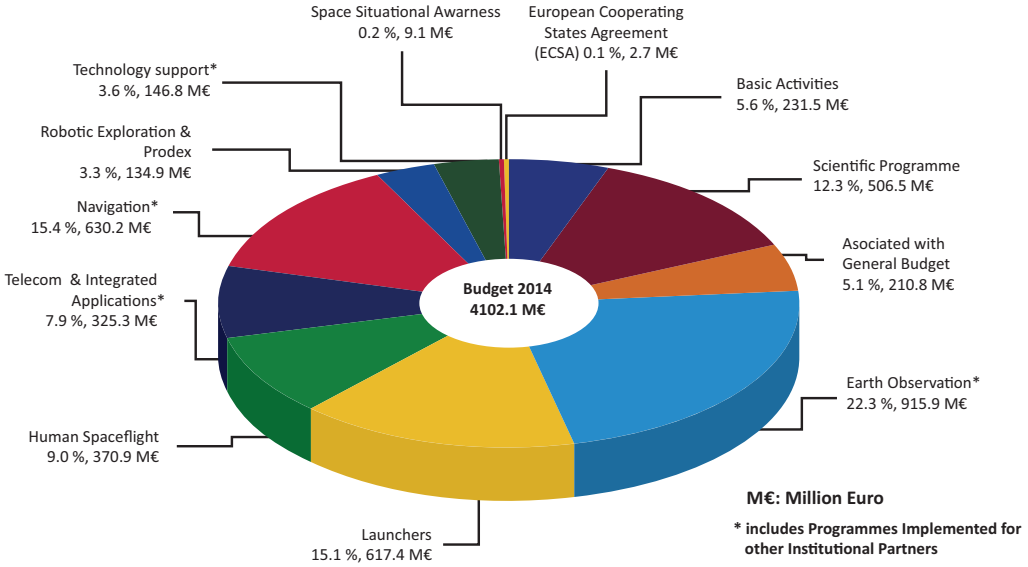

Figure 7: Amounts approved for commitment in 2014 by domains. Source: ESA

Industrial Policy

In general, 90-95% of ESA's budget is spent on contracts with industry.[8] Industrial policy of ESA is therefore essential tool to motivate Member States to invest to ESA's programmes. The motivation is driven by so called industrial return or geo-return (in the context of EU this approach is called *juste retour*). To monitor and control the geo-return, ESA keeps track of geographical distribution of all contracts among its Member States as well as the technological value of the contract. From this statistical data a geo-return coefficient is derived for each Member State as ratio of actual and ideal weighted value of contracts. Weights where established to represent how interesting and important contracts are in terms of technology. Ideal value is pro rata proportional to contribution of each Member State to each concerned programme. In ESA mandatory activities and in each of its programmes ESA ensures geo-return that at least 84% of the Member State contribution (minus ESA internal costs) returns to them in the form of contracts (some optional programmes have higher guaranteed percentage). ESA further ensures that, when all mandatory activities and optional programmes are taken into account, the geo-return for each Member State will be at least 95% at latest at the end of 2024 (similarly 91% and 93% are guaranteed by ESA for respectively 2019 and 2022).

The emphasis on geo-return is an absolutely unique feature of ESA, which motivates Member States to fund ESA activities. For the Czech Republic geo-return is especially important as it guarantees the return on Czech contributions made to ESA back to the Czech Republic – even when Czech industry – for the time being – may by less competitive vis-à-vis the rest of Europe.

[7] ESA/C/CCXXXIX/Res.2.

[8] http://www.esa.int/Our_Activities/Technology/Going_up.

Czech Industry Incentive Scheme

In the Agreement between ESA and the Czech Republic[9] concerning the accession to the ESA, 45% of the Czech mandatory contribution (amounting to €2.3 million at the economic conditions of 2009)[10] was allocated to a special transitional ESA programme entitled Czech Industry Incentive Scheme (CIIS).

The aim of this transitional programme is, in accordance to the ESA's rules and procedures, to adapt the Czech Republic's industry, operators, scientific community and other actors to the ESA's requirements preparing the Czech actors to become competitive and thereby achieving maximum return of the contributions (industrial return), as well as to efficiently engage in appropriate optional programmes of ESA.

To advise ESA's Director General on the implementation of transitional measures under this programme a Czech-ESA Task Force was established with a membership nominated by both ESA and the Government of the Czech Republic. The mandate of the Task Force is for 6 years and terminates at the end of the transition period (2009-2014).

The transitional measures allow, inter alia:

- Recommending and placing of contracts;
- Training activities;
- Organisation of workshops or seminars and;
- To cover the implementation costs of the programme.

This special ESA programme has been instrumental in the achievement of all mid-term objectives of the NSP (2010) but comes to an end of 2014.

Czech Republic in ESA

The Czech Republic acceded to ESA in November 2008.[11] It has been cooperating with ESA since 1996 when the Cooperation Agreement was signed. Since 2004, the Czech Republic participated in the Programme for European Cooperating States (PECS).

The contribution of the Czech Republic to ESA is around €13.9 million in 2014 which represents 0.34% of ESA budgets. It covers both mandatory activities and optional programmes. Of this total, 57% of the contribution is dedicated to mandatory activities (incl. Guiana Space Centre). Based on GDP calculation, the Czech Republic is currently obliged to contribute 0.99% of ESA mandatory activities budget (General budget).

The Czech Republic is currently the smallest contributor among the ESA Member States in spite of its GDP. E.g. Greece, Portugal and Romania contribute more than the Czech Republic. Some ESA Member States have even smaller GDP per inhabitant than the Czech Republic.

[9] Agreement between the Czech Republic and the ESA concerning the accession of the Czech Republic to the Convention for the establishment of a ESA and related terms and conditions (Communication of MFA No. 93/2009 Coll. of International Agreements).

[10] This amount includes contributions from the other ESA Member States.

[11] Convention for the establishment of a ESA (Communication of MFA No. 92/2009 Coll. of International Agreements).

ESA Member State	2014 Contribution (mil. €)	Comparision with Czech Republic Contribution (%)
Germany	765,720	5,516%
France	754,535	5,436%
Italy	349,985	2,521%
Great Britain	270,038	1,945%
Belgium	**188,645**	**1,359%**
Spain	139,194	1,003%
Switzerland	126,536	912%
Netherlands	**125,103**	**901%**
Sweden	**94,564**	**681%**
Norway	57,145	412%
Austria	**50,169**	**361%**
Poland	**28,686**	**207%**
Denmark	23,373	168%
Romania	**22,528**	**162%**
Finland	**19,908**	**143%**
Ireland	**18,375**	**132%**
Luxembourg	18,302	132%
Portugal	**16,342**	**118%**
Greece	**14,529**	**105%**
Czech Republic	**13,882**	**100%**

Figure 8: Contributions to 2014 ESA Budget. Source: ESA; MT analysis

HDP - PPS per Inhabitant (€)		
	2012	%
Austria	33,100	160%
Belgium	30,700	148%
Czech Republic	20,700	100%
Denmark	32,100	155%
Finland	29,400	142%
Greece	**19,200**	**93%**
Ireland	32,900	159%
Netherlands	32,600	157%
Poland	**17,100**	**83%**
Portugal	**19,400**	**94%**
Romania	**12,800**	**62%**
Sweden	32,200	156%

GDP (mil. €)	
2012	%
307,004	201%
375,881	246%
152,926	100%
245,252	160%
192,350	126%
193,749	127%
163,938	107%
599,338	392%
381,204	249%
165,108	108%
131,579	**86%**
407,820	127%

Figure 9: GDP Comparison of some ESA Member States. Source: Eurostat, MT analysis

Recommendations

After the Czech Republic acceded to ESA in 2008, also Romania (2011) and Poland (2012) joined ESA. There are also other EU Member States wishing to become ESA Member States in near future (Hungary and Estonia probably in 2015). Since the transitional period of 6 years will be completed by the end of 2014, the Czech Republic will not benefit any longer from the protection ESA and its Member States granted to it. The ESA rules on geographical return in connection with the massive contributions of states joining ESA after the Czech Republic will help these states to create and incubate capacities and capabilities in their respective industries, which will be soon ready to compete with the Czech industry. Without significant increase of contribution to ESA optional programmes, the Czech Republic will lose the competitive advantage which has been systematically built so far. It could also lead to devaluation of current investments of the Czech Republic to its space capabilities and capacities and loss of its positions in the European and global space market. Having in mind this fact, the Czech Republic's contribution to ESA optional programmes has to be at least doubled. These contributions to ESA should be seen as leverage to increase the return of the Czech contributions to the space activities of the EU and EUMETSAT procurements (Galileo, Copernicus and MSG, MTG, MetOp-SG) and in development in Horizon 2020.

The Czech Republic subscribed optional programmes at the ESA Councils at ministerial level in Hague 2008 and Naples 2012.

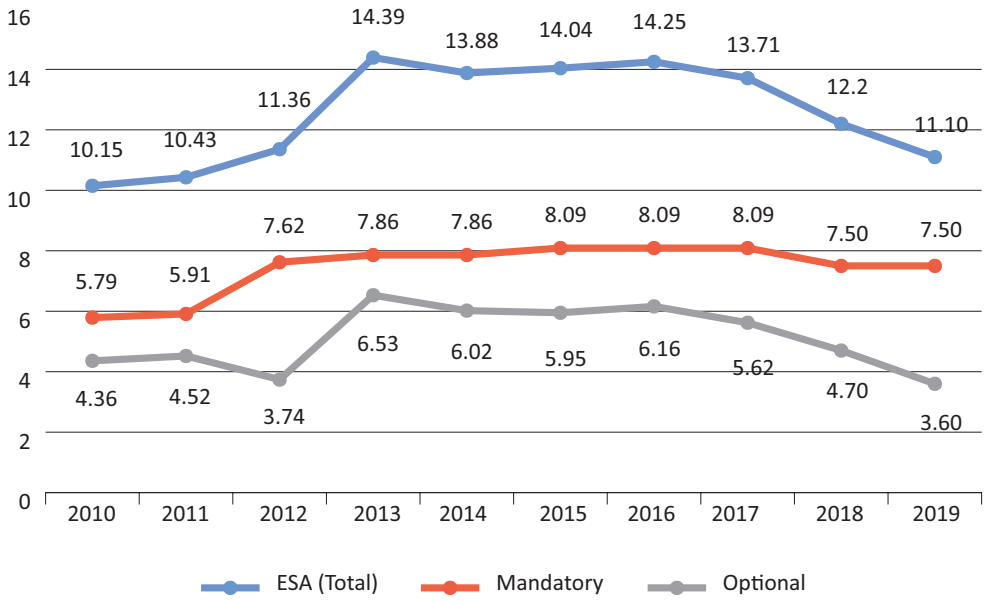

Figure 10: The Czech Republic's Contribution Evolution based on CM08 and CM12 [mil. €]. Source: MT

Recommendations

Since the usual proportion between investments to mandatory activities and optional programmes is approx. 25% to 75% to be able to increase the geographical return from mandatory activities and in general to launch the sustainable return on investment, the low contribution of the Czech Republic to optional programmes (43% of its total contribution) may be considered as the major obstacle for the further development of the space industry and academia in the Czech Republic.

3.2.1.2 European Union

Mission

The strategic objectives of EU´s space policy are namely:

- To develop and exploit space applications serving Europe's public policy objectives and the needs of European enterprises and citizens, including in the field of environment, development and global climate change;
- To meet Europe's security and defence needs as regards space;
- To ensure a strong and competitive space industry which fosters innovation, growth and the development and delivery of sustainable, high quality, cost-effective services;
- To contribute to the knowledge-based society by investing strongly in space-based science, and playing a significant role in the international exploration endeavour;
- To secure unrestricted access to new and critical technologies, systems and capabilities in order to ensure independent European space applications;
- To secure independent, reliable and cost-effective access to space.

With the Treaty of Lisbon,[12] space policy also becomes a key area of interest of the EU with very high political, security and economic potential, as can transpire from its objectives above.

The goals of space policy are linked to a number of present EU policies (for example, transport policy, information society, environment policy) and overlap with a multitude of scientific fields of the General Programmes (space, traffic, environment, information and communication technology, nanotechnology, and materials).

[12] Lisbon Treaty amending the Treaty on European Union and the Treaty establishing the European Community (Communication of MFA No. 111/2009 Coll. of International Agreements).

Governance

The space part of the EU Competitiveness Council takes place regularly. The outcomes of these sessions are Orientations or Conclusions related to important space issues – industrial policy, space policy, security and space, space programmes.

There is also the Space Council as a joint and concomitant meeting of EU Competitiveness Council and ESA Council at ministerial level based on Article 8 of the Framework Agreement between EU and ESA.

The European Defence Agency (EDA) acts under the EU Council's authority and according to its guidelines support the EU Member States and the EU Council in their effort to improve European defence capabilities for the EU Common Security and Defence Policy. EDA manages cooperative European defence projects, supports R&T, boosts the European defence technological and industrial base, etc. The total EDA budget was approx. €30.5 million in 2013.

EDA support several space-related activities in its work programme, bearing an important potential for cost-effective capability improvements for the defence community. Five key areas have been looked at in particular, ranging from space situational awareness (SSA); communications; observation; and command control of unmanned air systems; to the area of critical space technologies for European non-dependence.

The European Commission (EC) is the main actor and creator of initiatives relating to space policy. It has been releasing several Communications on this matter.

The European GNSS Agency (GSA) is an official EU regulatory authority which implements certain tasks associated with the progress of GNSS programmes Galileo and EGNOS. It deals with the security issues and the promotion and marketing of the systems, including by establishing contacts with users and potential users of the services provided under the Galileo and EGNOS programmes. Furthermore, it performs tasks associated with the exploitation phases of the systems, including the operational management of the programmes, the promotion of the applications and services on the satellite navigation market and the promotion of the development of fundamental elements relating to the programmes.

The European Union Satellite Centre (EUSC) is an EU agency located near Madrid, Spain. It is one of the key institutions for EU Common Security and Defence Policy. Its mission is to support the decision-making of the EU by providing analysis of satellite imagery and collateral data. The EUSC priorities reflect the key security concerns as defined by the European Security Strategy, such as monitoring regional conflicts, state failure, organized crime, terrorism and proliferation of weapons of mass destruction.

The European Parliament acts as a co-legislator for nearly all EU law and together with the EU Council the European Parliament adopts or amends proposals from the EC. Parliament also supervises the work of the EC and adopts the EU budget. It also works closely with national parliaments of EU Member States.

In order to do the preparatory works for the plenary sessions, its Members are divided into a number of specialised standing committees. Especially the Committee on Industry, Research and Energy and the Subcommittee on Security and Defence (Committee Foreign Affairs) are space relevant. In order to informally exchange views among Members on particular subjects and to promote contacts between Members and civil society, the interngroups are being established. Interngroup Sky & Space focus on support of space related decision processes and activities of the European Parliament.

Activities

EU actually governs the following space programmes: Galileo, EGNOS, the European Programme for the establishment of a European capacity for Earth Observation (Copernicus) and the Space Surveillance and Tracking. EU also supports space activities in the framework of Horizon 2020 (for 2014-2020) especially in the priority “Space”. The EU activities are in details discussed in Section 6.

The Horizon 2020 budget directly dedicated to space amounts to €1.536 billion which represents 1.94% of its total budget €79.271 billion (including EURATOM Regulation). Beyond this amount, for the period 2014-2020 €7.071 billion in current e.c. (including €100 million on Galileo chipsets R&D) is allocated for Galileo programme and €3.786 billion (in 2011 e.c.) for Copernicus programme.

Practical consequence of the higher interest and involvement of EU to space activities is the need of European space standards. That has led to the request by EC to the three European standard organizations (CEN, CENELEC and ETSI) to implement the production of European space standards. In practice it is closely coordinated with the European Cooperation for Space Standardization (ECSS).

The European Interparliamentary Space Conference (EISC) was established in 1999 as a permanent forum for interparliamentary co-operation in space between the European national parliaments interest in space policy. It aims at facilitating the exchange of information on space activities and at promoting mutual understanding of national policies through the provision of a forum for analysing the major issues at stake in the European space sector.

Industrial Policy

The EC released in 2013 its Communication on EU space industrial policy in which it sets five specific objectives:

- Establish a coherent and stable regulatory framework
- Further develop a competitive, solid, efficient and balanced industrial base in Europe and support SME participation;
- Support the global competitiveness of the EU space industry by encouraging the sector to become more cost-efficient along the value chain;
- Develop markets for space applications and services;
- Ensure technological non-dependence and an independent access to space.

The EC also underlined that an EU space industrial policy can only be effective if based on efficient cooperation between the three actors of the European space policy: the EU, ESA and their respective Member States.

EU procurement is governed by the Financial Regulation and its Implementing Rules which are in line with the WTO Agreement on Government Procurement. These instruments embody the principle of non-discrimination and do not allow any form of geo return.

Czech Republic in EU

Since 2004 the Czech Republic is an EU Member State[13] and contributes to EU budget (i.e. also to EU space activities) according to its share (its share is about 1.2% of EU budget). As the result of EU Cohesion Policy the Czech Republic may benefit from the EU funds to improve the economic well-being and avoid regional disparities. In 2013, the total income of the Czech Republic from EU budget was approx. 3.2 % its GDP, the share of net incomes was 2.2 % of its GDP.

The contribution of the Czech Republic to EDA was approx. €0.67 million in 2013 (€0.35 million which represents 1.14 % of EDA budget and €0.32 million as the contribution to optional R&D projects and programmes). The Czech Republic has not directly support any space related activities as well as the Czech entities were not active in this area in 2013.

The Czech Republic inherently participates in all EU space related activities. The Czech Republic actively supports the strengthening of the role of GSA especially when the use of its existing infrastructure for other EU space programmes is concerned to avoid any unnecessary duplications and budget increases. The seat of the GSA was relocated to Prague in September 2012.

3.2.1.3 EUMETSAT

Mission

EUMETSAT[14] is an intergovernmental organization founded in 1986, focused on continuous supplying weather and climate-related satellite data, images and products to the National Meteorological Services of its Member and Cooperating States in Europe, and other users worldwide.

The service provided by EUMETSAT helps to enhance and safeguard the daily lives of European citizens. They aid meteorologists in identifying and monitoring the development of potentially dangerous weather situations and in issuing timely forecasts and warnings to emergency services and local authorities, helping to mitigate the effects of severe weather and protecting human life and property.

[13] Treaty on European Union and Treaty on the Functioning of the European Union

[14] Convention for the Establishment of a European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and Amending Protocol to the Convention for the Establishment of a European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) (Communication of MFA No. 3/2011 Coll. of International Agreements).

This information is also critical to the safety of air travel, shipping and road traffic, and to the daily business of farming, construction and many other industries.

Governance

EUMETSAT is governed through the EUMETSAT Council as the highest delegate body of representatives of the Member States. The decisions of Council are based upon recommendations of its by its advisory bodies, namely: the Administrative and finance group (AFG), Scientific and technical group (STG), Policy advisory committee (PAC), Data policy group (DPG), STG operations working group (STG-OPSWG), STG science working group (STG-SWG), EUMETSAT Advisory committee of Cooperating states (EACCS).

The Director-General is the Chief Executive Officer and legal representative of EUMETSAT, reporting to the Council. He is responsible for the implementation of all Council decisions and for the execution of all tasks and commitments of the organisation.

Activities

EUMETSAT's key partner in developing and manufacturing satellites and supporting technologies is the ESA. EUMETSAT has been also carrying out its own programmes focused on meteorological Earth observations on mandatory and optional programmes, which the Czech Republic have to / can participate in.

Mandatory programmes are the basic programmes required to continue the provision of observations from geostationary and polar orbits or other programmes as defined as such by the EUMETSAT Council. Financial contributions of Member States to mandatory programmes are proportional to the Gross National Income (GNI) of the individual Member States. In case of optional programmes, any Member State shall have the opportunity to participate in accordance with its interest.

The mandatory programmes of EUMETSAT are Meteosat Transitional Programme (MTP), Meteosat second generation programme including extension for MSG-4, Meteosat Third Generation (MTG), EUMETSAT Polar System (MetOp) and EUMETSAT Polar System Second Generation (MetOp-SG). The optional programmes of EUMETSAT are EUMETSAT Jason-2 Altimetry Optional Programme and EUMETSAT Jason-3 Altimetry Optional Programme.

Industrial Policy

EUMETSAT don´t apply the industrial return or geo-return policy. Due to the partnership of EUMETSAT and ESA in development of satellites, there is the opportunity to take advantage of synergy between ESA and EUMETSAT meteorological programmes. In frame of ESA´s programmes are developed just functional prototypes of each meteorological satellite. Other satellites of the series are procured by ESA on behalf of EUMETSAT and from the EUMETSAT´s budget. In case of participation in ESA´s meteorological programme there is the chance to reach the return-on-investment expressed by coefficient 4 – 5 in total (depends on in concrete case).

Czech Republic in EUMETSAT

The Czech Republic is a full Member State of EUMETSAT since 2010, after having been a Cooperating State since 2005. The Czech Republic takes part in EUMETSAT mandatory programmes, and also can (in principle) participate in its optional programmes. As a full Member State, the Czech Republic can take part in all EUMETSAT's industrial, technological and research projects and tenders.

The total expenditure of EUMETSAT on mandatory and optional programmes for the year 2013 was €168 million.[15]

The Czech Republic's annual contribution for the period 2014 – 2019 will be €2.53-5.34 million (1 % of EUMETSAT budget). The Czech Republic contributes to all mandatory programmes but not to the optional ones, as it does not take part in them. In recent years there were no contracts placed by EUMETSAT to the Czech Republic.

Recommendations

Given the fact that data from the EUMETSAT meteorological satellites are one of the key information elements of modern meteorology (namely for weather forecasting and warnings, as well as in climatology),

[15] EUMETSAT Annual Report 2013.

and taking into account very close, mutual links between EUMETSAT, ESA and Copernicus activities and programmes, it is highly desirable and recommendable to support present and future Czech activities within EUMETSAT. Besides supporting EUMETSAT mandatory programmes (MSG, MTG, MetOp, EPS-SG) through the regular membership of the Czech Republic in EUMETSAT, the Czech Republic should also continue to play an active role in various R&D activities of EUMETSAT and its programmes. Beyond this, Czech companies and institutions should broaden their involvement in various tenders of EUMETSAT, benefiting on their experience with similar ESA tenders and programmes (namely MTG and MetOp-SG/EPS-SG related programmes). All of this assumes and requires that the Czech Republic maintains its full membership in EUMETSAT.

3.2.2 *ORGANISATIONS WITH A STAKE IN SPACE ACTIVITIES*

These organizations have a stake in space activities (from technological, science or another point of view). They use the space systems as a key tool for their mission or activities. They can also operate their own satellites. Their activities have strong synergies with activities of organisations directly involved in space activities. They may also serve as platforms for creating of environment and rules for using of outer space.

3.2.2.1 European Southern Observatory

The European Southern Observatory (ESO)[16] was founded in 1962 and is the foremost intergovernmental astronomy organisation in Europe and the world's most productive astronomical observatory. ESO has 15 Member States.

Mission

ESO's main mission is to provide state-of-the-art research facilities to astronomers and astrophysicists, allowing them to conduct front-line science in the best conditions.

Governance

ESO's ruling body is ESO Council where the Member States are represented. The day-to-day running of the organisation is the responsibility of the Executive under ESO's Director General. Other governing bodies of ESO are: the Finance Committee (FC), the Scientific Technical Committee (STC), the Observing Programmes Committee (OPC) and the Users Committee (UC).

Activities

The ESO does not have space related activities however; its work often either complements space science activities or is instrumental in defining them. ESO is operator of world´s most advanced mirror telescope VLT located at Paranal observatory (Chile) and at the same time major participant in consortium operating the biggest and most expensive radio-telescope array located at Chajnantor (Chile). The world´s most prominent project of ground-based astronomy has been started by ESO this year – construction of the new world´s largest telescope E-ELT. The construction should last for 10 years and calculated expenses are over 1 billion €.

By building and operating a suite of the world's most powerful ground-based astronomical telescopes enabling important scientific discoveries, ESO offers numerous possibilities for technology spin-off and transfer, together with high technology contract opportunities and is a showcase for European science and industry.

The annual Member State contributions to ESO are approx. 150 million €, overall budget is about 180 million €.

Industrial Policy

So far ESO has been awarding contracts without considerations regarding fair re-distribution of the financial contributions from its Member States. With the recently announced financially demanding optional programmes (E-ELT) the geo-return principle is seriously considered by ESO in order to make the contribution to the programme attractive for ESO Member States.

[16] Convention establishing the European Organisation for Astronomical Research in the Southern Hemisphere (Communication of MFA No. 73/2011 Coll. of International Agreements).

Czech Republic in ESO

The Czech Republic became a Member State in 2007. The annual contribution of the Czech Republic amounts to approx. 1.4 million €, that represents 1.05% of all Member States´ contributions.

Observing time of ESO assets is allocated on the basis of the quality of the project. The success rate of projects by Czech astronomers is around 3.5 %.

In some cases, Czech scientific teams and industry that participates in space activities have also been involved in ESO programmes.

3.2.2.2 North Atlantic Treaty Organization

The North Atlantic Treaty Organization (NATO) is an intergovernmental military organisation based on the North Atlantic Treaty signed in 1949. The organization constitutes a system of collective defence whereby its Member States agree to mutual defence in response to an attack by any external party. NATO has 28 Member States, mainly in Europe and North America.

Mission

NATO's essential purpose is to safeguard the freedom and security of its Member States through political and military means. NATO promotes democratic values and encourages consultation and cooperation on defence and security issues to build trust and, in the long run, prevent conflict. It also has the military capacity needed to undertake crisis-management operations if the diplomatic efforts fail.

Governance

NATO is ultimately governed by its 28 Member States represented by Permanent Representatives. The Permanent Representatives from the North Atlantic Council (NAC). From time to time the NAC also meets at higher level meetings involving foreign ministers, defence ministers or heads of state or government (HOSG) and it is at these meetings that major decisions regarding NATO's policies are generally taken. NATO summits also form a further venue for decisions on complex issues, such as enlargement. The NAC is chaired by the NATO Secretary General.

NATO has both civilian and military structures.

Activities

NATO´s space activities are mainly carried out by the Science and Technology Organization (STO). STO is a NATO subsidiary body established with a view to meeting to the best advantage the collective needs of NATO in the fields of science and technology. The centrepiece of the space technology work is carried out by NATO Space R&T Team comprised of senior space experts and operators from government, industry and academia representing the full spectrum of national and industry space planning, acquisition, test and operational organizations. The focused technical activities of the Team are conducted under the auspices of several STO Panels addressing space technologies and capabilities.

A primary objective of the Team is to facilitate a cross-NATO Community of Interest (COI) that brings world-class technical expertise and solutions to NATO's space capabilities requirements. The technical space-related activities of the STO Panels directly benefit from the involvement and assistance of the subject matter experts within the COI. The COI also provides a forum for shared awareness of NATO's current and future space requirements for force enhancement, space situational awareness and space capability preservation. The lessons learned from the shared challenges of bringing space effects to today's NATO forces help guide the underlying research and technology initiatives necessary to develop and protect the next generation of NATO Alliance space forces.

Although specific developmental requirements are not currently documented for NATO-common space capabilities, NATO Allied Command Transformation (ACT) has established a Long Term Capability Requirement (LTCR) for Space Capabilities Preservation addressing general space situational awareness and space mission protection requirements for NATO space capabilities. The implementation steward for this LTCR is the STO SCI Panel, which has formulated a framework to enable an organized programme of work across involved NATO space organizations and activities.

NATO's budget for 2013 was €2.365 million.

Industrial Policy

NATO does not use the geo-return approach.

Czech Republic in NATO

The Czech Republic became a NATO Member State in 1999. In 2013, the Czech Republic contributed approx. €29 million to NATO budget ((cost share arrangements for the Czech Republic valid from 2014 to 2015 represent 0.942% of NATO budget). In frame of NATO´s space activities the Czech representative participates in STO Task Group "Space Environment Support to NATO Space Situational Awareness". Since STO activities are based on non-contractual cooperation there is no space specific income from NATO.

3.2.2.3 Intersputnik

Mission

Intersputnik[17] is an international intergovernmental organization headquartered in Moscow, with 26 Member State countries from all over the world.

Governance

Intersputnik's highest governing body is the Board. Each Intersputnik Member State has its Representative on the Board, and each Representative has one vote regardless of the amount of the country's investment in the Share Capital. All Representatives have equal rights.

Activities

Intersputnik's core business is leasing satellite capacity to telecommunications operators, broadcasters and corporate customers under agreements with partner operators as well as providing full-scale services for the establishment and operation of satellite networks through its subsidiary Intersputnik Holding, Ltd.

Industrial policy

Intersputnik is implementing full-scale projects aimed at procuring and deploying telecommunication satellites in Intersputnik's own orbital positions.

Czech Republic in Intersputnik

Former Czechoslovakia was a founding Member State in 1971, the Czech Republic has been the Member State since 1993. Moreover the Czech Republic has been a member of the Intersputnik´s revision commission since 2000. The Czech Republic has also chaired the commission since 2010.

3.2.2.4 European Standardization Organizations

European Standardization plays an important role in the development and consolidation of the European Single Market, and thereby helps to create the conditions for increased trade and economic growth.

The three European Standardization Organizations (ESOs), CEN, CENELEC and ETSI are officially recognized as competent in the area of voluntary technical standardization. EU Regulation (1025/2012) which settles the legal framework for standardization, has been adopted by EP and by the Council of the EU, and entered into force on 1 January 2013. ESOs cooperates on policy and technical matters of common interest. This cooperation is coordinated by the Joint Presidents' Group (JPG).

In area of space activities the standardisation is closely coordinated with the European Cooperation for Space Standardization (ECSS).

3.2.2.4.1 CEN/CENELEC

Mission

The European Committee for Standardization (CEN) and The European Committee for Electrotechnical Standardization (CENELEC) are two private organizations that brings together the National Standardization Bodies of 33 European countries. Mission of CEN/CENELEC is to fulfil the needs of the stakeholders via

[17] Agreement on the establishment of the International System and Organization of Space Communications (Decree of MFA No. 142/1973 Coll.).

providing voluntary European standards and related products and services for the benefit of businesses, consumers and other standard users in Europe. Governance

The European Standardization Organizations have created a joint structure to facilitate cooperation on strategic matters of common interests: the CEN-CENELEC Presidential Committee, which is a governing body mandated by the Administrative Boards of both organizations to manage and administer non-sector specific policies and joint actions in relation to matters of common interest.

In general, CEN and CENELEC each have their own respective governance bodies - General Assembly, Administrative Board, Technical Board, Advisory Bodies and Technical Bodies.

Activities

CEN very closely cooperates with two other standardization organizations – CENELEC and ETSI.

The standardization activities of CEN and CENELEC cover products, processes and services across a wide range of particular fields. Although their fields of competence are generally different, CEN and CENELEC cooperate in a number of areas of common interest, such as the machinery sector or information and communication technologies (ICTs). Furthermore, they share common policies on a number of issues.

Specific CEN activities cover: Accessibility, air and Space, bio-based products, chemistry, construction, consumer products, energy and utilities, environment, food, health and safety, healthcare, heating, ventilation and air conditioning (HVAC), ICTs, innovation, machinery safety, materials, measurement, nanotechnologies, pressure equipment, security and defence, services, transport and packaging.

Specific CENELEC activities cover electrotechnical standardization in sectors such as: Electric vehicles, smart grids, smart metering, household appliances, information and communication technologies (ICTs), electromagnetic compatibility (EMC), electrical engineering, fibre optic communications, fuel cells, medical equipment, railways, smart grids, smart metering, solar (photovoltaic) electricity systems, etc.

Industrial Policy

Industrial policy is not implemented.

Czech Republic in CEN/CENELEC

The Czech Republic represented by the Czech Office for Standards, Metrology and Testing (COSMT). Czech experts can participate on the development of new standards and via COSMT can comments the prepared standards, in which they are not involved directly.

3.2.2.5 Committee on the Peaceful Uses of Outer Space

The UN Committee on the Peaceful Uses of Outer Space (COPUOS) was established by the General Assembly resolution in 1959. Today, COPUOS has 76 Member States and is one of the largest committees in the UN.

Mission

The mission of COPUOS is to review the scope of international cooperation in peaceful uses of outer space, to devise programmes in this field to be undertaken under UN auspices, to encourage continued research and the dissemination of information on outer space matters, and to study legal problems arising from the exploration and uses of outer space.

Governance

The Committee has two standing Subcommittees: the Scientific and Technical Subcommittee and the Legal Subcommittee. The Legal Subcommittee is the primary international forum for the development of laws and principles governing outer space.

The Committee and its two Subcommittees meet annually to consider questions assigned by the General Assembly, reports submitted to them and issues raised by the Member States. The Committee and the Subcommittees make recommendations to the General Assembly.

The activities of COPUOS are administratively supported by the UN Office for Outer Space Activities (UNOOSA).

Activities

COPUOS oversees implementation of five UN treaties and agreements relating to activities in outer space. Among others it manages, through UNOOSA, "Programme on Space Applications", which promotes knowledge and experience of space applications around the world; and the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER), delivering satellite imagery during disasters.

Industrial Policy

Due to the nature of and limited budget for activities, industrial policy is not implemented.

Czech Republic in COPUOS

Out of five treaties and agreements[18] the Czech Republic has not yet ratified the "Moon Treaty", which is the agreement governing the activities of states on the Moon and other celestial bodies.

The former Czechoslovakia was one of the founding Member States of COPUOS. The Czech Republic as one of the successors continues playing an active role in COPUOS and in its two subcommittees.

During the last thirty years several UNOOSA directors and senior officers came from the Czech Republic. The Czech Republic has had a post of the chairman of the Legal Subcommittee in 2008-2009. Furthermore the Czech delegation has always been actively involved in various discussions at the COPUOS meetings, mainly on the topic of space debris.

The Czech Republic has developed as of 2013 together with Canada and Germany the "Compendium on Space Debris Mitigation Standards adopted by States and International Organizations" which is intended to be maintained in the framework of COPUOS as a reference document on national and international mechanisms on space debris mitigation and regularly updated.

The Czech delegation actively contributes to the annual meetings of all the Committee bodies and presents reports on national space activities and its position to selected agenda items.

3.2.3 OTHER ORGANISATIONS

These organizations are usually users of space systems or their technologies. They use the space systems or technologies as a part of their mission or activities or vice versa and therefore could have strong synergy with organisations directly involved in space activities.

3.2.3.1 European Centre for Medium-Range Weather Forecasts

Mission

The European Centre for Medium-Range Weather Forecasts (ECMWF) was established in 1975, in recognition of the need to pool the scientific and technical resources of Europe's meteorological services and institutions for the production of medium-range weather forecasts and of the economic and social benefits expected from it.

Governance

ECMWF is an independent inter-governmental organisation supported by 30 Member States and concluded co-operation agreements with 14 Co-operating States. ECMWF is established by a Convention that came into force on 1 November 1975. The organs of the ECMWF are the Council and the Director General. The Council is assisted by the Scientific Advisory Committee and Finance Committee. Council further established the Technical Advisory Committee, Policy Advisory Committee, Advisory Committee for Data Policy and Advisory Committee of Co-operating States.

Activities

ECMWF provides weather services with medium-range forecasts of global weather to 15 days ahead as well as with monthly and seasonal forecasts. ECMWF runs a sophisticated medium-range prediction model of the

[18] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Decree of MFA No. 40/1968 Coll.), Agreement on the rescue of astronauts, the return of astronauts and the return of objects launched into outer space (Decree of MFA No. 114/1970 Coll.), Convention on International Liability for Damage Caused by Space Objects (Decree of MFA No. 58/1977 Coll.), Convention on Registration of Objects Launched into Outer Space (Decree of MFA No. 130/1978 Coll.).

global atmosphere and oceans. The starting point for all medium-range forecasts is accurate information about the current state of the weather worldwide. The accuracy of forecasts has been greatly enhanced by data from geostationary and polar-orbiting satellites.

ECMWF is one of the most advanced users of satellite data for weather prediction and climate monitoring and collaborates closely with satellite data providers such as the EUMETSAT and the ESA, the NASA, and the NOAA.

Industrial policy

Due to the nature of and limited budget for activities, industrial policy is not implemented.

Czech Republic in ECMWF

The co-operation Agreement between the Czech Republic and the ECMWF has entered into force on 1 August 2001. ECMWF's budget is funded almost entirely from annual contributions from Member and Co-operating States according to a scale based on their gross national income. The budgeted contributions for 2013 were £41.4 million and the Czech Republic contribution was 0.499% of the total ECMWF budget.

Czech Republic is granted for its own requirements in the field of weather forecasting a non-exclusive license and any other non-exclusive rights of use in respect of industrial property rights, computer programs and technical information which results from work carried out pursuant to the Convention and which belong to the ECMWF.

Recommendations:

The Czech Republic should become a Member State of the ECMWF in the near future. That would give the national meteorological service the opportunity to co-decide on a long-term strategy for the development of the global medium-range forecasting systems developed and operated by the ECMWF.

3.2.3.2 Group on Earth Observations

Mission

The Group on Earth Observations (GEO) was established in February 2005 by the Third Earth Observation Summit in Brussels at the end of a process that started in 2003 with the First Earth Observation Summit in Washington, DC. Summits all called for improving the world´s observation systems. GEO coordinates international efforts to build a Global Earth Observation System of Systems (GEOSS). It links existing and planned Earth observation systems and supports the development of new ones in cases of perceived gaps in the supply of information on the environment. The aim is to construct a global public infrastructure for Earth observations that, like the Internet, consists of a flexible and distributed network of content providers.

Governance

GEO is a voluntary partnership of governments and international organizations. Membership in GEO is open to all Member States of the United Nations and to the European Commission. GEO's members include 90 countries, the European Commission and 77 intergovernmental, international and regional organizations. GEO is governed by a Plenary, takes decision by consensus of its Members and is funded by voluntary contribution. The Geo Secretariat plays a lead role in coordinating and supporting the Work Plan for implementing the Global Earth Observation System of Systems (GEOSS). The Implementation Boards and working groups provide high-level review advice, recommendations, and support in the ongoing development and implementation of the GEOSS 10-Year Implementation Plan. Ten-year work plan is prepared for the period 2005-2015 and is updated annually. The GEO-X meeting in Geneva in January 2014 approved the document Vision for 2025 GEO. Simultaneously was approved by the Geneva Declaration, which provided the GEO mandate to continue into 2025.

Activities

The main goal of GEO is creating a single global Earth observation system, GEOSS (Global Earth Observation System of Systems) for the removal of the existing fragmentation and duplication of Earth observations. Earth Observation serves different purposes, and is used by a number of institutions that operate many independent and mutually uncoordinated systems. Individual countries should gradually harmonize their national interests and objectives with the activities of GEOSS so that the financial resources were used in a

targeted where basic data sources arise. The GEO Portal offers a powerful internet access point for user seeking data, imagery and information system and services relevant to all parts of the globe. It connects users to existing data bases and to portals and provides reliable, up-to date and user-friendly information vital for the work of decision makers, planners and emergency managers. GEOSS is addressing nine areas of critical importance to people and society. It aims to empower the international community to protect itself against natural and human-induced disasters, monitor the environmental sources of health hazard, manage energy resources, respond to climate change and its impact, safeguard water resources, improve weather forecast, manage ecosystems, promote sustainable agriculture and conserve and sustainably use biodiversity.

Industrial policy

Due to the nature of and limited budget for activities, industrial policy is not implemented.

Czech Republic in GEO

The Czech Republic became a member of the Group on Earth Observations (GEO) under Government Resolution No 1469 of 20 December 2006 in connection with the participation of the Czech Republic in the European Union's Copernicus. Responsibility for involvement in structures GEOSS is the MOE, MOT, MEYS. Coordination and participation in GEO/GEOSS manages National Secretariat for GEO/Copernicus. The Czech Republic actively participates in the GEO Plenary and in Committees. CHMI through is active in the working group for sharing data (Data Sharing Task Force) focusing in particular on the activities of extreme hydrological events monitoring, forecasting and early warning and participates the development of a global warning system on droughts (Global Drought Monitor). In the future, more attention will also focus on activities in the field of agriculture and forestry. Activity aimed to build GEO/GEOSS/Copernicus is integration of coordinated observations of the atmosphere, hydrosphere, geosphere and other components of Earth observation in the Czech Republic so that the resulting data and information can more efficiently serve both decision-makers as well as state institutions, the private sector and for citizens of the Czech Republic.

3.2.3.3 European Organisation for the Safety of Air Navigation

The European Organisation for the Safety of Air Navigation (EUROCONTROL) is an intergovernmental organisation and pan-European civil-military organisation promoting cooperation and driving performance improvements in the European ATM system. It is made up of 40 Member States and the EU. It is an operational organisation that is the key player in increasing of performance of Air Traffic Management (ATM).

Mission

EUROCONTROL's mission is to harmonize and integrate air navigation services in Europe, aiming at the creation of a uniform ATM system for civil and military users, in order to achieve the safe, secure, orderly, expeditious and economic flow of traffic throughout Europe, while minimizing adverse environmental impact. The vision of EUROCONTROL is to effectively drive the development and operation of the pan-European ATM system to facilitate the sustainable growth of aviation.

The expertise of EUROCONTROL is an essential tool to enhance the current level of ATM and aviation safety, not only at regional level, but also at global level.

Governance

The governance structure of the EUROCONTROL organisation is composed of two governing bodies, the EUROCONTROL Commission and the Provisional Council, and an executive body: the Agency. The organization involves aviation stakeholders in its decision-making process.

The EUROCONTROL Permanent Commission represents Member States at ministerial level. It formulates general policy and is responsible for decisions and regulatory functions. The Commission also approves the EUROCONTROL annual budget, the five-year programme, contract regulations, financial regulations and staff regulations, and is responsible for appointing the Director General and Directors. It gives a final ruling on the Agency’s annual accounts.

Member States are represented in the Provisional Council at Director General of Civil Aviation level. The EU participates in the work of the Provisional Council. The Provisional Council is responsible for implementing

EUROCONTROL's general policy, as established by the Permanent Commission, and for supervising the Agency's work.

EUROCONTROL's budget for 2014 is planned approx. at €510 million (not included the Maastricht Upper Area Control Centre). The Air Traffic Management Services are funded mostly by the charges applied to each aircraft, which uses the airspace of each of the Member States.

Activities

EUROCONTROL deploys European-wide air traffic management programmes and projects, involving a range of ATM players. All programmes and projects aim to build a single European sky that will deliver the ATM performance required for the twenty-first century and beyond.

Industrial Policy

As an operational organisation, EUROCONTROL does not use the geo-return approach. EUROCONTROL serves all Member States and supports them with a range of programmes, projects and activities in order to help with designing, managing, operating and supporting the European Air Traffic Management Network.

Czech Republic in EUROCONTROL

The Czech Republic became a EUROCONTROL Member State[19] in 1996. In 2014, the Czech Republic contributes €6.555 million to EUROCONTROL's budget. In recent years there were no contracts placed by EUROCONTROL in the Czech Republic.

3.2.3.4 World Meteorological Organization

Mission

The vision of World Meteorological Organization (WMO)[20] is to provide world leadership in expertise and international cooperation in weather, climate, hydrology and water resources and related environmental issues and thereby contribute to the safety and well-being of people throughout the world and to the economic benefit of all nations.

Governance

The supreme body of the Organization is the World Meteorological Congress. It assembles delegates of Members once every four years to determine general policies for the fulfilment of the purposes of the Organization, consider membership of the Organization, determine the General, Technical, Financial and Staff Regulations, establish and coordinate the activities of constituent bodies of the Organization, approve long-term plans and budget for the following financial period, elect the President and Vice-Presidents of the Organization and members of the Executive Council and appoint the Secretary-General.

WMO's members include currently 191 Member States and 6 Territories.

Activities

WMO carries out its activities through scientific and technical programmes. These are designed to assist all Members to provide, and benefit from, a wide range of meteorological and hydrological services and to address present and emerging problems. The programmes contribute substantially to the protection of life and property against natural disasters, to safeguarding the environment and to enhancing the economic and social well-being of all sectors of society in areas such as food security, water resources and transport. WMO promotes cooperation in the establishment of networks for making meteorological, climatological, hydrological and geophysical observations, as well as the exchange, processing and standardization of related data, and assists technology transfer, training and research. WMO facilitates the free and unrestricted exchange of data and information, products and services in real or near-real time on matters relating to safety and security of society, economic welfare and the protection of the environment. It contributes to policy formulation in these areas at national and international levels.

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[19] International Convention on Cooperation for the Safety of Air Navigation EUROCONTROL (Communication of MFA No.130/2004 Coll. of International Agreements).

[20] Convention of the World Meteorological Organization.

WMO does not use the geo-return approach.

Czech Republic in WMO

The Czech Republic became a member of the WMO in 1993.[21] Membership is ensured by Czech Hydrometeorological Institute (CHMI). Permanent representative in WMO is Director of CHMI who acts on technical matters for government between sessions of Congress. In the Czech Republic WMO activities affecting particular activities focused on the issue of prediction of floods, droughts and climate change.

3.2.3.5 International Maritime Organization

Mission

The International Maritime Organization (IMO)[22] is the UN specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships.

Governance

The Organization consists of an Assembly, a Council and five main Committees: the Maritime Safety Committee; the Marine Environment Protection Committee; the Legal Committee; the Technical Co-operation Committee and the Facilitation Committee and a number of Sub-Committees support the work of the main technical committees.

IMO currently has 170 Member States and three Associate Members.

Activities

IMO measures cover all aspects of international shipping – including ship design, construction, equipment, manning, operation (including monitoring and control) and maritime radio communication – to ensure that this vital sector for remains safe, environmentally sound, energy efficient and secure.

Industrial policy

Industrial policy is not implemented.

Czech Republic in IMO

The Czech Republic has been the Member State of the IMO since 1993. The Czech Republic´s financial contribution to the IMO in 2013 was £ 27,217.

3.2.3.6 International Civil Aviation Organization

Mission

To serve as the global forum of States for international civil aviation, International Civil Aviation Organization (ICAO)[23] develops policies and Standards, undertakes compliance audits, performs studies and analyses, provides assistance and builds aviation capacity through many other activities and the cooperation of its Member States and stakeholders.

Governance

The governance structure is consist of the Assembly, comprised of all Member States of ICAO, the Council, ICAO permanent body responsible to the Assembly. It is composed of 36 Member States elected by the Assembly for a three-year term.

The Secretary General of ICAO is head of the Secretariat and chief executive officer of the Organization responsible for general direction of the work of the Secretariat.

The Air Navigation Commission considers and recommends, for approval by the ICAO Council, Standards and Recommended Practices (SARPs) and Procedures for Air Navigation Services (PANS) for the safety and efficiency of international civil aviation.

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[21] The accession to the Convention of the World Meteorological Organization was established by the notification of Embassy of the Czech Republic in Washington, D.C. in January 25, 1993, which entered into force on February 24, 1993.

[22] Convention on the International Maritime Organization (Communication of MFA No. 105/1996 Coll.).

[23] Convention on International Civil Aviation (No. 147/1947 Coll.).

Activities

ICAO works with the Convention's 191 Signatory States and global industry and aviation organizations to develop international Standards and Recommended Practices (SARPs) which are then used by States when they develop their legally-binding national civil aviation regulations.

There are currently over 10,000 SARPs reflected in the 19 Annexes to the Chicago Convention which ICAO oversees, and it is through these SARPs and ICAO's complementary policy, auditing and capacity-building efforts that today's global air transport network is able to operate over 100,000 daily flights, safely, efficiently and securely in every region of the world.

In connection to space activities, ICAO publishes ICAO doc. 9613 Performance based Navigation Manual, which describes standards for using GNSS in navigation. The use of GNSS systems is also laid down in Annex 10 of ICAO Convention.

Industrial Policy

Due to the nature of organization industrial policy is not implemented.

Czech Republic in ICAO

The Czech Republic is ICAO Member State by the MT from the early beginning of ICAO.

3.2.3.7 European Organization for Nuclear Research

The European Organization for Nuclear Research (CERN) is an intergovernmental organization with 21 Member States, which site straddles the French-Swiss border. The European Centre was established under the auspices of UNESCO in 1954 in Geneva.

Mission

CERN is the laboratory dedicated to fundamental physics research of elementary particles and the structure of matter. CERN shall provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto. The Organization shall have no concern with work for military requirements and the results of its experimental and theoretical work shall be published or otherwise made generally available.

Governance

The CERN council is the highest authority of the organization and has responsibility for all-important decisions. It controls CERN's activities in scientific, technical and administrative matters. It approves programmes of activity, adopts the budgets and reviews expenditure. The council is assisted by the Scientific Policy Committee and the Finance Committee. The Director-General, appointed by the council, manages the CERN laboratory. He is assisted by a directorate and runs the laboratory through a structure of departments.

Activities

The purpose of CERN is to operate the world's largest laboratory for nuclear research, structure of matter research and related scientific experiments.

The programmes of activities of CERN is the programme carried out at its Laboratory at Geneva including a proton synchrotron for energies above ten gigaelectronvolts (10^{10} eV) and a synchro-cyclotron for energies of six hundred million electronvolts (6×10^{8} eV); the programme for the construction and operation of the intersecting storage rings connected to the proton synchrotron described in sub-paragraph (a) above; the programme for the construction and operation of a Laboratory to include a proton synchrotron for energies of about three hundred gigaelectronvolts (3×10^{11} eV) and any other programmes failing within the mission of CERN.

Industrial Policy

CERN procures supplies and services and awards orders and contracts in compliance with the principles of transparency and impartiality. CERN's tendering procedures are selective and do not take the form of open invitations to tender or price enquiries. They shall, in principle, be limited to firms established in the Member States. There should be achieved balanced industrial return for the CERN Member States.

The Czech Republic is a full Member State since July 1993. The membership enable to Czech scientific teams to use unique CERN scientific infrastructure and participate on international scientific experiments. During the cooperation the Czech scientists obtains lot of new very valuable contacts and experiences. At the same time it open doors for the Czech industry which could become the suppliers of components to CERN infrastructure, incl. high tech a specialized elements.

CERN and ESA have an agreement on cooperation in R&D.

CERN and ESA also have an agreement of the sharing of the use technologies developed. This has allowed the implementation of the SATRAM project building on a detector (Timepix) developed for the Large Hadron Collider (LHC) with the participation of a Czech academic entity. SATRAM instrument developed in industry using know-how provided by academia is currently flying in ESA's PROBA-V.

In some cases, Czech scientific teams and industry that participates in space activities have also been involved in CERN programmes.

MEYS is responsible for Czech membership in CERN.

3.2.3.8 International Mobile Satellite Organization

Mission

The International Mobile Satellite Organization (IMSO)[24] is the intergovernmental organization that oversees certain public satellite safety and security communication services provided via the Inmarsat satellites.

Governance

The residual intergovernmental organization IMSO continues with 98 Parties, operating through the Assembly of Parties, its Advisory Committee (comprising a number of Member States appointed by the Assembly) and a small Directorate, headed by the Director General who is the Chief Executive Officer and legal representative of the Organization.

Activities

The IMSO provides some public services – services for maritime safety within the Global Maritime Distress and Safety System (GMDSS) established by the International Maritime Organization (IMO), distress alerting, search and rescue co-ordinating communications, maritime safety information (MSI) broadcasts, etc.

Industrial policy

Industrial policy is not implemented.

Czech Republic in IMSO

The Czech Republic has been the Member State of the IMSO since 1988. Membership of IMSO does not incur any costs or financial commitments for Member States, as the budget of the Organization is funded through contributions from the companies that provide public satellite communication services.

3.2.3.9 International Telecommunication Union

Mission

The International Telecommunication Union (ITU)[25] is a specialized agency of the United Nations. It is an inter-governmental organization founded 1865 that seeks deepening of the international cooperation in all aspects of telecommunications, promotes the development of corresponding telecommunications means, ensures the efficient distribution of the radio spectrum and its coordinated use.

Governance

The ITU´s supreme decision making body is the Plenipotentiary Conference held once every 4 years. At the Plenipotentiary Conference, the Member States´ delegations elect the Secretary General, the Directors of the three ITU sectors and the Council consisting of 40 Member States. There are 193 Member States of the

[24] Convention on the international mobile satellite organization (Communication of MFA No. 7/2011 Coll. of International Agreements).

[25] International Telecommunication Constitution and Convention (Communication of MFA No.69/2013 Coll. of International Agreements).

The Czech Republic in CERN

ITU at the moment and the membership is also open to non-governmental organizations like telecommunications operators, equipment manufacturers, research and academic organizations which can join ITU as non-voting Sector Members.

Activities

The ITU is structured according to the purpose to the three sectors - the radiocommunication sector (ITU-R), the telecommunication sector (ITU-T) and the development sector (ITU-D). For the NSP purposes, relevant parts of the ITU-R are important to be mentioned, as the ITU-R facilitates coordination and harmonisation of the use of the radio spectrum on a global scale and promotes international cooperation in assigning satellite orbits.

Industrial policy

Industrial policy is not implemented.

Czech Republic in ITU

The Czech Republic has been the Member State of the ITU since 1993, respectively, as former Czechoslovakia, since 1920.

3.2.3.10 International Telecommunications Satellite Organization

Mission

The International Telecommunications Satellite Organization (ITSO)[26] is an intergovernmental organisation charged with overseeing the public satellite telecommunications service obligations of Intelsat S.A., the commercial telecommunications entity.

Governance

The ITSO is headed by a Director-General, who is overseen by Assembly of Parties.

Activities

The ITSO monitors and interfaces with Intelsat, Ltd., to ensure the availability of international public telecommunications services to all countries in the world since the privatisation of the former intergovernmental organization in 2002.

Industrial policy

Industrial policy is not implemented.

Czech Republic in ITSO

The Czech Republic has been the Member State of the ITSO since its creation in 2002.

3.2.3.11 EUTELSAT IGO

Mission

The EUTELSAT IGO[27] is the intergovernmental organisation charged with overseeing the basic principles that oblige Eutelsat S. A., the commercial telecommunications entity, separated from the former intergovernmental organisation by privatisation in 2001.

Governance

To fulfil its role, the EUTELSAT IGO consists of the following organs:

- Assembly of Parties, composed of all States, Parties to the EUTELSAT Convention, which holds ordinary meetings every second year;
- Secretariat, headed by an Executive Secretary, is appointed by the Assembly of Parties for a four year mandate.

[26] Agreement relating to the International Telecommunications Satellite Organization.

[27] Convention establishing the European Telecommunications Satellite Organization.

Activities

The EUTELSAT IGO monitors and interfaces with Eutelsat S.A, to ensure that the Eutelsat satellite fleet provides coverage for all Member States and that all Member States' operators, service providers and broadcasters have equitable access to Eutelsat S.A.'s services in terms of operational, commercial and financial conditions.

Industrial policy

Industrial policy is not implemented.

Czech Republic in EUTELSAT IGO

The Czech Republic has been the Member State of the EUTELSAT IGO since its creation in 2001.

Recommendations (to 3.2)

Synergies among various activities defined in the text above have to be actively identified to enable use and further development of industrial capacities and capabilities and maximize the return on public investment of the Czech Republic to space related activities. In this respect the Czech Republic should exploit all opportunities connected with its membership in international organisations and motive Czech entities to use their capacities and capabilities and participate in activities of these international organisations.

The future National Space Agency should be also responsible for identification and exploitation of the aforementioned synergies.

3.3 Funding of space activities in the Czech Republic

Since there is no specific national tool in the Czech Republic which would be used directly to support space activities, the Czech Republic participates only in space activities of international organisations as ESA, EU and EUMETSAT.

As far as the international organisations are concerned, there is no single source of funding of their space activities.

EU space activities (today EU space activities include Galileo, Copernicus, SST and Horizon 2020 – Space) are funded from EU budget. The Czech Republic's share is approx. 1.2 % of its total EU budget. The payment is made by the MF.

The ME is responsible for funding of the membership fee of the Czech Republic to EUMETSAT since 2014. Before 2014 the payment was made by MFA.

Payment of the contributions to ESA is currently divided between MT and MEYS. For this purpose the MEYS uses its budget for international cooperation in R&D to fund ESA mandatory activities and selected optional programmes. MT uses its general budget to fund selected optional programmes.

[mil.€]	xy ESA	MD (ESA)	MEYS (ESA)*	MF (EU)	MFA** (EUMETSAT)	ME (EUMETSAT)	TOTAL
2010		0.00	10.15	11.29	1.78	0.00	23.22
2011		0.00	10.43	12.92	1.83	0.00	25.19
2012		0.00	11.53	10.88	2.50	0.00	24.91
2013		3.39	11.00	9.08	2.39	0.00	25.86
2014		3.24	10.64	22.69	0.00	2.53	39.10
2015	**NSP**	3.14	10.91	20.20	0.00	3.67	37.91
2016	**NSP**	3.22	11.03	21.25	0.00	4.44	39.94
2017	**NSP**	2.82	10.89	21.56	0.00	5.01	40.28
2018	**NSP**	2.33	9.88	21.91	0.00	5.08	39.25
2019	**NSP**	1.60	9.50	24.74	0.00	5.34	41.18

* The payment fee in amount of 2.9 mil. € was paid in 2008 - 2009.
** Plus the accession fee in amount of 5.076 mil. € was paid in 2010 - 2013.

Figure 11: Share of payments. Source: MT

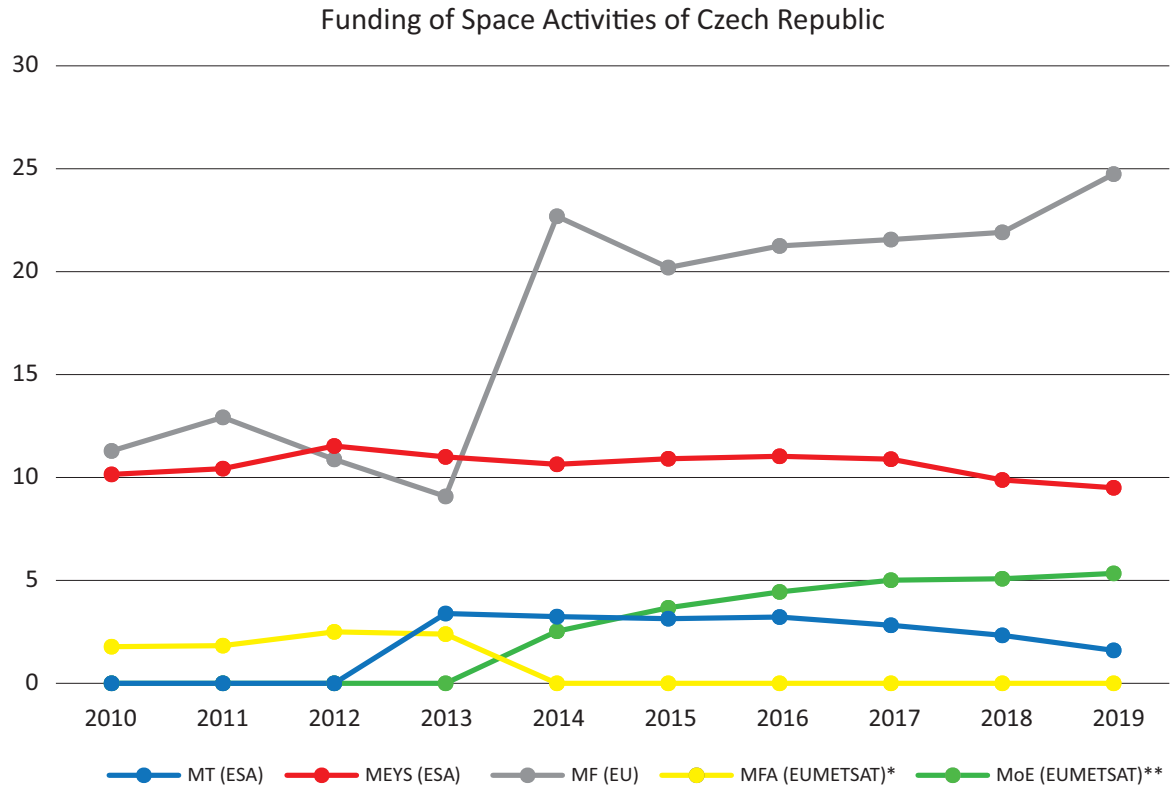

Figure 12: Funding of space activities in the Czech Republic. Source: MT

Domain	MT	MEYS
Earth Observation		EOEP
	MTG	
	MetOp-SG	
	GSC	
Telecommunications	ARTES 1	
	ARTES 3-4	
	ARTES 5.1	
	ARTES 10	
	ARTES 14	
	ARTES 20	
Satellite navigation	EGEP	
Launchers	FLPP	
Space situational awareness		SSA
Space exploration, human space flights and microgravity		ELIPS
		MREP
General technologies	GSTP	
Payload for scientific missions		PRODEX

Figure 13: Payment of the contributions to ESA is currently divided between MT and MEYS. Source: MT

Even if the Czech Republic invests to space activities through its membership in international organisations approx. €34 million per year in average (2010-2019), it can influence only the contribution to ESA (approx. €14 million per year), and more effectively only to its optional programmes (approx. €6 million per year). The key principle unique in ESA is the guarantied geographical return of contributions.

Since the optional programmes periods are multiyear but timely limited, there is the need to sustainably subscribe new optional programmes and continue in the next phases of the existing ones. Otherwise they will end in few years without continuation.

However, it should be noted again that especially the contribution to ESA optional programmes helps the Czech Republic to create and incubate its academic and industrial capacities and capabilities to be competitive in EU and/or EUMETSAT space programmes and to enter to European and global commercial market.

[mil. €]	ESA (TOTAL)	Mandatory	Optional	EU (TOTAL)*	Galileo	Copernicus	FP7/H2020**	EUMETSAT	TOTAL
2010	10.15	5.79	4.36	11.29	8.72	1.27	1.31	1.78	23.22
2011	10.43	5.91	4.52	12.92	10.00	2.36	0.55	1.83	25.18
2012	11.36	7.62	3.74	10.88	7.38	3.11	0.40	2.50	24.74
2013	14.39	7.86	6.53	9.08	4.65	3.92	0.50	2.39	25.86
2014	13.88	7.86	6.02	22.69	16.38	4.32	1.99	2.53	39.10
2015	14.04	8.09	5.95	20.20	11.41	6.66	2.18	3.67	27.91
2016	14.25	8.09	6.16	21.25	11.41	6.95	2.89	4.44	39.94
2017	13.71	8.09	5.62	21.56	11.41	7.26	2.89	5.01	40.28
2018	12.20	7.50	4.70	21.97	11.41	7.65	2.89	5.08	39.25
2019	11.10	7.50	3.60	24.74	11.41	10.44	2.89	5.34	41.18

* The Czech Republic contribution to EU budget represents approx 1,2% of the total EU budget. SST programme will be funded by Galileo, Copernicus, H2020

** Excluding Copernicus (treated separately)

*** Budget for Galileo, SST and partially Horizont 2020 in 2015-2019 are set as annual average amounts.

Figure 14: Level of contributions of the Czech Republic to space activities [mil. €]. Source: MT

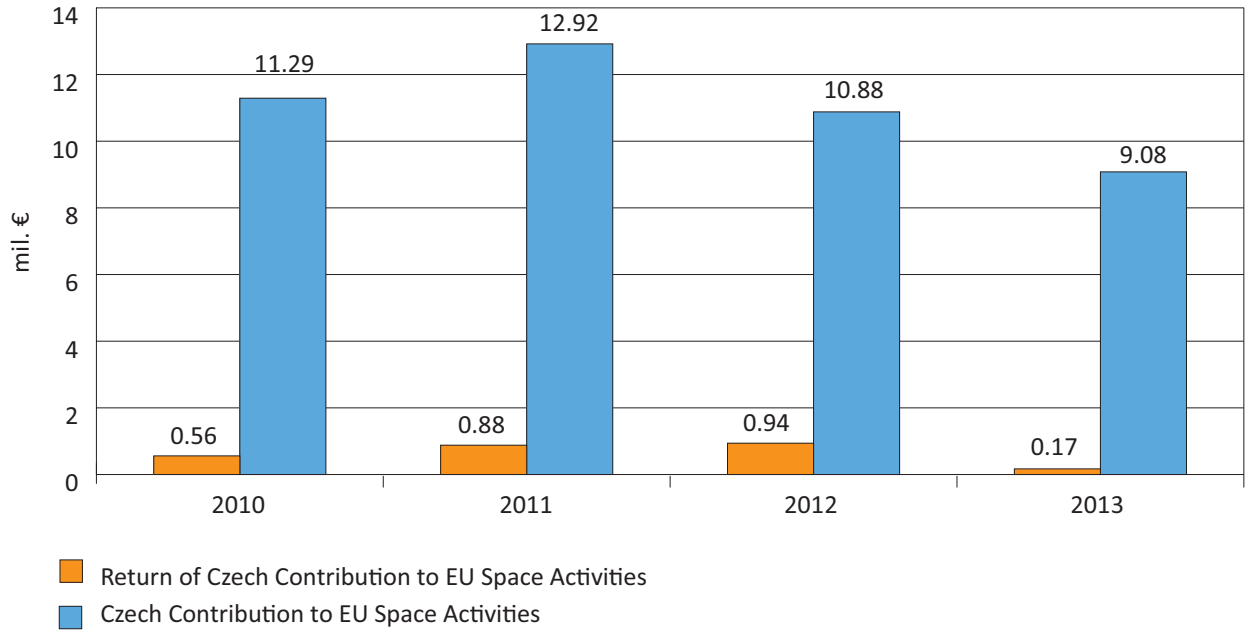

Figure 15: Return of Czech Contribution to EU Space Activities [mil. €]. Source: MT

Return of Czech contribution to EU Space Activities is currently realized only via FP7 projects. There is no activity in frame of Galileo of Copernicus.

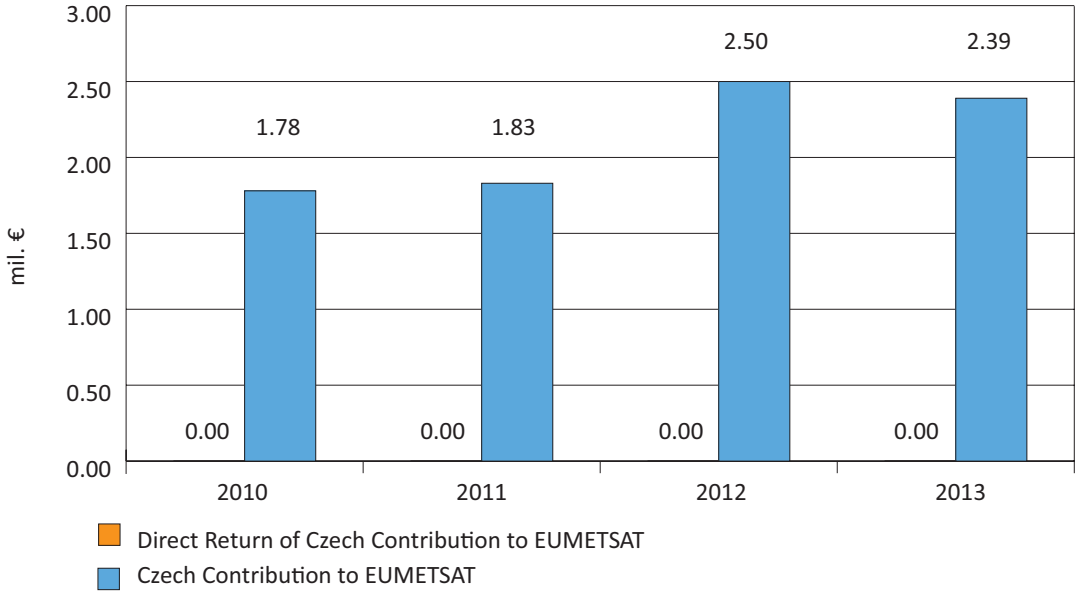

Figure 16: Direct Return of Czech Contribution to EUMETSAT [mil. €]. Source: MT

The Czech Republic still not participate at industrial tenders of EUMETSAT. This could be possible in the future due to the Czech participation in respective ESA programmes.

4 MARKETS AND TRENDS

4.1 EARTH OBSERVATION

Current situation

Earth Observation (EO) is one of the fastest developing space sectors with the broadest application and service potential. It can benefit a lot of market sectors not directly related to space domains and can foster subsequent innovations both in terms of EO products and in terms of more efficient processes in the specific sectors. The EO systems provide the optical and radar data in very wide range of characteristics which predestine it to very different tasks. Among the key characteristics determines the task of satellite are counted orbit details, spatial, spectral, radiometric and time (revisit) resolution.

There are 3 main EO stakeholders in Europe – ESA, EUMETSAT and EU. ESA is by far the largest European institutional customer in all fields. Only in the EO systems, where the strategic dimension translates into the heavier implication of national programmes, other European institutional customers represent a sizeable market share.

Earth Observation systems overview

There are estimated 160 EO satellites (15 for commercial use) in global on the 2012. It is expected, that the number will increase up to 305 EO satellites (44 for commercial use) in next 10 years; 75% of them is expected to be operated by the main institutional stakeholders (Europe, USA, Russia, China, India and Japan).[28] In spite of increasing number of commercial missions, the institutional segment, from upstream point of view will remains dominant (approx. 85%). It is estimated more than €10 billion[4] of upstream investments in governmental EO sector per year in global.

ESA, EUMETSAT and EU intends to launch about 18 EO satellites in next 10 years; 13 will be focused on applications (meteorology and others) and 5 for scientific purposes.[29] Numbers could be corrected due to the small missions[30] representing one of the EO upstream trends and which could be developed relatively fast during a few years.

Trends

- Users demands Very High Resolution data (only 6 European civil satellites could provide it on 2014); With reference to this and for the security reasons EU considers about the VHR Regulatory framework.[31]
- EO microsatellites for focused on acquiring of data for specific services; the mission characteristics shall be adapted to narrow market. Users demands more often revisits of satellites, especially in case of specific tasks.
- Optimization of data chain, processing, compression, storage, transmission, etc. Users demand very fast accessibility to freshly sensed data.
- Detectors supporting higher performance and cost efficiency.
- Increasing number of new developed geoinformation products with reference to increasing number of the free-of-charge data availability (Landsat 8, Sentinels, etc.).
- Offering of new and specialized value-added products and services on both satellite and aerial products to meet varying customer needs, stereo imaging, etc. The institutional market in “world development” will grow (products highly demanded by institutional users).
- New superspectral and hyperspectral data available should be the “market grow drivers” in the future.

[28] ESD Partners 2013: European Space Directory 2013, 28th edition.

[29] ESA 2013: ESA Long Term Plan 2013-2022, draft version (ESA/C(2013)81).

[30] ESA intends to start the "small mission initiative" in frame of its EO programmes. Some of the private companies, focused on services, intends to develop/acquire their own small satellite focused on acquiring of data for user demanded services.

[31] Booz&Co. 2013: Evaluation of options for an EU initiative on the improvement of certain framework conditions for the economic development of space related activities, EO VHR Satellite Data Regulation and Market, final report for EC Contract No. 30-CE-036363/00-01.

Earth Observation market diversification[32]

- **Upstream:** EO space infrastructure – satellites, ground segment, operators, launch providers, etc.;
- **Midstream:** data providers – upstream infrastructure users for commercial and institutional purposes; focused on acquisition, production, processing, archiving and distribution of space-derived data, etc.;
- **Downstream:** companies offering Value-Added Services, commercial applications developers, etc.

Upstream

EO upstream trends are defined by user (political or commercial) needs to the final products (data). In civil EO investments dominates the environmental monitoring (incl. meteorology) missions. Due to the pressure to more valuable data are the advanced technologies and mature instruments needed. That's causes higher development costs then first- or second-generation imaging satellites. Among the short tracks are increasing of spatial resolution and revisit improvement. Missions with high resolution and the pressure to competitive missions provides opportunities for a secondary market for Earth observation systems. In medium range the new generation of detectors supporting higher performance and cost improvement are demanded.

Due to the Czech membership in 3 most important European organization, which are involved on EO space infrastructure development (ESA, EUMETSAT, EU), it is for the Czech (mainly industrial) subjects possible to participate on EO programmes with total budget roughly €870 million (2012).[33]

At 2014 there are several EO space systems in preparation. From European institutional point of view are Copernicus space segment with dedicated Sentinels 1-6 (there is still opportunity to participate on Sentinel 5 and 6), meteorological MTG and MetOp-SG, scientific ADM Aeolus, EarthCare and Biomass which is in preparation and for next years is planned to start with development of new Earth Explorers 8 and 9.

Czech Republic (Upstream)

Apart from the development and utilization of services, the EO sector involves a whole set of hardware development related to remote sensing sensors, optical systems, advanced data analysis techniques and data processing and distribution infrastructures. In these areas, the Czech Republic needs time to consolidate and advance current skills present at some of the industrial and academic organizations.

Midstream

Global midstream turnover amounts to approximately €1.2 billion and it is expected to reach €3.4 billion on 2022. Current commercial data sails represent 83% of optical images and SAR data 17% of total expenditures. The largest commercial market is in North America (42% of total turnover) and it is expected as the largest to the future as well, NA shall be followed by Europe (15%), Asia (15%), Latin America (14%), Middle East (10%) and Africa (4%).[34]

Current European EO midstream market is estimated at €0.2 billion (civil market only). Key customers are in defence market and demands imagery intelligence applications with preference of VHR. The VHR data shall has the highest turnover in next years, but due to the competition, downward price pressure on data is expected. On non-VHR data market in Europe should dominate the Copernicus data (it is necessary to have in mind the pressure of commercial providers to imposition of a charge of Sentinel data for downstream).[8]

Challenges to the future are mainly optimization of data chain, processing, compression, storage and data transmission. Challenges in case of Czech Republic are mainly:

- To ensure the broadband data access mainly to the free-of-charge EO data, e.g. through the national EO storage, and ensure the sustainability of the storage operation.
- To ensure the access to the real-time meteorological data and images necessary for the weather forecast and warning services (but not only).

Czech Republic (Midstream)

Easy access to the Sentinels data should boost the utilization in downstream and boost the EO market in Czech Republic in general.

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[32] Space Tec 2012: European Earth Observation and Copernicus Downstream Services Market Study – Executive summary.

[33] EUROCONSULT 2013: Government Space Markets - World Prospects to 2022, The Space Industry's Essential Assessment of Government Spending in Space Applications, 4th edition.

[34] SpaceTech 2013: European Earth Observation and Copernicus Midstream Market Study (Final Extended Executive Summary).

With descend price of VHR data it is expected higher demand on VHR based applications. In spite of that due to the costs it is expected mainly for special applications (information) demanded by users.

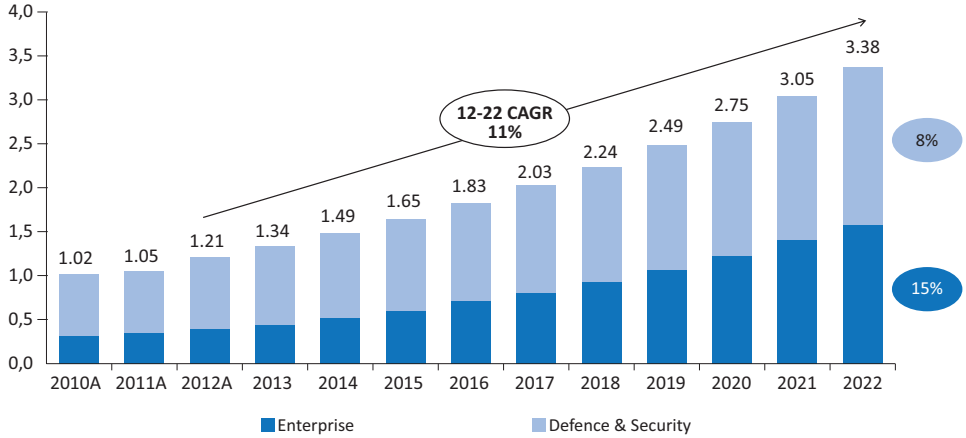

Figure 17: Commercial EO data sales (Midstream) by customer World 2010-2022 [bil. €] Source: SpaceTec Partners study

Downstream

European EO downstream market is estimated at €0.7 billion on 2012 and it is estimated the growth to €1 billion on 2015 in Europe and over € 2 billion in global. The European EO downstream turnover is estimated to grow around 7% annually.

The EO space systems are usually not focused just onto one task or target, with exception of meteorological systems. Most of them are used across the very different fields.

The largest EO system build in Europe with the huge downstream potential is the space component of Copernicus (for detail see Chapter 6). This EU programme is built in close cooperation with ESA and in next EU MFF period (2014 – 2020) will run with a budget of €3.7 billion (at 2011 prices), €2.9 billion just pro space component.

Copernicus dedicated mission data (Sentinel data) and Copernicus information shall be made available on a full, open and free-of-charge basis. Due to this policy the price of the data shall be not projected into the costs of the services. It shall lead to the stimulation of new EO spaceborne data based applications and services development and stimulation of the EO downstream sector in general.

Future application of EO services is expected in following NACE sectors: agriculture, forestry, mining, transportation and storageing, financial and insurance activities, waste management, infrastructure monitoring, education, healts, etc.

The thematic areas and segmentation, market breakdown by thematic sector and share of the EO service market by type of customer are the subjects of the following figures.

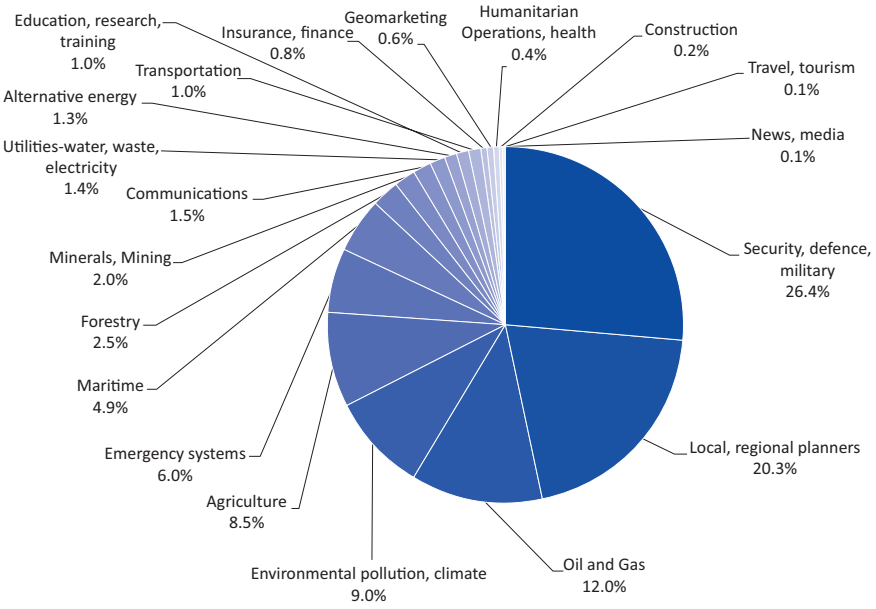

Figure 18: Thematic segmentation based on revenues. Source: EARSC[35]

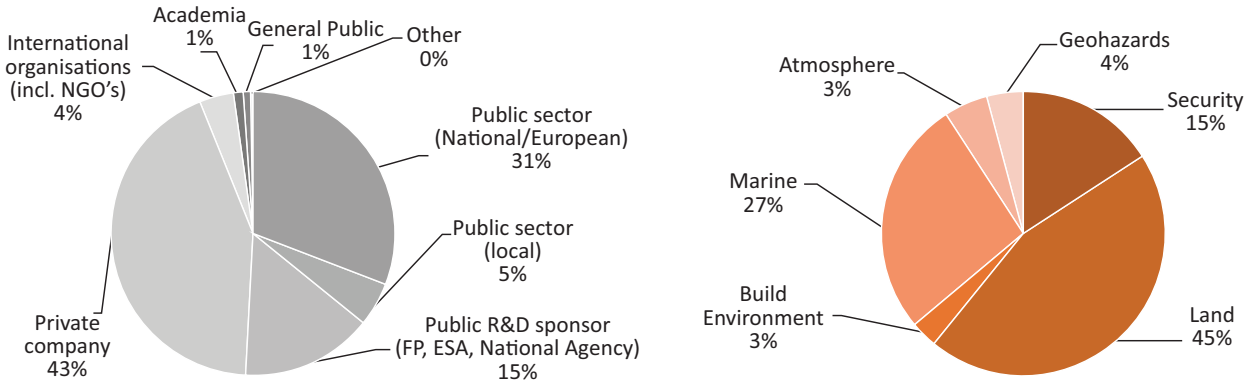

Figure 19: (1) Share of the market by type of customer (2012 figures). Most of academic institutions are direct users of EO data, they usually are not customers of the companies). Source: EARSC and **(2) Market breakdown by thematic sector.** Source: EARSC.

Czech Republic (Downstream)

The Czech service providers and users should be prepared to use the system and available data. To secure the competitiveness of Czech EO service providers and the competency of the users at all levels, the national space programme should support coordination of all EO activities at national level.

Copernicus open a wide field of opportunities for national institutions, business and academia as well. National institutions acquire new source of data for supporting of decision making, companies will have new opportunity for business and academia will have new data source which could use in scientific projects.

[35] EARSC 2013: A Survey into the State and Health of the European EO Services Industry.

4.2 NAVIGATION

Current situation

Global navigation satellite systems (GNSS) provide autonomous geo-spatial positioning with global coverage and allow small electronic receivers to determine their location to high precision (within a few meters) using time signals transmitted along a line of sight by radio from satellites. The GNSS market, comprising various applications in plenty of domains, has been evolving for more than a decade, and even nowadays can be seen rapid development of some market segments.

Galileo, a European GNSS system, will provide accurate global positioning services worldwide firmly under civilian control and wholly interoperable with GPS, GLONASS and Compass (BeiDou). Many GNSS receivers and chipsets in the marketplace are already "Galileo-ready".

According to GSA Market Report[36] ("the Report"), the GNSS market comprises products (receivers and devices) and services, which use GNSS-based positioning as a significant enabler.

The report recognises following market segments, which can be identified (status 2013):

- **Location-Based Services** (LBS): smartphones, tablets, digital cameras, laptops, fitness and people tracking devices, and mobile data revenues.
- **Road**: Personal Navigation Devices (PNDs) and In-Vehicle Systems (IVS) used for navigation; devices used for Road User Charging (RUC), Pay-Per-Use-Insurance (PPUI), eCall, and Advanced Driver Assistance Systems (ADAS); and other devices supporting Intelligent Transport Systems (ITS) applications and data revenues for traffic information services.
- **Aviation**: GNSS-certified devices for commercial, regional, general & business aviation, and uncertified devices aiding pilots flying under Visual Flight Rules (VFR).
- **Rail**: GNSS usage in safety-critical devices supporting signalling (high and low density lines) and non-safety devices supporting other applications (asset management and passenger information).
- **Maritime**: GNSS devices to support general navigation, the Automatic Identification System (AIS), the Long Range Identification and Tracking (LRIT) System, port operations (including portable pilot units), dredging, and search & rescue beacons.
- **Agriculture**: GNSS devices used for tractor guidance, automatic steering, asset management, and Variable Rate Technology (VRT).
- **Surveying**: GNSS devices to support land surveying (including cadastral, mining, construction, and mapping) and marine surveying (including hydrographic and off-shore surveys).

The segments have own value chains, some might be significantly different from each other (e.g. LBS value chain (chipset manufacturers, device vendors, service and content providers, app developers and retailers, app stores) compared to surveying value chain (complementary infrastructure providers, receiver and firmware, professional users, customers)).

The Report defines the core GNSS market as a market, which for multi-function devices (such as smartphones) includes the value of GNSS functionality only (e.g. for GNSS-enabled smartphone only the value of GNSS chipsets is counted, estimated at 1% of the price) and for service revenues only those directly attributable to GNSS functionality (e.g. data downloaded by smartphones to use LBS).

EGNOS, the European Satellite Based Augmentation System (SBAS) fully operational since 2009, increases the accuracy of GPS positioning and provides information on its reliability (integrity), making it suitable for safety-critical applications. It was designed primarily for aviation; however it has been widely adopted in other segments, such as agriculture and road. An enhanced version of EGNOS is under development, main new features will be multi-constellation concept, wider coverage area and use of dual-frequency.

Other complementary infrastructures on local or global scale (such as StarFire or CZEPOS), which provide observation and correction data via communication means, proved to be viable at the market, e.g. in the agriculture or surveying segments.

[36] GSA 2013: GNSS Market Report, issue 3.

To complete the picture, the upstream sector of GNSS, in contrary to satcom domain, cannot be for the time being considered a market as such. The sector is completely under control of relevant governments and it doesn´t have contours of institutional market (like in Earth Observation domain) as well, as the competition is restricted to local entities.

Trends

The projected long-term growth revenues indicates significant business opportunities, however the changing technological environment requires constant innovation on the supply side. Global enabled GNSS markets are forecasted to grow to approximately €250 billion per annum by 2022. Core revenues are expected to reach €100 billion in 2019.

Worldwide regulatory measures are being undertaken in several domains to promote the use of GNSS. For example, regulatory requirements for emergency location sharing, such as the European eCall, the mobile 911 (North America) and 112 (Europe), or Search and Rescue (SAR) services, promise to provide further impetus for growth in Europe and North America over the next five to ten years.

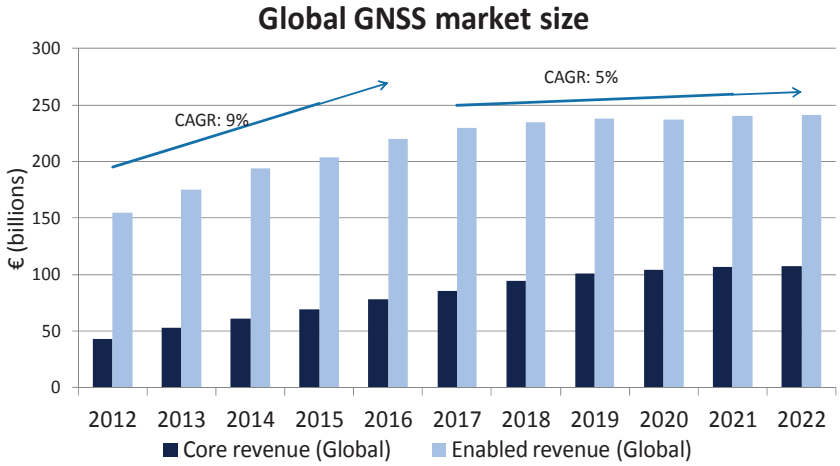

Figure 20: Global GNSS market size 2012-2022. CAGR stands for Compounded Annual Growth Rate. Source: GSA

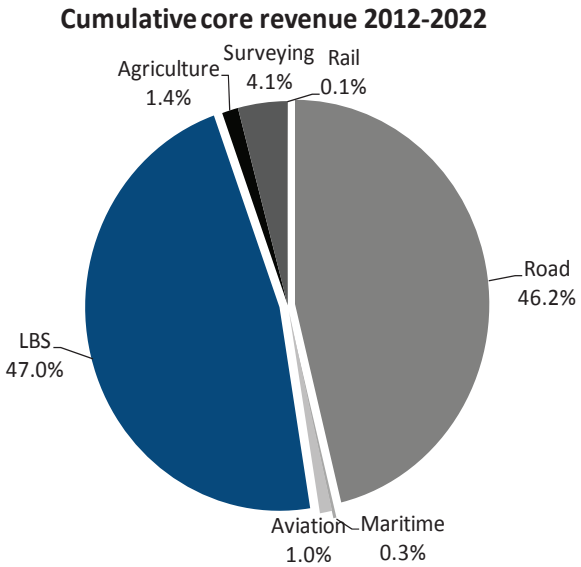

Figure 21: Cumulative core revenue 2012-2022. Source: GSA

New smartphone capabilities alongside integrated technologies are blurring the market segment breakdowns, as LBS devices increasingly support navigation and services in other applications. LBS is forecasted to be the largest market segment by revenue, overtaking Road, where the PND market continues to decline, being cannibalised by the use of smartphones in cars. LBS devices are also being increasingly used in general aviation and leisure maritime.

New applications are continually introduced and consumers have begun to appreciate the capabilities of LBS in their daily lives. Competitive pricing has made smartphones more affordable and their market share is rapidly increasing compared to traditional mobile phones without GNSS capability; leading to an increase in GNSS penetration, especially in lower income countries.

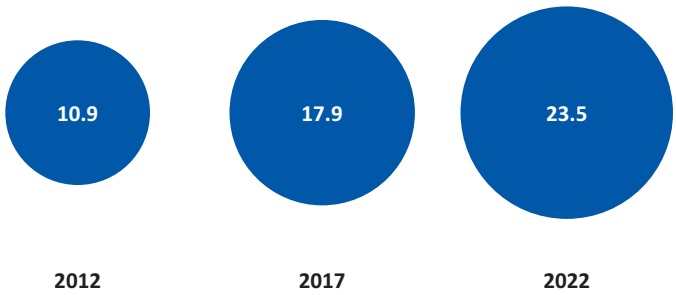

Figure 22: Revenues in billion € raised in the EU27. The size of the bubbles and number represent revenues raised from end-users in the EU27. Source: GSA

Czech Republic

The Czech Republic already benefits from the applications offered by satellite navigation and actively supports the development of new technologies that exploit the potential of satellite navigation. Czech companies regularly and successfully take part in the European Satellite Navigation Competition ESNC as well. We can see plenty of Czech entities involved in all market sectors and in some parts of the relevant value chains. However, due to highly dynamic nature of the sector, support from the public domain is needed.

GNSS systems are indisputably assets of strategic and economical nature and as such, main world economies are investing into their modernization or building new ones. By 2020, there should be four GNSS systems (GLONASS, GPS, Compass, Galileo), and more than five operational SBAS systems. As an example, relevant for The Czech Republic, the EU has allocated within the multi-annual financial framework (2014 to 2020) more than seven billion € for development (of new generations), deployment and exploitation of Galileo and EGNOS systems.

4.3 TELECOMMUNICATIONS

Current situation

The telecommunication market can be labelled as the most mature market out of all space markets. Both governmental/institutional and commercial market segments are well-developed markets, with observable and seemingly repeating cycles.

According to ESA LTP[37] during the last years, communication satellite operators have witnessed a constant growth of the demand for broadcasting TV channels, and this trend is expected to be globally confirmed with the increase of wealth in areas such as Latin America or Far East. Global operators like SES or Intelsat have significantly invested for renewing or developing their fleets, while a significant number of regional or national initiatives are expected to be initiated.

On the other hand, the market has recently seen a fierce competition, coming mostly from the US (together with hurdles to bid in US) and new players in the rest of the world (Russia, China, India and others). The competitiveness of the industry of the ESA ARTES participating states lies in its ability to innovate in technologies and in continuous improvements of its products, applications, and services.

[37] ESA, ESA Long Term Plan 2013-2022.

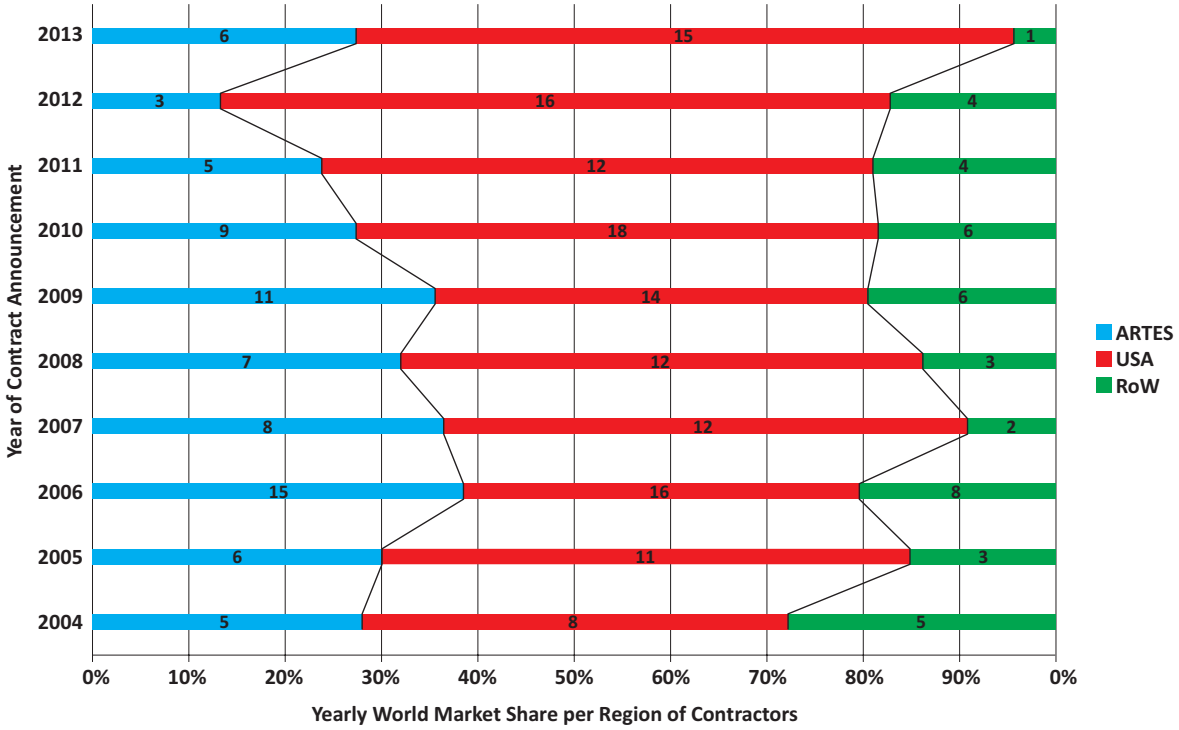

Figure 23: ESA, Presentation "Satcom market evolution Prime contracts market share (geostationary satellites segment) during 2004-2013. ARTES stands for primes from ESA Member States, RoW stands for Rest of World. Source: ESA (2014)

As a reaction to market challenges, ESA has been systematically promoting platforms development for more a decade, namely Alphabus (market segment more than 6 tonnes, first launch of satellite based on the platform, Alphasat, took place in July 2013), SmallGEO (market segment up to 3 tonnes, launch foreseen for 2015, satellite Hispasat AG1) and newly NEOSAT (market segment 3-6 tonnes, launch of two PFM foreseen for 2018/19). All of these platforms and PFMs have been developed through public-private partnership. Other ESA telecom programmes are dedicated to new technologies or whole systems designed for particular application, e.g. Electra (Electric orbit raising initiative), or SAT-AIS (Automatic Identification System for vessels), Iris (subsystem of ATM system utilizing satellite solutions) and EDRS (European data relay system, using Optical and Ka-Band DRS technology). Integrated and purely telecom applications have been promoted through well-established programmes too.

Regarding the services, broadcasting (BSS) has the main share (market size €55 billion in 2011), followed by fixed satellite services (FSS, market size €11 billion in 2011) and Mobile Satellite Services (MSS, market size €1.2 billion in 2011).

Trends

According to ESA LTP, telecommunication systems (both commercial and military), as well as the technologies, products, applications and services associated to these systems but also to the core broadcasting-satellite market need to be consolidated and validated - the competitiveness of industry has to be developed at both platform equipment and payload equipment, as well as at prime level. New applications and services which have the largest impact on the economic growth, have also to be proposed to telecommunication service providers to endeavour the development of the satellite communication sector and to further promote its integration into the global telecommunication information networks.

Focus in the coming years will probably be on development of HTS (High Throughput Satellites), electric orbit raising of geostationary platforms, integration of satcom into terrestrial networks, optical data relay technology, increasing the size of satellites as well as number of transponders and innovation technologies.

Both the commercial market and governmental market of geostationary satellites will see increasing competition, due to expected decreasing governmental expenditures and newcomers to the market. At the side of services demand, growth is expected, driven e.g. by demand for channels in HD, broadband or machine-to-machine segment.

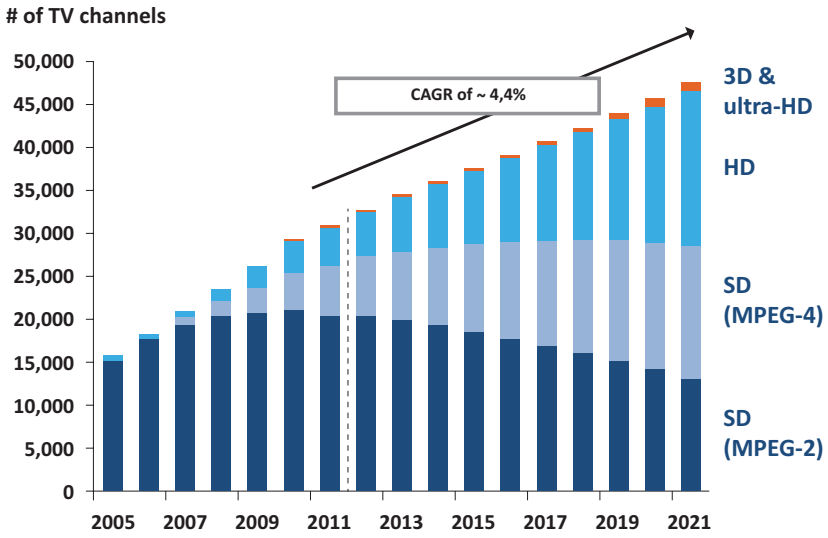

Figure 24: Number of Satellite TV Channels worldwide 2005-2021. Source: ESA, Presentation "Satcom Sector – News and views update", 2012

Czech Republic

The Czech Republic does not own and does not operate any satellite network. However, there are terminal manufacturers and service providers, representing satellite networks operated e.g. by EUTELSAT, ASTRA, INMARSAT and INTELSAT. Successful examples of Czech companies can be already found, which are trying to get into the satcom technology supply chains (satellite components or user terminals), through the support of various ARTES elements. Purely commercial contract for mechanical subsystem has been signed in 2011 as well. Regarding some fact and figures from the end user part of the value chain, there has been 1200 satellite internet accesses and €1.8 million subscribers of TV and radio broadcasting services in 2012.

Satellite communication is a one of a key pillar also for aerospace segment and getting momentum especially in these days thanks to the Air Traffic Management (ATM) related programs (SESAR, NextGen). Also passenger's connectivity as well as safety services for cockpit applications requires new communication systems available globally with higher capacity, lower latency and broadband connectivity when compared to up-to-date systems, which lead towards the upgrades or completely new satellite communication systems design. The market potential of cockpit satellite communication depends on ESA strategy, outcome of related ATM programs and corresponding mandates. However, the forecasted magnitude of potential user terminal business is about €30 million a year.

4.4 LAUNCHERS

Current Situation

While European launcher industry represents less than 10% of launches and at the same time only around 1/6 of launched mass or number of spacecraft launched, it still maintains position of global player in commercial launches being able to acquire around half of the accessible market. Accessible market is an important term, since most of the launch service contracts are not accessible to European companies Arianespace and Eurockot due to national interests (mostly security and military) of states procuring the services. Those are then logically restricted to service provides from the respective countries – this is in particular case of USA, Russia, China, Japan and India.

For states with geopolitical ambitions it is essential to have guaranteed access to space to be able to deliver in orbit any satellite needed to fulfil their national objectives. Of course, this is often driven by security requirements. Commercialization considerations are secondary except for Europe where there always had been stress on commercial exploitation of European launchers and thereby minimizing the cost of maintaining the launch system in operational condition. In Europe currently there is a heated debate on the future of the launcher programme. The commercial exploitation cost is the main argument in the discussion.

ESA spending in launcher sector is currently at steady level of €800 million per year[38] including development, maintenance in operational condition of all European launch systems and European spaceport. The European launcher sector offers another €800 million business coming from commercial sales of launchers.

Trends

While launched mass as well as number of spacecraft launched is steadily growing since 2003, recent launch market forecasts predicted peak of launcher market in 2013 at $9 billion and then steady decrease to $8.36 billion by 2020.[39] Other forecasts mark peak of $9.3 billion in 2017 driven by large procurements of the U.S. Department of Defence and new developments in Europe, Russia and China. This peak is predicted to be followed by decline starting 2019 down to $7.4 billion in 2022.

Arianespace, the largest European launch service provider, along with Airbus Defence & Space (formerly Astrium) as prime contractor for the Ariane 5 launcher are likely to face fierce competition from new commercial service providers like SpaceX with aggressive pricing policies and track record of successful launches including the first Geostationary Transfer Orbit (GTO) launch in December 2013. Investments to development of new expandable launch vehicles are worldwide trend and more competition will be seen soon. Five agencies/countries are preparing major evolutions of their launch vehicles.

Ariane 5 launcher is Europe's prime launcher with proven track record of successful launches, however its expensive yet too-cheap-to-make-profit pricing causes financial difficulties to Arianespace, its operator. Recalling that Ariane 5 was not developed to serve GTO market (it was intended for Hermes spacecraft) while today GTO is by far its most usual target, the launcher has to face the fact that it is too powerful (therefore too expensive) to launch single satellite to GTO. At the same time, with the growing average mass of telecommunication satellites, more and more often it runs into problems to find suitable coupling of two satellites for dual launch.

Two possible solutions to this problem that hinders Arianespace's business are either a brand new Ariane 6 with 6 – 6.5 ton capacity to GTO or an upgraded version of Ariane 5, known as adapted Ariane 5ME (formerly Ariane 5 post ECA) with 11.5 ton capacity allowing more options for satellite pairing. The cost of Ariane 6 development is estimated at €4 billion, more than triple that of Ariane 5ME. This high development cost is difficult to afford for the Member States, especially in the current economic situation. Moreover there is a high probability that due to pressure on time to develop Ariane 6, there would be very little technical innovation introduced which could hinder its competitiveness during its exploitation phase in 2025 - 2040.

Czech Republic

In the Czech Republic, there are several preparatory projects being funded with the expectations to master new technologies that will be later applied to European launchers Vega, Ariane 5ME and Ariane 6.

For the Czech Republic, it is therefore by far better – both technically and economically – to support development of technologies that can be used across whole portfolio of launchers Ariane 5ME, Ariane 6 or Vega. Thermoplast welding, tank insulation, structural health monitoring, ultra-wide band wireless communication, software for clean space applications, pyrotechnic separation, acoustic load and flutter analysis and last but not least sensing and vibration attenuation technologies can be taken as typical examples.

4.5 HUMAN SPACEFLIGHT, MICROGRAVITY AND EXPLORATION

Current Situation

In human spaceflight, microgravity and exploration the market is driven by institutional needs. Historically human spaceflight has been a nationalistic governmental activity. But in recent years, two changes can be observed. First, there is high interest in international collaboration (except for China). Second, there has been a gradual movement towards more commercial solutions, including government outsourcing of orbital crew and cargo operations, space tourism related-endeavours, and, in the longer term, commercial ventures targeting business operations on the Moon or Mars.

[38] ESA 2013: Cost plans of on-going Launchers Programmes in preparation of draft budgets for 2014 ESA/PB-LAU(2013)45.

[39] Frost & Sullivan: Press Release.

For the last two decades, human spaceflight has received a constant revenue stream of between $8 billion to $9 billion per year. However, following a 2010 peak in funding of $11.8 billion, human spaceflight started to decrease with the winding-down and termination of NASA's space shuttle programme.

Still, NASA's human spaceflight programme accounts for about 3/4 of the world's total investment and represents 40% of NASA's budget. It fuels exploration systems development, commercial spaceflight programme, exploration research, and development and space operations.

ESA's human spaceflight budget focused on International Space Station (ISS) utilization has been decreasing from 19% in 2003 to 10%. Most of the current human spaceflight budget of ESA is spent on designing and building the MPCV-ESM for NASA as an in-kind contribution in exchange for ESA's share of ISS operating costs. JAXA and Roscosmos maintain and respectively increase the human spaceflight budget but no game-changing targets were announced.

Human spaceflight is dominated by the ISS in low Earth orbit (LEO) which, today, is the only destination that astronauts can reach.

ISS remains to be the highlight of the microgravity research and by far the strongest magnet for microgravity research funding when compared to other microgravity research platforms e.g. drop towers, parabolic flight, sounding rockets or free fliers.

Trends

ISS has recently been completed (with very few non-essential elements to be still installed) and its lifetime was extended till 2020. Discussions are under way whether or not further extend its operations. US announced it continuation recently and invited other partners to join. ISS operations are costly and it is yet to be seen whether ESA Member States participating in the ISS programme will find it affordable. As an alternative, Russia and some US commercial operators plan an independent space station.

Chinese ambitious and highly successful human spaceflight programme is managed by the Chinese military and is considered defence expenditure. Its budget doubled in five years and is likely to further grow. The ultimate Chinese plan is an independent space station of at least three habitable modules. However no international partner is foreseen to join in this endeavour.

Human exploration beyond LEO is a rather distant future, but precursor robotic missions are being planned, designed and launched. Exploration is coordinated among national agencies by the International Space Exploration Coordination Group (ISECG) that published in 2013 the Global Exploration Roadmap as its key output.

Current planning of ESA for Mars exploration mission (some affordable combination of missions ExoMars, Phootprint, Inspire and Precision Lander + Rover) with further aim of Mars Sample Return mission foresee yearly funding of €150 million till 2016 and around €200 million per year from 2017. The first proposal for CM14 assumes combined budget for the complete HSF and exploration (i.e. Mars+Moon+LEO) around €600 million per year.

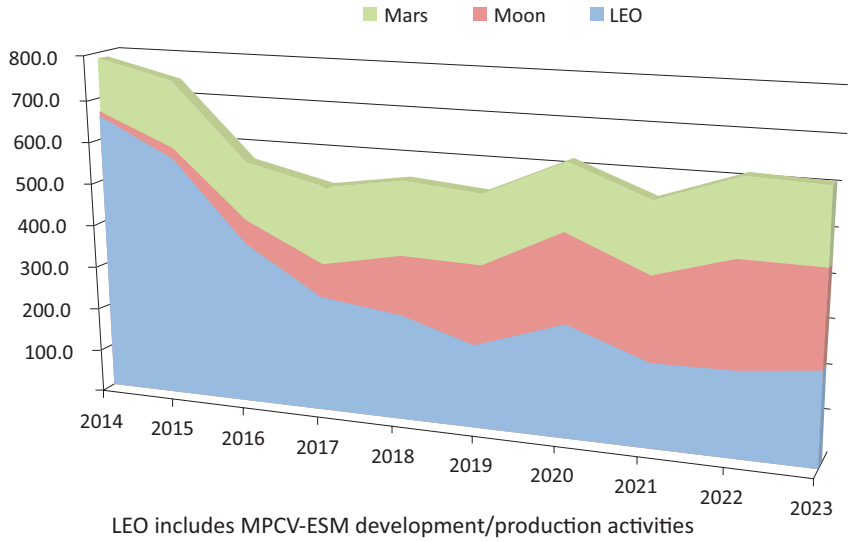

Figure 25: Chart illustrates the projected ESA investments into projects targeting the three key destinations of ESA. Decrease of LEO funding is linked to decommissioning of ISS. Source: ESA, Detailed cost plans for Human Spaceflight, Microgravity and Exploration, ESA/C(2013)81

Czech Republic

The Czech activities in this domain are limited on experiments at ISS, research in psychological and sociological aspect of human spaceflight and development of platform systems or instruments for robotic exploration missions.

4.6 Space Science and Exploration

Current Situation

The scientific exploration of space is dominated by government funded activities in fundamental scientific research. Since the beginning of space era, this traditional domain of space activities has constituted an important part of any national or international space programme and major space agencies allocate a significant fraction of their budgets to scientific missions. In FY 2013, NASA allocated $4.9 billion to science program, representing 28% of its total budget.[40] In the same year, ESA's contribution to Science programme (€507.9 million) and Mars exploration and PRODEX programmes (€138.6 million) amounted to 15.1% of agency's total budget.[41] It is worth noting that the above ESA budget does not include the costs of scientific instrumentation and subsequent data analysis funded by national agencies of Member States.

The segment of scientific space exploration is by its nature a non-profit activity with little to no direct commercial exploitation of its results. Nevertheless, scientific spacecraft are often highly technologically advanced, enter unexplored areas of space, and provide space validation and increase of TRL for new technologies with commercial potential. Scientific spacecraft and instruments are typically single purpose designed, but in some cases spacecraft platform segments (communication, power supply and distribution) as well as scientific instruments are being re-used with minor modifications on multiple missions. Wide international consortia and multi-agency missions are common in this domain. The worldwide spending in space science has stabilized in the $5-6 billion range in the last 5 years, but is predicted to grow to $6.9 billion in 2017 and to $9.6 billion in 2022.[42]

The following general categories of scientific space missions are recognised:

Solar System exploration missions: Missions to planets and other solar system bodies, including orbiters and landers, carrying a diverse payload composed of cameras, spectrometers, particle and electromagnetic sensors. This category includes missions studying the impact of solar activity on solar system and outer layers of Earth's atmosphere and magnetosphere. Recent examples include Cassini (joint NASA-ESA mission

[40] NASA FY 2013 President's Budget Request Summary.

[41] ESA budget 2013 as presented during DG conference on January 24 2013.

[42] EUROCONSULT 2013: Government Space Markets - World Prospects to 2022, The Space Industry's Essential Assessment of Government Spending in Space Applications, 4th edition.

to Saturn), Mars Express and Venus Express (ESA), NASA Mars rovers, Rosetta comet chaser (ESA) and missions STEREO and SOHO (NASA and ESA missions observing the Sun and solar wind).

Astronomical and astrophysical missions: Earth orbiting spacecrafts (or spacecrafts orbiting a Sun-Earth system Lagrangian point) carrying large telescopes designed for imaging of astronomical objects across the spectrum – from microwave to gamma ray wavelengths. Examples include gamma ray observatory INTEGRAL (ESA-NASA-Roscosmos), X-ray satellite XMM-Newton (ESA), UV and visible light Hubble space telescope (NASA-ESA), visible light observatory Gaia (ESA), decommissioned infrared telescope Herschel (ESA) and JWST (NASA-ESA) under construction, and microwave cosmic background observatory Planck (ESA).

Fundamental physics missions: A diverse category of missions performing fundamental physics experiments in space. A typical example are the planned LISA and LISA pathfinder missions of ESA, dedicated to testing of general theory of relativity by ultra-high precision laser interferometry in space.

Trends

In European context the Cosmic Vision 2015-2025 of ESA (with an approximate budget of €500 million per year) is the most significant programme in the area of scientific space exploration, being a part of the mandatory science program. In the framework of this programme ESA issues periodic calls for mission proposals divided into M-class (~€0.5 billion) and L-class (~€1 billion) and implements the selected candidates. The most recent Cosmic Vision mission with substantial Czech scientific participation are M2 Solar Orbiter (solar observatory approaching the Sun from a close distance – to be launched in 2017), L1 JUICE (Jupiter icy moon mission – to be launched in 2022) and L2 ATHENA (X-ray mission designed to study hot and energetic universe – to be launched in 2028).

It has been observed that selections of M- and L-class mission were perceived be the scientific community as a fierce fight between various space science disciplined because eventual non-selection had long-lasting negative impact of the discipline. Thus for the next L2 and L3 missions ESA takes different approach. First one theme per flight opportunity is selected in an open call. Than proposals for particular mission will be solicited restricted by the selected theme. This way mission selections are not providing expectations (and later disappointment) across vast scientific community. At the same time the intra-discipline competition is expected to lead to better mission proposals.

Two optional programs of ESA are relevant to space research (note that microgravity research and human spaceflight is covered in the previous section): robotic exploration programme Aurora and PRODEX (PROgramme for Developments of EXperiments). The former is strictly focused on Mars exploration, in particular on the ExoMars mission (both 2016 and 2018) and preparation of future Mars missions including the ultimate goal of the Mars the sample return mission. The PRODEX programme provides a framework for development of space-based scientific experiments and instrumentation (instrument development is not included in the mandatory space program).

In global context, NASA and other space agencies (such as Roscosmos, JAXA or Chinese CNSA) possess rich scientific programs and joint missions between ESA and the respective agencies are common. Recently, CNSA is actively seeking a joint Chinese-ESA mission and negotiations with ESA have been open on this topic. On the contrary, NASA has recently withdrawn its planned contribution to the joint two-spacecraft ExoMars programme and joint two-spacecraft Jupiter moons mission (EJSM – the predecessor of the selected JUICE mission) due to budget cuts. Such withdrawals severely impact the whole missions and for this reason ESA established a policy for all its future joint missions not to accept junior partners with higher than 20% involvement. Japanese space agency JAXA currently participates in Bepi-Colombo, a joint ESA-JAXA mission to Mercury.

In terms of exploration mission targets NASA is known for its interest in asteroids while many nations show increase interest in lunar exploration. In this decade alone, several lunar landers are planned followed by (in the next decade) Russian sample return mission and Chinese manned mission. European participation in this activities is likely to be very limited due to low affordability of Europeans space faring nations, due to financial burden of running programmes (ExoMars, ISS) and higher priorities (new European launcher).

In the recent months and years there is apparent and increasing interest in exoplanets which is further boosted by the media. In the European context S1 mission CHEOPS and M3 mission PLATO are contributing to this field.

Czech Republic

Significant activities of Czech subjects in space exploration exist in the domain of development of scientific instrumentation. Czech research institutes and companies have contributed scientific instrumentation for ESA PROBA II and PROBA-V missions and instruments for PROBA-3, Solar Orbiter and JUICE missions are in various stages of development, funded from the PRODEX program. Instrumentation for French spacecraft (TARANIS, DEMETER) and Russian missions (Spectr-R, RESONANCE, Luna-Glob) is contributed by Czech academic institutions in collaboration with Czech industry. This established heritage in instrumentation development, boosted by the funding available in the PRODEX programme of ESA, clearly shows significant potential for future expansion.

Apart from direct hardware contribution to spacecraft, Czech research institutions are the end users of scientific data obtained by many scientific missions with or without Czech hardware participation. ASCR also operates a telemetry station Panská Ves where data from several scientific spacecraft such as Cluster (ESA) and Chibis-M (Roscosmos) are currently being received. Czech academia also significantly contributes to scientific preparation of planned missions, for example by simulations of various detector parameters with aim to define necessary features to achieve scientific excellence.

Recommendations (to Chapter 4)

The Czech Republic should not support development of industrial capacities and capabilities which have very low chance to be successful on European or global market. When evaluating whether or not to grant the support to the project proposals, the great emphasis should be laid on compliance with technology and market trends, competitive advantages and orientation on niches.

The Czech Republic should also support scientific research of planned missions and development of scientific instruments for space science missions to enable Czech academia teams to pursue their own projects proving their scientific excellence worldwide.

5 CAPACITIES AND CAPABILITIES

This Chapter starts by discussing the different roles of academia and industry in the value-added chain of technology and space. It then discusses the actual capacities and capabilities of industry and academia in the Czech Republic. Finally, it recommends actions to be implemented to increase the capacities and capabilities in the fields which may bring the biggest benefits to the Czech Republic.

5.1 ROLES OF ACADEMIA AND INDUSTRY

As already mentioned space activities are generally characterised by their high technological content, multi-disciplinarily, complexity, extreme visibility and often high cost.

To ensure that the natural missions of academia and industry are exploited to maximise the economic benefit across society, also in terms of return-on-investment of the public money, and ensure economic sustainability, it is important to discuss and define their roles. It cannot be over-emphasised that both communities are highly important in the space sector as in other economic sectors of activity and depend on each other. At the same time, it should not be forgotten that the funding of the academic community activities constitutes less than a tenth of the ESA budget, most of the funding for the academic or scientific community comes from national research budgets that are hard to obtain for industry.

The Czech Republic has had a long tradition in utilization of space for scientific purposes. Several scientific payloads and sensors were developed, as well as small scientific satellites however, these activities were implemented in a different economic context and mostly in scientific institutions with small industrial involvement and little economic consideration or sustainability.

Whereas the space industry had to start learning how to develop space technologies almost from scratch, the scientific community had very good continuity of the work throughout the changes of the economic model in the Czech Republic. On the other hand the scientific community has to consider if and how they are prepared to work in commercial context, with clearly defined outputs, detailed documentation and following a strict schedule of deliverables. The experience of the last years was mixed, with some successful cooperation and some complications from some sections of the academic community which arose from an incomplete adaptation to different rules, or even non-acceptance of work with industry where deliverables and deadlines are crucial.

Project Phasing

Typically the life cycle of space projects, independently of its nature, is divided into 7 phases namely:[43]

- Phase 0 – Mission analysis/needs identification
- Phase A – Feasibility
- Phase B – Preliminary Definition
- Phase C – Detailed Definition
- Phase D – Qualification and Production
- Phase E – Utilization
- Phase F – Disposal

In Phase 0, where the requirements and project needs are being identified, academia plays a very important in most missions except possibly those of a commercial nature. The mission analysis may even in some cases be performed in academia even if, in most cases, industry is better equipped to perform it since it involves also an estimate of the expected performance and dependability and the mission operating constraints as well as possible mission concepts.

Phase A is where the feasibility of the overall space mission is studied by:

- Elaborating possible system and operations concepts and system architectures and compare these against the identified needs, to determine levels of uncertainty and risk.

[43] Space Project Management – Project Planning and Implementation, ECSS-M-ST-10C_Rev. 1 (6March2009), European Cooperation for Space Standardization.

- Establishing the preliminary management plan, system engineering plan and product assurance plan for the project.
- Assessing the technical and programmatic feasibility of the possible concepts by identifying constraints relating to implementation, costs, schedules, organization, operations, maintenance, production and disposal.
- Identifying critical technologies and proposing pre-development activities by quantifying and characterizing critical elements for technical and economic feasibility.
- Proposing the system and operations concept(s) and technical solutions, including model philosophy and verification approach, to be further elaborated during Phase B.
- Elaborating the risk assessment.

In the development of non-commercial missions, in this phase, academia is involved to help to validate that the original requirements are satisfied when using the proposed system architecture and to support the trade-off between different configurations.

As can be easily understood the level of engineering required at this stage transcends those usually found in academia except for very small scientific satellites however, academia may also be involved or even need to be involved in the pre-development activities identified in Phase A. This may be the case for particular technologies or retrieval algorithms that need development during Phases B to C and specifically for the case of scientific payloads, where academia often needs to be involved throughout all project phases.

It is in Phase E where academia, in missions of a scientific nature, plays again an important role as users of the data collected by the mission. In the case of scientific missions academia also plays an important role in algorithm development, validation and verification.

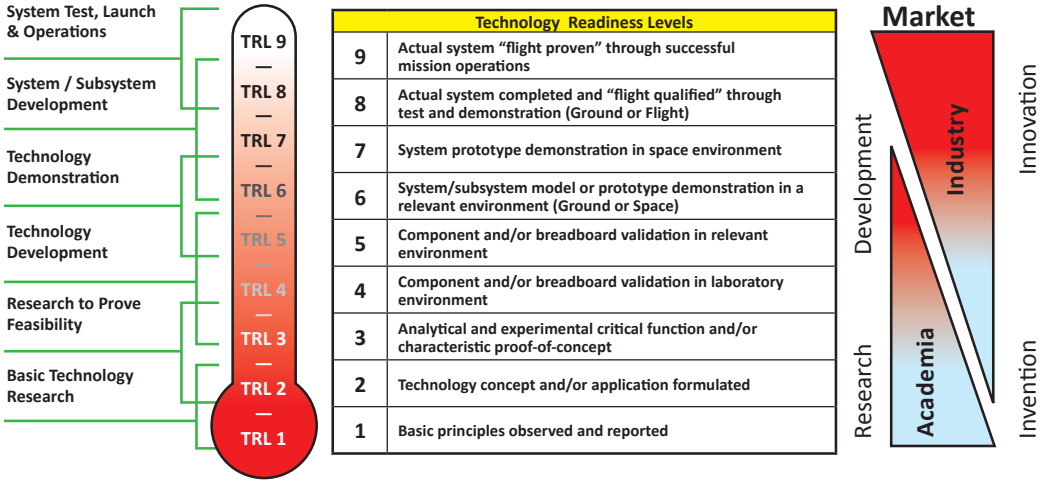

Figure 26: Technological Readiness Levels in the context of the roles of academia and industry. Source: ESA

Technology Readiness

The Technology Readiness Level (TRL) concept was developed originally for space that describes the status of development of a technology in a scale from 1 to 9. TRL 1 is the lowest level and is when basic principles were observed and reported. TRL 9 is when the technology associated with the system was successfully used in a space mission. Significant TRL is 6 corresponding to the demonstration of a prototype using the relevant technology in a representative environment while TRL 3 is when the technology proof-of-concept was analytically or experimentally confirmed.

Technology readiness (or lack of it) is one of the major sources of cost over-runs or delays in space missions. The reason for this is directly related to the risks associated with having the systems on a satellite, that use a particular technology, ready within cost and in time for the launch. For this reason, space agencies use TRL for all the technologies that may be necessary for a space mission.

As can be understood from the TRL, academia plays a fundamental role up to TRL 4. Around this level, the technology is more efficiently implemented in industry with decreasing level of involvement of academia with increasing TRL. It should be noted that while the TRL shown in Figure 24 are pertinent to space

activities, the same concept can be (and is) applied to many other sectors of economic activity that involve R&D targeting the market and innovation.

Intellectual Property Rights, including Patenting

Since the Czech Republic has a serious deficit in intellectual property rights (IPR) exploitation, the great emphasis should be laid on this area. For the further development of space activities in the Czech Republic it is very important to improve by all means all possible ways how to ensure the protection and exploitation of IPR in the Czech Republic.

Recommendation

All activities under NSP should consider the protection of the IPR and the exploitation of these rights.

All R&D activities funded with public funds should aim towards developing and protecting their own IPR and the exploitation of these rights should take place in the Czech Republic. This does not exclude that, for the purpose acquisition of know-how, fully licensed products may be manufactured and/or exploited in the Czech Republic.

It does not exclude funding of activities where ESA retains the ownership of the IPR for operational or continuity reasons like maintenance, upgrade or development of the systems developed, as they ensure a competitive advantage for participating academia or industry.

For both low and high TRL technologies, the role of IPR is crucial to ensure the property of the technology at the base of future products, applications and services that can bring benefits across the whole of the Czech economy.

For this purpose a scheme to support academia and industry to ensure protection of the IPR, including the registration of patents, must be devised urgently with a specific strategy.

The property of the technology however, is not the only condition necessary to achieve these benefits. It is also necessary to ensure, to the maximum possible, that these technologies are exploited in the Czech Republic. The collaboration or teaming of academia with Czech industry is a very important factor, especially in the middle-low TRL, in this process. For this purpose projects that encourage this collaboration, in the respect of their roles, should be encouraged.

Return-on-Investment

Assuming that, in some special cases, academia is able to pursue a technology up to TRL 6 or above, then the problem is one of maximizing the return on investment to develop the technology.

In these cases, the difficulty is in transforming the technology into a product and in retaining the scientists or engineers that performed R&D in academia. The return-on-investment in this case is very small, translating into having the personnel employed during the course of the activity and little else.

An exception is the development of scientific payloads where institutes of the ASCR are the end users of the product and often participate in its development, together with industrial partners, from conception to operational phase. In such cases, when permanent academic staff is involved in the development, the know-how and continuity can be preserved both by the academic and industrial partners.

In an industrial setting it is easier to achieve a product that can be exploited commercially, because market considerations will be taken into account that will influence its design, manufacturing and production. Also in industry, it is usually easier to retain the scientists or engineers that performed R&D. This is very often what renders a development with a high return-on-investment because the market for the new product becomes economically sustainable.

This is what innovation is. It is not just invention. Invention is the conversion of cash into ideas. Innovation is the conversion of ideas into cash. Good examples are Thomas Edison and Nikola Tesla. Thomas Edison was an innovator because he made money from his ideas. Nikola Tesla was an inventor. Tesla spent money to create his inventions but was unable to profit from them. In this context, it is understood that innovation is easier to implement in industry.

Recommendations

The collaboration between academia and industry, exploiting their natural roles and missions, is a key for a successful technological development and innovation with a high content of added value and is a pre-

condition to economic sustainability. This collaboration between academia and industry should be supported using national schemes.

The Czech Republic should also aim at creating an environment for knowledge transfer acquired through space activities including results from research, technology development and services into other fields. Furthermore, the Czech Republic should focus on establishing an environment for knowledge transfer from other sectors to the space sector. Knowledge transfer should be supported using national schemes.

Furthermore, in order for Czech entities to actively participate in the development of new technologies and their ultimate implementation/application, it is desirable that they participate in relevant projects from their initial stage when directions and goals are defined.

5.2 ENTITIES

5.2.1 INDUSTRY

5.2.1.1 Directly related to space activities

Czech Space Alliance

The Czech Space Alliance (CSA) was established in 2006 and grew to represent 14 companies, all involved in space activities related to up-, mid- and down-stream. In 2007, CSA was a co-founder of the pan-European association of national space associations SME4space, through which it participates in activities in Eurospace and communicates with ESA. Since 2010, CSA also represents the Czech space industry in the worldwide forum of the International Astronautical Federation.

CSA members represent a wide range of industrial activities, such as development and production of electronic subsystems, development and production of mechanical subsystems, software, production space of the mechanical and electronic components and testing.

CSA has the following main objectives:

- To participate in the building of the space industry in the Czech Republic;
- To market the skills and achievements of the Czech space industry world-wide,
- To communicate with, and voice the industry needs to, the national space stakeholders. As such CSA develops relationship with space agencies (Brazil, UK, Spain, Austria, Italy, Japan, Thailand, Korea, etc.), space industry associations and other space entities. Results of these include e.g. a bilateral cooperation agreement with the Brazilian Space Agency, joint overseas missions (with the support from Czech Embassies, CzechInvest, etc.) and industry seminars (e.g. in UK, Austria, the Netherlands, Brazil, etc.) and presentations of the achievements of the Czech space industry at conferences worldwide (e.g. Europe, Japan, Argentina, Thailand, Korea, etc.). In cooperation with the MT it initiates similar events in the Czech Republic with industry delegations or large primes (e.g. JAXA, SpaceNed, Astrium UK, etc.).

Association of Aerospace Manufacturers of the Czech Republic

The Association of Aerospace Manufacturers of the Czech Republic (ALV), represents more than 30 members - from major prime contractors and systems suppliers to small specialized companies. Their portfolio covers the whole spectrum of skills and capabilities ranging from design & development to production of various aviation products and services and some very specific space products and services involving a very limited number of companies (two that are related to the up-stream segment).

ALV acts as a representative of aerospace industry in Czech Republic, Europe and international organizations and institutions, both governmental and private (e.g. ASD and Confederation of Industry of the Czech Republic). In liaison with universities, engineering schools and other institutions ALV contributes to various Czech training & education programs.

The Association for Transport Telematics

The Association for Transport Telematics (SDT, know abroad as ITS&S) is mostly pertinent to the mid- or down-stream segments of space. It is a public-private non-profit association of companies and institutions from the Czech Republic and Slovakia that deal with information and communication technologies and their

applications in transportation (Intelligent Transport Systems). With more than 80 members on board ITS&S operates as an active and independent “think-tank” in the region, providing well-balanced, high quality information to policy makers, suppliers, users and creating sustainable opportunities for ITS deployment. ITS&S is an active member of ITS Nationals, the network of national ITS association hosted by ERTICO.

On behalf of its members ITS&S is active in advocacy, strategic marketing & product development, it supports international co-operation, provides assistance to European ITS initiatives, education & training of ITS professionals, co-ordinates members' projects and supports ITS deployment via working groups. In relation to the space technologies the association members have been very much active in many national and international research, development & deployment projects that use satellite communication and/or localization infrastructure to provide intelligent transport services in the area of road, railway, waterway and space transport, incl. ESA projects and projects supported by the European GNSS Agency (GSA).

5.2.1.2 Other entities indirectly related to space activities

Czech Chamber of Commerce

The Czech Chamber of Commerce (CCC) represents the entrepreneurial public. It protects the interests of its members – SMEs and large enterprises, voluntarily associated in a network of regional chambers and trade associations. Its mission includes the representation of entrepreneurial interests, support of private enterprise, consulting for entrepreneurs, commenting legislature, establishment of business contacts abroad, arbitration, etc. Its strategic objectives are quality entrepreneurial environment in the Czech Republic, European Union and the world, support of knowledge economics, services for all Czech entrepreneurs, and international cooperation.

Association of Small and Medium-Sized Enterprises and Crafts of the Czech Republic

The Association of Small and Medium-Sized Enterprises and Crafts of the Czech Republic (AMSP) brings together SMEs and craftspeople and their organisations from around the whole country on an open, non-political platform. It successfully promotes the basic idea behind the Programme for the Development of Small and Medium-Sized enterprises in the CR, compiled in 2003.

While not directly relevant to space activities the AMSP has also a role to play since most industry involved in space in the Czech Republic are SMEs.

The association cooperates with the government, individual ministries, and over recent years has initiated a host of statutory measures which are helping to create the business environment in the Czech Republic.

The AMSP is a member of the Confederation of Industry of the Czech Republic and cooperates closely with other specialist and professional federations.

The AMSP informs all of its members of the possibilities of cooperating within the framework of the EU and offers them assistance and consultation when selecting suitable projects. In cooperation with the Czech-Moravian Guarantee and Development Bank support for these projects will be provided in the form of interest-free loans for the acquisition of long-term tangible and intangible assets, the financing of reserves, receivables within the maturity deadline, and operating costs directly linked with a project. Support will be provided under the terms of contracts concluded between the final recipient and the final user.

Confederation of Industry of the Czech Republic (SPCR)

Confederation of Industry of the Czech Republic (SPCR) is the biggest employers association of the Czech Republic, consists of 28 collective members and 121 direct members, altogether about 1550 companies with nearly 800 000 employees, is a voluntary, non-political and non-governmental organization that brings together employers and enterprises in the Czech Republic, participates in shaping the economic and social policy of the Czech Government in order to create optimal conditions for business development in the country, represents Czech employers and enterprises at international organizations.

The Confederation of Industry of the Czech Republic, inter alia, represents and promotes the common interests of its members with the goal to create an environment that is appropriate to enterprise and employment, supports and promotes the respect of ethical principles of business that will lead to a long-term and sustainable prosperity for the Czech society and strives to improve the quality of the Czech business environment, promotes foreign trade relations and cooperates with other employers´

organizations, federations, alliances and enterprises as well as with the Czech Republic´s Chamber of Commerce.

Recommendation:

In the Czech Republic there are several technologies that are sufficiently advanced to be applicable relatively easily to space programmes or applications. However, only the companies with the determination and motivation to overcome the initial hurdles will be able to move into the space arena. Among the reasons are strict project management, standards and documentation requirements, the limited profit margins that ESA contracts allow, as well as the relatively small contribution of the Czech Republic towards ESA. The size of the Czech contribution to the ESA budget, the general trend, and specific recent practical experience, point to the realisation that the space business in the Czech Republic must focus especially on innovative SME. Specific measures to support SME and their innovative behaviour should be devised. These measures should also contemplate protection of IPR, including patent registration, support.

5.2.2 ACADEMIA

5.2.2.1 Academy of Sciences of the Czech Republic

The primary mission of Academy of Sciences of the Czech Republic (ASCR) and its institutes is to conduct basic research in a broad spectrum of the natural, technical and social sciences, and the humanities. This research, whether highly specialised or interdisciplinary in nature, aims to advance developments in scientific knowledge at the international level, while also taking into account the specific needs of both Czech society and national culture. Scientists of the ASCR institutes also participate in education, particularly through doctoral study programmes for young researchers and by teaching at universities as well. The ASCR also fosters collaboration with applied research and industry. The integration of Czech science into the international context is being promoted by means of numerous joint international research projects and through the exchange of scientists with counterpart institutions abroad.

The space research at ASCR benefits among others of a strong heritage which includes the experience of scientists and engineers who designed, built, and operated the first Czechoslovak spacecraft, MAGION 1, launched in 1978. Nowadays, space activities at ASCR are coordinated by the Council for Space Activities which was constituted as an advisory committee of the Academic Council of ASCR. Fourteen research institutes of the ASCR are active in space research.

The space activities of these institutes includes data analysis of past spacecraft missions and a direct participation in the design and development of scientific instruments for future spacecraft projects. Scientists are deeply involved in analysis and interpretation of data from current missions of ESA (SOHO, Cluster, Integral, GOCE, SWARM, XMM-Newton, Gaia, Proba 2), NASA (Van Allen Probes, Polar, THEMIS, STEREO), and CNES (DEMETER) and also participates at preparation of the planned ESA projects at different stages of their development (JUICE, Solar Orbiter, BepiColombo, ATHENA, MarcoPolo-R, ArtEMISS, LOFT and on scientific aspects related to Proba 3, Sentinel 3 and GNSS). The spacecraft experiments under preparation in which the institutes of the ASCR participate also include missions of CNES (TARANIS), and Russian Federal Space Agency Roskosmos (Resonance, Luna-Glob) but these institutes primarily work on ESA projects.

5.2.2.2 Universities

Several Czech universities have activities that are related to space activities and that could play an important role in the support of the development of industrial capabilities.

Worth of special mention are:

- Czech Technical University in Prague
- Brno University of Technology
- Charles University in Prague
- University of West Bohemia
- University of South Bohemia in České Budějovice
- Czech University of Life Sciences in Prague
- VŠB - Technical University of Ostrava

- Masaryk University

These universities should play an importing role in supporting the industrial development of all space segments (up-, mid and down-stream).

The main Czech goals in academia in the field of space R&D area include:

- For space physics: plasma and radiation environment near Earth and in solar system, solar research, meteorite research, objects in solar system, stellar research;
- For Earth sciences and EO data applications: gravitational research, magnetospheric and ionospheric research, atmospheric and hydrological research, mineralogical and carbon cycle studies, land cover and urban development, disasters management;
- For life sciences: biological research (algae grow) and radiation biological modelling, psychological aspects (stress) of spaceflight;
- For telecommunication research and application: atmospheric radio propagation, generic satellite navigation signal receiver development, indoor signal modelling, microwave onboard transmitters;
- For propulsion systems research: system analysis, innovative thermal protection, structural and thermal modelling, pyrotechnic devices;
- For space platform systems: small satellites systems, electronic and electromechanical systems, robotic systems, composite advanced materials, optical and polarization filters;
- For ground segments: satellite data processing architecture and method development, spacecraft ground control and testing procedures.

5.2.3 EVOLUTION OF CAPACITIES AND CAPABILITIES

5.2.3.1 Before 2005

Before 2005 the Czech Republic had a proven capability to develop advanced technologies and manufacture products. This was demonstrated by number of successful projects realized during the second half of the last century. However this was done, as already mentioned, in a very different economic framework where economic sustainability or return-on-investment of the institutional funding was not a concern.

The Czech and Slovak engineers and scientists contributed, for instance, significantly to many disciplines of the Soviet space program. Notwithstanding, nowadays, the awareness of world markets of Czech innovative skills and strengths does not do justice to their real potential, except in some special cases. One of the reasons is that before the 1989, there was practically no need for marketing and business development relevant skills only started being (re-)developed over the last 25 years. It should be also noted that the previous space science and technology developments were carried out in isolation from any market forces and commercial considerations.

Before admitting the Czech Republic as a Member State, ESA conducted two surveys to assess industrial capabilities. First in 2002 for PECS that has mainly a scientific orientation (the Plan for European Cooperating States is design to allow European states to participate in the scientific activities of ESA) and then with a more detailed and focused one in 2007 for the accession to the ESA and oriented towards an industrial participation in ESA activities and programmes.. In both cases, with the different contexts, the results were very positive. These surveys undoubtedly contributed significantly to the Czech Republic being accepted to ESA before the envisaged end of the PECS period. In order to fulfil its geographical returns rule, ESA would not want to receive Czech financial contributions without having reasonable confidence that industry will be able to absorb them effectively.

The surveys provided confidence that the accession of the Czech Republic to the ESA would be successful ensuring a good industrial participation of industry.

Only a few years later, the Czech industry can boast successful participation in projects won with international competition in both Galileo and ESA tenders, as well as successes in international competitions such as the European Satellite Navigation Competition (ESNC), also known as the Galileo Masters.

5.2.3.2 ESA PECS (2005-2008)

Between 2005 and 2008 the Czech Republic was a European Cooperating State (PECS), PECS projects were mostly of a scientific nature with relatively low industrial participation when compared to the typical profile of space activities in ESA. Its selection criteria rarely included considerations of direct use in ESA programmes and activities, except for those related to the ESA Space Science programme, since the European Cooperating States are not yet ESA Member States.

5.2.3.3 ESA Member State

Since becoming an ESA Member State in 2008, standard ESA bidding procedures were applied, which created a clear context and the level playing field necessary for industrial participation. The First Call for outline Proposals under the CIIS resulted in first set of ESA contracts awarded, including development of mechanical components for satellites, electronics, electronic devices and components, ground and space software, software applications and various studies for new areas.

CIIS helped companies with the determination and motivation to overcome the initial hurdles and to move into the space arena and understand ESA requirements - strict project management, standards and documentation requirements, fixed price and the very restricted profit margins (maximum 8% since the activities, differently from the EU, are 100% funded since they target specific developments for ESA missions).

5.2.3.4 Five Years into ESA Membership

Notable improvement of the skills in depth and breadth of experience and skills has been achieved through ESA membership. Moreover, the excellent references from the projects carried out mainly under the ESA's CIIS (implemented in the period from 2008 to 2014 to develop Czech industrial capabilities in space) opened the door to successful participation in other ESA optional programmes and to international tenders and partnerships with renowned European space companies. The competitiveness of the industry has markedly increased from the national to the European level. The number of competitive international tenders won by Czech companies outside the relative protection of the CIIS increased from one before 2008 to almost forty by 2013. The partners include both the main ESA prime contractors, as well as a number of their major suppliers.

It should not be overlooked, that 80% of the tenders from the CIIS went to the members of the Czech Space Alliance.

In general, valuable experience has been developed in building space qualified electronics, sensors, engineering consultancy, space qualified mechanical subsystems, qualified software for GNSS, satellite communications, multi-constellation global navigation satellite system (GNSS) receivers, satellite and mission control systems, flight software, EGSE, Earth Observation software technologies, world class passive electronic components. A range of new know-how and references has been acquired in advanced materials, composite technologies and crystals.

A list of all projects with a short description can be found in Annex E.

The activities funded by the CIIS have allowed Czech industry to score commercial successes. Notable examples are:

- A Czech company become the supplier of a major European satellite provider in a large contract to supply a constellation of satellites to a US company. The commercial contract was to design and manufacture the crucial mechanical subsystem for deployment of solar panels for the Iridium fleet of satellites.
- Another Czech company is now the only global supplier of hermetically sealed tantalum capacitors for space and non-space applications.
- Enhancement of EGNOS real-time monitoring system, re-developed for a large European space company. The system is now operating in the European EGNOS simulator. Commercial SBAS opportunities have also opened up in Asia.

It must be underlined that in the light of experience, that the approach needed to do business with ESA (and hence the necessary infrastructure and support from the government entities) is diametrically different from

that with EU, ESO or CERN, not to speak of national R&D programmes, which are typically not based on commercial principles.

ESA has atypical procedures by EU standards and requires a very specific approach from both the industry participants and from the supporting national space entities. The rules of the participation and financing have been honed by 50 years' experience and do not fit in the "box" of national grant or other projects. The attempts by some national bodies to bring ESA activities in the fold of existing or future non-space specific programmes or agencies are due to lack of awareness of those specifics. Such attempts, if pursued further, could jeopardise the good progress we have made under the focused Coordination Council for Space Activities or dedicated future national space agency.

During the CIIS the Task Force prepared the ground for the first commercial space project, which involves developing key mechanical components for a large US satellite fleet. As the CIIS is coming to conclusion, the role it has played since 2008 in creating Czech capabilities will disappear at the end of 2014.

It will now depend predominantly on the initiative of the industry and its partners to apply their ESA acquired know-how to the commercial world. Strategic partnership with a major European space prime contractor in hardware and software development is being prepared or already in place, which could take advantage of decades of commercialisation of space by our partners.

The size of the Czech contribution to the ESA budget, the general ESA trends, and practical results so far, imply that the space business in the Czech Republic must focus on innovative enterprises that can use outputs of space related projects elsewhere and thus reduce overall development cost. Indeed the results of our ESA membership, the number of won project and their financial volume, strongly underline this reality.

It is well understood in Europe, that it is mainly SMEs which drive innovation and creation of jobs. Participation in ESA projects enables them to develop cutting edge technologies, use existing wealth of technologies developed previously, and learn fast by participating in international teams with very experienced space partners. Exploiting this know-how to increase their competitiveness and develop new indigenous products or services does not happen overnight, but Czech companies make good progress faster than their competitors would expect.

Very effective tools, implemented with the support of the CIIS, to improve our participation in ESA projects were:

- Tutorial on doing business with ESA;
- Proposal Writing Course;
- Partner Matching and support to Czech industry in internationalisation and presentation;
- Respect for the natural roles of academia and industry.

These are activities that that will still be necessary after the end of CIIS that needs to be to be supported.

We should also aim to exploit and learn from the experience of our partner countries, if they are willing to share it, as they have accumulated several decades of experience in commercialisation of space technologies.

A very important point that has to be carefully followed is the recent accession to the ESA of Romania and Poland. Soon, expected in 2015, Hungary and Estonia will also become ESA Member State. These new Member States will seriously increase the competition with the Czech Republic also because the financial resources allocated to ESA programmes by these countries (with the exception of Estonia) is much higher than those allocated by the Czech Republic.

Czech industry is developing a portfolio of competencies with an indigenous and sustainable supplier base in the Czech Republic. This is being done in both the manufacturing and R&D segments and in accordance with the knowhow and possibilities of the Czech Republic. Successful projects described in Annex E are creating a pathway to compelling new capabilities for the Czech space industry and long-term growth for the Czech economy.

Even in current tight space budget environment there is a need for innovative new products and systems that will allow Czech industry to achieve decisive benefits from their participation in space activities. However, the very low public investments of the Czech Republic in space is a current serious constrain which will need to be addressed.

Long-term success can only be achieved through the implementation of the newly developed capabilities that will require consolidation into economically sustainable products. This will help the whole Czech space industry further strengthen its excellent international reputation and to operate in areas capable of bringing high added value and not only to create but also retain intellectual capital.

ESA programmes are therefore from this perspective the opportunity to engage not only in international cooperation in various fields but also to improve the competitiveness of Czech industry and to the Czech Republic economic growth.

The existing space related eco-system around Czech space industry is expected to bring multiple benefits to the Czech Republic. For instance, some of the most tangible benefits that need to be considered are:

- Employment of high educated people → retain Czech talents in the country,
- Creation of synergy between SMEs and large industry,
- The natural strengthening of cooperation between industry and academia (Universities and ASCR)
- Creation of business incubators → high potential for start-up business,
- Commercialization and manufacturing of space products in Czech Republic,
- Revenue from intellectual property licensing.

Another important benefit from this eco-system is the impact on Czech academia. The eco-system will provide a unique opportunity to Czech academia to refine its research agenda, and open new PhD positions in order to address the new issues related to space systems.

The following sections describe some market opportunities in a non-extensive manner, where current Czech capabilities and capacities could be employed in the upstream, midstream and downstream space sectors. Again it should be noted that the following potential opportunities are highly dependent on the levels of public investment through the contributions to ESA programmes. This would support and develop the existing eco-system that already has expertise with a strong background in the space domain and should also foster the re-use of products across adjacent markets, in order to increase sales volume and thus secure additional future resources for future R&D activities.

5.2.4 UPSTREAM SEGMENT

The upstream space sector includes all areas directly pertinent or supporting satellites, launchers, satellite operations and ground-segment.

Mechanical Systems for Space Applications

Czech space industry has a long term heritage in mechanical systems for space applications. A good example of their current capability is the supply of the solar array hinges for the next generation of Iridium satellites. Other areas in development are pointing mechanisms for antennas and thrusters, and mechanical structural elements.

It is highly recommended to utilise the experience in design, testing and manufacturing of mechanical systems in both ESA and commercial projects.

Overall competencies in this area include e.g.:

- Stress, thermal and fluid dynamic calculations,
- Fatigue life and fracture mechanics evaluation,
- Design of highly loaded components and their optimization,
- Numerical computation involving complex physical effects,
- Thermal design and analysis of the space subsystems,
- Structural evaluation of space components,
- Aerodynamics, aero elasticity, acoustics,
- Climatic, mechanical and life-time testing of components, parts and materials ,
- Additive manufacturing,
- Composite production and bonded sandwich structures, epoxy adhesives for extra high strength bonds, epoxy resins for lamination, pultruded composite profiles and sandwich panels,
- Production and delivery of qualified mechanical parts, assembled modules and subsystems.

Flight Hardware Design and Production

Overall competencies in the area include e.g.:

- Development of digital circuits and single-chip microcontrollers,
- In-flight use of wireless sensors,
- System health monitoring (SHM),
- Design of the mechanical parts and/or entire systems,
- Space hi-rel electronics cleanroom manufacturing activities,
- Products for crystal chemistry, study of crystal growth and solidification processes, growth of crystals for technical applications (optics including x-ray, acousto-optics, electro-optics, adaptive and adaptive optics, free-form optics, thin layers, polarisers, laser applications, fine mechanics, etc.),
- Equipment for material sciences and technology in space,
- Development and manufacturing of apparatuses and devices according to specific requirements and various space applications, including mechanics, optics and electronics.

Software

Over all competencies in this area includes e.g. following activities:

- On-board software:
    - Flight Software for various missions.
    - Complete software packages in all phases (requirements and architecture design phase, detailed design and implementation phase, delivery and acceptance phase).
    - StartUp SW, Mission critical SW & Application SW).
- Software development for the ESA Ground Station and Mission Control System (e.g. for ESTEC, ESTRACK, etc.). Software for ground segment infrastructures e.g. robotization of antennas and telescopes, control systems development, tracking software.
- Software development for the Earth Observation and Navigation Services Infrastructure.

Simulation and Testing

Over all competencies in this area (existing for the aeronautical sector) includes e.g.:

- Stress, thermal and fluid dynamic calculations,
- Fatigue life and fracture mechanics evaluation,
- Validation of highly loaded components and their optimization,
- Numerical computation involving complex physical effects,
- Thermal design and analysis of the space subsystems,
- Structural evaluation of space components,
- Climatic, Mechanical, Aerodynamics, Aero Elasticity, Acoustics and Life-time Testing of Components, Parts and Materials.

Multi-constellation Global Navigation Satellite Systems (GNSS)

Czech companies started research in multi-constellation global navigation satellite system (GNSS) receiver that will combine multiple signals to improve reliability and accuracy for global positioning many years ago.

Running developments related to GNSS are monitoring performance and accuracy of multi-constellation systems, avionics products for the aviation industry products include EGI (Embedded GPS/INS), SIGI (Space Integrated GPS/INS), EGPWS (Enhanced Ground Proximity Warning System), etc. Research labs in the Czech Republic have currently expertise in all aspects of GNSS technology including GPS receivers, differential GPS, GPS/INS integration, etc. The current focus of GNSS R&D is software GPS algorithms for improving acquisition/tracking performance of GNSS receivers, ultra tight coupling of GPS and INS to achieve anti-jam/anti-interference, high integrity INS/GPS algorithms for precision approach and autonomous landing. Czech companies are continuously interested in the development of technologies and products that use GALILEO system mainly in area of multi-constellation global navigation satellite systems capable of receiving GPS and GALILEO (in future also GLONASS) signals.

The resulting market potential for GNSS systems is enormous but hard to precisely calculate due to number of regulation and legislation issues.

Satellite Communication

Satellite communication domain provides an excellent environment for fostering the cooperation between Czech industry, research institutes and universities participating in advanced applied R&D topics. Especially close cooperation with MT and ESA have created new business opportunity in this area with potential to further grow significant business impact in following areas:

ATN/OSI and security gateway development for Inmarsat User Terminal (Iris-Precursor) enabling satcom to complement VHF datalink as enabler for near and mid-term safety critical ATM applications Design and development of User Terminal of new satellite communication system for safety critical air/ground data and voice communication

RPAS C2/C3 SatCom terminal development up to final product

The market potential of cockpit satellite communication depends especially on ESA strategy, outcome of ATM programs (SESAR, NextGen) and corresponding mandates.

Assuming also growth of civil RPAS market and potential of satellite communication for C2/C3 the corresponding avionics business opportunity within the Czech Republic could be significant. The exact revenue depends especially on RPAS deployment strategy, public and internal investment and other factors.

Inertial Sensors for Space Application

It should be mentioned that a micro-accelerometer currently flying in ESA's SWARM satellites was developed in the Czech Republic however the specification of this accelerometer is scientific and as a consequence with very high sensitivity and it is not pertinent to any other common or generic space use (cost, mass and size).

Inertial navigation sensors are a good example of a cross-domain product family in a high tech technology area with significant economic added value. As the navigation sensors are comprised of multiple technology domains it provides another excellent area for fostering the cooperation between Czech industry, Czech research institutes and Czech universities participating in advanced applied R&D topics.

At the end of 2012, a feasibility study was successfully executed under the CIIS. The outcome of this study was not only proving the feasibility of the technology development but also provided a suggested approach. The study also showed the estimated market potential of the Czech navigation sensor technology. Based on the encouraging results of the above mentioned feasibility study extensive team was set up, fully dedicated to the area of navigation sensors.

The ultimate goal is the development of Czech space qualified MEMS gyroscopes and sensors. The gyroscope is the most critical part of inertial measurement unit. If the MEMS gyroscope technology will be developed in the Czech Republic, the technology will fall under licensing rules of the Czech Republic and the European Union. As such it will be completely independent from US technology and will allow addressing the needs of European and global customers.

Electric Power and Controls for Space Applications

Main directions of development for European satellites are currently the following:

- Performance improvements
- Cost reduction
- EU Competitiveness and independence

At the same time, clear trend of increase of the satellite on-board power is emerging, caused by a transition to electric propulsion, increased consumption of the payload equipment, and availability of higher mass efficiency of power sources, typically solar panels.

This desire to handle more power on-board the spacecraft, along with demand for lower cost, results in need for higher power density electronic components – the launch cost, dependent amongst other aspects on the weight of the satellite, is a significant share of the total lifetime cost of satellites. The emerging need to launch all-electric satellites (i.e. without chemical thrusters) necessitates a development in the areas of electric propulsion and energy storage capable of high power release or generation.

While many of such components are available by various US manufacturers, often their application is limited by International Traffic in Arms Regulations (ITAR) of the United States. European satellite manufacturers

typically prefer to purchase local, non-restricted versions of such equipment, even sometimes with some cost and performance penalties.

Substantial synergy between the space and aeronautics development exists and could open opportunities.

The specific areas, where the synergy is evident could be:

- **Power management**, including **conversion** and **distribution** (e.g. Power Processing Unit, Power Control Unit, Power Control and Distribution Unit, Advanced monitoring such as Electrostatic Discharge monitoring and mitigation).
- **Electric actuation** (e.g. Electric Motors, Attitude Actuators – Reaction Wheels, Control Moment Gyros, Flow Control Units, Electronic Pressure Regulators, Thrust Vector Control Systems).
- **Energy storage systems (including energy accumulation and generation)** (e.g. Battery Systems including battery management, Innovative concepts of energy storage and possibly capacitors)
- **Thermal management** (e.g. Cryo-Cooling solutions, Heaters, Heat Exchangers).

However this is an area of very strong competition with several already established European players.

On-board Systems

Avionics or aviation electronics is the heart of any spacecraft (S/C) or aircraft (A/C), and is typically controlling all the operations of a vehicle and its vital sub-systems. The term avionics refers to all the electronics-based equipment in S/C, and typically includes on-board data system, along with its on-board computer (OBC) and remote interface units (RIU), Altitude and Orbital Control System (AOCS), along with its software, sensors and actuators, flight software, payload data handling, interfaces, and communication services and protocols.

More specifically, next generation (NG) on-board platform systems (OBPS) is expected to integrate European non-dependent technologies and to be free of technologies subjected to U.S. export regulations. The NG OBPS include five major lines:

- **Hardware platforms**, including:
  - Platforms for control, data handling, guidance and navigation, payload processing,
  - Processing modules, based on contemporary packaging technologies, such as system-on-chip, multi-chip modules, system-on-package, and system-in-package,
  - Processing modules extensively integrating multi- and many-cores,
- **Software platforms**, including
  - Reference software architectures to enable software re-usability across different space missions and across space and aerospace market segments,
  - Mechanisms for ensuring time and space partitioning of S/C and/or A/C functions,
- **Network interfaces/Data buses**, including payload and platform buses, to take into account the growing need for high-speed interfaces,
- **Modules to provide integrity** of on-board data systems, such as:
  - Reference system architectures,
  - Remote interface units,
  - Network interface cards,
  - Integrated tool chains for acceleration of development, and verification and validation cycles, including tools for HW/SW co-design and end-to-end cycles,
- **Integrated test-beds to enable application testing in a laboratory** environment and thus early in development cycles.

According to already conducted surveys some of the key differentiators are as follow:

- Increased processing capabilities,
- Reduced size, weight and power (SWaP),
- Implementation of functional services linked to on-board communication,
- Rationalization of interfaces,
- New architectures for lower level and application SW,
- Enhanced modularity and multi-instruments support capability,
- High data throughput links and increased memory capacity.

However this is also an area of very strong competition with several already established European players.

Launchers and Propulsion Systems

Current capabilities are based on existing local industrial capacities and capabilities and cooperation across entire industrial and R&D sectors (universities, research institutes). Industry already successfully benefited from cross domain synergies in the space, aerospace and automotive industries paving solid way to long term benefits to the national economy. ESA currently aims in cost reduction and competitiveness increase for the new programs like Ariane 6 or Ariane 5ME in close relationship to already running FLPP-3 (Future Launcher Preparatory Program). The utilization of technologies and suppliers from outside of the traditional space industry is one of the ways how to achieve this goal. Projects supporting this domain include composite advanced insulation materials developed for cryogenic fuel tanks and pyrotechnical systems proposed for the Ariane launcher.

Another possible area of Czech interest may be in micro-launchers, especially associated with sounding rockets that is currently not yet addressed in ESA's Launcher programmes except for FLPP.

Industry is currently preparing several promising projects in following areas:

- Monomers and polymeric materials (coatings, adhesives, casting resins),
- Tailored surface modifications,
- Embedded microcontrollers,
- In-flight use of wireless sensors,
- SHM systems,
- Computational mechanics, Payload comfort damping & isolation system for space environment

This domain is very linked to the possible future participation of the Czech Republic in ESA's launcher development programme such as Ariane 5 ME, Ariane 6 and Vega.

5.2.5 MIDSTREAM SEGMENT

Midstream segment consists of components and technologies for support space missions' utilization. From this point of view it in some cases ensures bridging between upstream and downstream. The midstream segment is that associated with the pre-processing, storage, archiving and distribution of satellite related data as well as the associated networks.

Development of midstream segment (e.g. building of data centres or archives, data access ensuring, building of GNSS permanent reference station networks, etc.) could strongly support the downstream segment development. Building of robust midstream components and its operation demand investments. And that is usual obstacle for development of this segment.

Very good example of functional midstream segment is Landsat data archive or permanent reference station networks providing corrections for positioning via GNSS (e.g. CZEPOS). These systems give rise to many applications, which cannot be able to develop without this supportive segment. Besides from it primary function several inter-disciplinary applications are foreseen such as input for assessments and inter-comparisons of numerical weather prediction models, monitoring the quality and homogeneity of tropospheric parameters in long time-series for climate studies etc.

For future the national storage of Earth observation (mainly Sentinel) data should be established. The objective of this storage is to ensure better data access for very wide range of national user groups, like governmental sector, companies, academia or citizens. Above the stored data could (and should) be developed new services for citizens provided on sustainable base. Linkage to the national spatial data infrastructure is recommended.

5.2.6 DOWNSTREAM SEGMENT

Downstream segment refers to industrial activities which use the space infrastructure and space based data to provide tools and services for general users. The estimated potential market for this area is very difficult to estimate.

So far, Czech industry has not made as much progress as in the upstream sector, which has received substantial support from the CIIS however services and applications capabilities and capacities related to Copernicus and Galileo were also developed.

To be successful in the downstream segment some fundamental ingredients are necessary: a) excellent software expertise, b) very close consultation with the potential customers, not only to define precisely what will be delivered in the service or application but, also the costs and possible income from those customers. However before the use of a technology becomes a commodity, a deep or detailed knowledge of the space systems or instruments of which data are used is also necessary. Very good examples of this are for example TomTom or Garmin that today are global players in the navigation sector. Before the use of navigation technologies became a commodity these entities were early adopters with technology knowledge close to the space segment. This has allowed them, not only to be early adopters but to become dominant in the market of navigation applications and services.

The downstream segment is harder to directly target through ESA activities since the EU funds, by more than an order of magnitude, support services and applications development related to the use of Galileo and Copernicus.

There is a significant number of companies with technology potential to develop space oriented focus - both in the upstream and the downstream sector. However, as pointed out above, the upstream work is constrained by the Czech contribution to ESA, and hence any effective significant growth has to be led by corresponding increase in the contribution to ESA.

On the other hand, while the downstream business may not have this direct constraint, it is much harder to break into because of the already established (developed before the Czech Republic became an ESA Member) European players.

At the same time, ESA fully funds preparatory activities in this segment and co-funds downstream activities that should be better exploited.

More than 30 projects have been implemented in this segment covering *inter alia*, the use of GNSS data for:

- Meteorology and climatology,
- High accuracy methods,
- Integration into other non-navigation products and

Earth observation data for:

- Agricultural applications (e.g. monitoring the status of forests, vegetation stress, etc.),
- Water quality,
- Flood protection,
- Civil protection,
- Cultural heritage protection and management.

Earth Observation

There are a few crucial factors in close relation of each other which affect the current size of the market of EO applications and information in the Czech Republic. It is mainly the price of EO data and service, and the lack of awareness on EO capabilities. Utilization of information based on EO data and services are very closely related to specific sectors (in meteorology satellite data is one of the key data but in other areas, e.g. urban or agricultural management EO satellite capabilities are less well known). It is necessary to have in mind that meteorology is mainly institutionally driven sector with huge institutional providers (national meteorological services, EUMETSAT). On the other hand e.g. for infrastructure monitoring EO data is currently used only in very specific cases only (2014).

Industry

Currently (2014) is in the Czech Republic a few companies which are able to proceed the EO data. These companies are focused mainly on geoinformatics in general, but there are already first examples of mostly “EO companies”. For a future it is expected rising number of companies, in which the EO will be part of their portfolio.

Very strong impulse for development of new application will provide the "free of charge" Sentinels data (see Chapter 4).

Land monitoring is in general very good example of dynamic EO sector with a number of rising applications. Land monitoring covers lots of applications for detecting land cover/land use, agriculture, forestry, monitoring of biotopes and landscape, monitoring of snow coverage, water clearance, infrastructure monitoring, mining, insurance, spatial development and many other thematic mapping applications. This field is very promising for further development. Many of EO applications are still in the initial, design, prototyping or system development phase. Markets are therefore not well developed yet. The EO data becomes the source of primary data for a wide range of applications. The near-real time services arising from ESA's Sentinels (EU's Copernicus) are very promising.

In spite of the development of new commercial applications, the government will remain the most important client for EO products and services. Implying that the market will be structured as B2G or G2G, resulting probably in services from government to citizens.

Recommendations

For stimulation of new applications development some suitable platform or scheme should be established (e.g. "Czech Copernicus Masters"). It is necessary to make easier the transfer of ideas of new promising applications to the market. In this case the ESA BIC is one of suitable supportive tools.

Academia

The Earth Observation as a sector is well established in universities and research institutes. There are two main motivations to use the EO data by R&D sector. In first case the EO data are "instrument" and key source of primary data for research. In second case the EO data are used as supporting source of information or as a tool supporting the goal of respective research. Among sustainable activities is possible to count spectroscopy and spectrometry, cal/val, multispectral and SAR data processing, gravimetry, etc. Some universities and research institutes are interested in hyperspectral data processing, but due to the lack of hyperspectral satellites are the data collected mainly by airborne sensors. Number of student fully or partly focused on EO is still increasing (2014), it could be expected they would like to use EO data and methods afterwards.

At least the following general capacities and capabilities for EO applications and products development can be found in Czech Republic:

- Development of new geo-informatics products from EO data;
- Application of SAR data for monitoring of infrastructure statics, multispectral and hyper-spectral data for environment applications, land use, land cover, monitoring or natural disasters, etc.;
- Cooperation in development of services for downstream Copernicus market;
- Development of integrated applications using EO data;
- Spectroscopy, spectrometry, SAR interferometry, gravimetry (mainly academia);
- Cal/Val;
- New processing algorithms development.

Navigation, satcom and integrated applications

GNSS applications are applications that use GNSS systems for its functionality. GNSS applications use GNSS Receivers to derive position, velocity and time information to be used by the application. In some specific cases other additional measurements might be used. The receivers might be generic all-purpose receivers or can be built specifically having the application in mind.

Many companies within Czech Republic are already active in the domain, using the data from GNSS systems for their solutions, in most cases as commodity as discussed above. They are utilised, as well as some EO and integrated applications projects, in many branches of national economy, ranging from transport, environmental and civil protection to agriculture.

When data from at least two existing and different space assets (namely two out of GNSS, EO and telecom) are combined, a term "integrated" application is used. It is a promising area, as many potential users are not still aware of how data from space assets could simplify their activities, bring new services, or reduce their operational costs. ESA has a programme dedicated to the promotion of integrated applications - ARTES 20.

There are already some companies active within this area, possessing technology know-how within one or more domains, or even entities that are non-technology-oriented, focusing on searching and promoting viable business cases.

We can see gradual involvement of Czech entities in the ESA satcom upstream activities, however there has not been any in the satcom downstream domain so far. Various reasons might be the cause, e.g. maturity of the satcom sector and related saturation of the market/competition, nevertheless we can expect some future involvement in the near future thanks to ARTES 5 and 3-4 subscriptions.

At least the following capacities and capabilities for GNSS/Integrated applications and products development can be found in CR:

- Remote non-invasive sensors monitoring various health body parameters together with user position
- Fleet management and localization systems of stolen cars, information support systems for all means of transport
- Various Intelligent Transport Systems using space assets
- Location based services development capacities, also for crisis in-the-field management
- Agricultural applications (e.g. forests and vegetation monitoring or optimisation of farm operations in general)
- Time and frequency transfer based on application-built receivers
- Others

Recommendations for downstream segment

It is recommended to implement the following actions in order to stimulate the downstream segment in the Czech Republic:

- Intensive awareness raising.
- Continuation of a dialogue with promising end-user communities.
- Demonstration of successful applications.
- Stimulating demand (through a mix of workshops, success stories). Promotion of capacity building and business incubation).
- Stimulation of new application development through suitable platform or scheme at national level.
- Closer cooperation among public sector, research institutes and companies should be established.
- Stimulation of the sector by participation of the Czech Republic in respective ESA and EU programmes as it is the key to European and global markets.
- Specifically for EO:
  - Copernicus implementation plan should be formulated.
  - National Sentinels data storage should be established (could be extended for another EO data).

5.2.7 SPACE SCIENCE AND EXPLORATION

Main scientific space experiments involving direct participation of the Czech research institutions include:

- Langmuir probes and thermal plasma measurement units for Proba-2 satellite (implemented by industry);
- Low frequency wave receiver and power supply for the radio and plasma waves instrument for JUICE (to be manufactured by industry);
- Space radiation detectors for Proba-V mission (implemented with an industrial lead and has led to a product) and compact radiation detectors for real time dose monitoring in the living modules of the ISS;
- Three micro-accelerometers for Swarm satellites precisely measuring movement caused by the non-gravitational forces impacting the spacecraft trajectory;
- Single photon laser detector instrument for the ELT experiment comparing the atomic clock time measurement offset between clocks on ISS and on the Earth by laser pulses (implemented through industry);

- Optical elements for the coronagraph at Proba-3 formation flying mission (implemented with industrial lead);
- Acousto-optical IR rapidly tuneable filter based on Calomel monocrystal (implemented with an industrial lead);
- X-ray scintillation detectors developed from enriched garnets monocrystals;
- Experiments for evaluation of short- and long-term radiation effects on algae and cyanobacteria;
- Power supply and distribution unit for X-Ray spectrometer-telescope and optical components for the coronagraph on ESA Solar Orbiter probe;
- Plasma wave instrument units for Solar Orbiter probe (manufactured by industry);
- Proton detector sub-units for Solar Orbiter probe (manufactured by industry);
- High frequency wave analyser and electron analyser for TARANIS microsatellite;
- Scientific data simulations aiming to identify desired parameters for X-ray detector FIFU for ATHENA satellite.

5.3 AWARENESS RAISING, EDUCATION AND TRAINING

5.3.1 AWARENESS RAISING

In order to ensure a high level of awareness in general public and knowledge of the professional community concerning the importance of space activities, their benefits for individuals and entire society and respective opportunities, there is a need for close collaboration, involvement of various player both of public and private sector and their one way approach.

5.3.1.1 General Public – Adults

Description of current situation

The official space web portal of the Czech Republic managed by the MT (Czech Space Portal)[44] and webpages of other entities have been addressing the general public with a wide range of information concerning both space activities of the Czech Republic and space activities in general (e.g. participation in ESA programmes, industry and students opportunities, interesting facts about astronautics, aerospace, intelligent transport systems ITS, etc.).

The awareness raising actions undertaken for general public can be summarized as follows: the distribution of relevant information through information portals and related social networks, publications (brochures, newsletters, informative video spots etc.), media coverage of Czech participation in the international projects overlapping to the space activities (HeERO/eCall, Copernicus, Galileo Macht Schule, etc.), presentations of space activities within the national events for the general public (NATO Days in Ostrava), media coverage of the relocation of the GSA to Prague, etc.

Analysis

Although the broad scope of awareness raising activities for the general public was carried out, the general public knowledge on space activities is still insufficient in the Czech Republic. The main obstacle to the dissemination of information on space-related activities and its benefits among the general public can be seen in the lack of interest in space-related themes among the traditional media channels (TV, radio, press, journals).

Another point that has a negative impact on raising awareness in the field of space activities within the general public is the fact that the relevant information is available in the form poorly understandable to the laymen. The terms “space” and “space activities” themselves seem to be far off daily life for them which may discourage them to further discover the real content and realize that they are more dependent on space and space activities than they expect.

Recommendations

Information for the general public must be presented in a simple form, preferably on real examples of the use of space technology and applications in the daily lives of people and real and measurable socio-economic benefits that space activities and applications bring to the whole society.

It is necessary to be focused on the identification and subsequent establishment of cooperation with appropriate media (TV, radio, newspapers, journals, etc.) and to build and maintain an active network of contacts to ensure dissemination of space-related information to the general public. It is also necessary to promote new awareness raising events and support the existing ones, broaden the range of visitors and extent the existing informative web portals supported by the social networks.

Another important action is to strengthen cooperation with cultural facilities systematically engaged in awareness raising in the area of the space activities like observatories and planetariums, science centres and parks for general public, etc.

[44] http://www.czechspaceportal.cz/.

5.3.1.2 General Public – Children & Youth

Description of current situation

The activities carried out in the area of awareness raising in the area of space activities towards children and youth can be summarized as follows: the distribution of relevant information through the specific web portal sections of the Czech Space Portal, social networks, publications (sheets, paper cut-outs, informative video spots, etc.), presentations of space activities for youth within the national events for the general public, specialized courses and circles arranged by observatories and planetariums, etc.

Analysis

The objectives of awareness raising in the area of space activities towards children and youth are to encourage their interest in further studies of subjects and disciplines relevant to space sector and motivate young generation to pursue careers in the fields relevant to space activities. Anyway, the majority of the undertaken awareness raising activities for general public is focused on adults. The negative impact on the awareness of children and youth in space activities can be seen again in the lack of interest across the traditional media channels and in the lack of tools which may raise the real interest.

It should be noted that schools do not generally impose an emphasis on involving space topics into current educational curriculums and extracurricular activities.

Recommendations

Awareness raising in the area of space activities towards children and youth shares the same recommendations contained in the previous case with emphasis to active use of social network channels. Space topics should be more involved in educational curriculums and extracurricular activities in order to motivate children to further study space related subjects and be involved in space activities in their professional lives.

5.3.1.3 Professional Public

Description of current situation

The majority of the activities already carried out is aimed at creating positive environment for the Czech industry and academia to be able to easily learn about actual or prospective possibilities and opportunities and help them to establish, develop and intensify their mutual cooperation and/or the cooperation with foreign entities, especially industrial ones, to accelerate the grow of their capabilities and ensure their competitiveness. The activities are more or less focused on the relatively narrow group of specialists.

The awareness actions undertaken towards the professional public can be summarized as follows: distribution of relevant information through information portals and social networks, organization of many professional and technical seminars/workshops, space industry days, networking events, user forums (Galileo User Forum, GMES/Copernicus User Forum), publishing activities (catalogues, brochures, information materials), media coverage of Czech participation in the international projects overlapping to the space activities (HeERO/eCall, Copernicus, Galileo Macht Schule, etc.), support of Czech participation in international competitions with overlap in space activities, as well as the organization of regional rounds of these competitions (European Satellite Navigation Competition, ESNC), presentations of space activities within the national events for the professional public, etc.

Analysis

The level of awareness and knowledge of professional public about space activities in the Czech Republic can be considered as satisfactory. A wide range of implemented activities with an appropriate support provided by the public sector is continuously promoting the awareness within the professional public. It is worthy to note that the activities of professionals are closely associated with their businesses, employments, scientific activities, efforts to find new markets or with a personal interest in the very issue. Therefore they actively and regularly ask for relevant information.

Recommendations

The range of the informative support provided to industry and academia on opportunities and possibilities for development of their capacities and capabilities in the field of space activities, with a particular focus on the activities of ESA and EU, might be further developed through seminars, conferences, information and industrial days, web portals, newsletters and other media channels. The close cooperation between relevant entities on national and international level should be established or intensified in this respect.

It is also necessary to seek for the opportunities in the field of strengthening the international cooperation. In this respect it seems to be necessary to further spread awareness about the national space policy of the Czech Republic on international level and display the capacities and capabilities to other states and relevant entities as large system integrators.

More attention should also be paid to awareness raising about current issues concerning the space activities and their benefits for the national economy towards decision makers.

It is also necessary to raise awareness about the opportunities offered by the ESA BIC platform.

5.3.2 EDUCATION AND TRAINING

As in whole EU there is a shortage of skilled technically oriented graduates in the Czech Republic in all high-tech sectors. The expanding space sector needs a sustainable supply of graduates and technicians with appropriate skills.

Space has a special role in using its exciting science and engineering to inspire young people to take STEM subjects at schools and universities.

5.3.2.1 Primary, Secondary and High Schools

Description of current situation

Space related education at primary and secondary schools is based on teaching STEM subjects. The level seems to be quite satisfactory, but there is apparently the lack of appropriate emphasis on teaching supplementation which will raise the interest of the young generation to pursue careers in the relevant fields of space activities.

Similar situation can be recognized at the high schools moreover with the lack of appropriate optional educational training courses and supporting activities like a realization of hands-on student's projects.

Analysis

Teaching of STEM subjects at primary and secondary schools must be adequately complemented to inspire youth and keep their initial interest in science and modern technologies. The objective is to teach STEM subjects in an entertaining and spontaneous way to show the students how science and technology can be utilized in various fields of human activities. At high schools, the emphasis should be placed on deepening the knowledge and understanding of specifics of space and scientific and technical disciplines related to space.

The supporting activities provided by specialized educational institutions which will work with government, education organizations and experts to exploit the inspirational effect of space in delivering education and capturing and shaping the skills and imagination of the next generation of innovators and scientists is required. The European Space Education Resource Office (ESERO), which is being implemented in the Czech Republic (in the middle of 2014) will markedly help to deliver those forthcoming educational goals.

Recommendations

Teaching STEM subjects at primary, secondary and high schools should be adequately complemented by extracurricular activities with overlap in space activities (e.g. courses, workshops and leisure activities on astronomy, astronautics, physics, etc.) leading to a deeper understanding of the particularities of scientific and technical disciplines. Concerning the high school students it is also essential that the foreign courses and hands-on projects opportunities in the field of astronautics can be identified. In this case, it is necessary to continuously raise awareness about these activities among high school students and teachers (e.g. through the ESERO), intensify international cooperation with foreign institutions (especially within ESA) and fulfil the opportunities offered in this field.

5.3.2.2 Universities and Ph.D. studies

Description of current situation

Czech technical universities prepare their graduates to work in the mechanical and electrical/electronic engineering fields of aerospace. Namely, they offer graduate courses on aircraft structures and design, flight

measurement systems, optical systems, communication systems including satellite telemetry and related technology. Respective departments of natural sciences give more scientific oriented courses focused on space science, astronomy, atmospheric and ionospheric research as well as on biology, geology, hydrology and geodesy.

In space technology the most advanced education programme available in the Czech Republic is the European international multi-disciplinary programme SpaceMaster. There is also new master programme Aircraft and Space Systems that was accredited in 2010. Nevertheless, the number of educational programmes taught at the Czech universities to provide experts in the field of hardware for space flight experiments is significantly smaller when compared to software engineering.

Analysis

The number of students managing to obtain a place in foreign universities (i.e. International Space University, TU Delft, etc.) is limited by lack of financial resources and the laxness in utilisation of the possibilities in the field of education offered by the international institutions.

Utilisation of the international cooperation in the field of space oriented education by the Czech students seen in numbers (since 2006): annual or short-term studies of Space Management course at the International Space University in France (6 students), space summer schools in Austria, Italy and in Germany (8 students) or participation in programmes, seminars and workshops organized by ESA and other partners (31 students, of that 14 university students).

According to the numbers listed above the prime source of space related expert personnel is obviously located in the Czech universities although no specific space long-term university programme exists. Other teaching courses on space science and technology are also provided in some universities using existing small space projects as opportunity for hands-on activities (university robotics research, partial realization of the CubeSat nanosatellites, etc.).

Recommendations

It is necessary to set up and strengthen the international cooperation with the foreign institutions (having its own educational corporate programme) and universities to promote broader list of opportunities for Czech graduates and undergraduates students (e.g. ESA´s Student Placement Programme and hands-on projects of ESA Education Office). The objective is also to find the funds for preparation of scholarship programmes for Czech students, to encourage short and long-term internships, courses, support and realization of hands-on student activities with high added educational value (e.g. full realization of CubeSat projects). More attention should also be paid to promote better communication between Czech universities and relevant stakeholders.

To make the skills training required by space-enabled research more sustainable, two steps should be introduced. Firstly, Ph.D. students aiming to space sector should get access to separate educational institutions and industry inside or outside country giving them relevant specialist and business skills that are needed in both the upstream and down-stream space sectors. To ensure this challenge it is necessary to develop new framework for Ph.D. studies, actively involving Czech universities, Czech industry and foreign companies/institutions. Best practices of similar Ph.D. framework which is beneficial for all parties, can be found across the Europe.

Second one is a comprehensive package of measures to support the entire space sector, with a single point of access, comprising improved project management tools, skills training, and mentoring.

5.3.2.3 Young Professionals & Life-long Education and Training

Description of current situation

The opportunities related to the “purely” space-oriented education for young professionals can be found abroad. Two internship frameworks for young professionals have been recently utilised by the Czech graduates and Ph.D. students, namely ESA’s Young Graduate Trainee (YGT) programme and student programmes (second stage of tertiary education) of the International Space University. Another opportunity can be seen in the use of the ESA´s Postdoctoral Research Fellowship Programme which aims to offers young

professionals the possibility of carrying out research in a variety of disciplines related to space science, space applications or space technology.

Concerning the further education it should be noted that three operational programmes, with possible overlap to support space-oriented education, are being finalized, namely the Employment Operational Programme (EOP), Integrated Regional Operational Programme (IROP) and the Operational Programme Prague - Growth Pole of the Czech Republic (OP PPR). Furthermore, IROP can be only used for creation of material conditions.

These programmes can be also used to support the life-long educational space-oriented vocational training courses or schemes (how to write a proposal, IPR, ECSS Standards, etc.).

Analysis

The educational programmes for young professionals mentioned above were attended by just a few Czech students. ESA's Young Graduate Trainee programme has a limited capacity and the programs of the International Space University are quite cost-demanding.

Recommendations

More attention should be paid to raise awareness among Czech graduates and postdocs about ESA's Young Graduate Trainee programme and Postdoctoral Research Fellowship programme and student programmes provided by the International Space University. With regard to demanding tuition fees, supporting tools like student loans or scholarships should be offered to the applicants.

The Czech framework should be established, supplemented by the internship/trainee framework for the young professionals across the Czech and foreign industry together with Czech Trainee programme within ESA. Also the possibility offered by the forthcoming operational programmes in the field of further education needs to be exploited.

Also life-long educational space-oriented vocational training courses or schemes should be introduced.

6 TOOLS

The space activities require a multi-year budget approach not only because of the length that any space mission requires but also because any discontinuity in the availability of resources will lead to a loss of the expertise, competence and know-how previously created – especially in industry.

This is of particular importance to the Czech Republic today when in ESA transition period is coming to the end (CIIS).

6.1 TOOLS TAILORED FOR SPACE ACTIVITIES

6.1.1 NATIONAL

Nowadays, there is no specific national tool in the Czech Republic which would be used directly to support space activities. However, the discussions on potential establishment of the national space programme are ongoing. In this respect the national space programme should be the main tool for implementation of the NSP. It also should help to interconnect in suitable way the existing general supportive tools and coordinate their use in favour of the area of space activities.

In general, availability of national tools for funding of some activities like e.g. preparatory activities, scientific payload to various missions, educational and training activities, etc. could influence the preparedness of Czech industry and academia to participate in European or international programmes and help them to become more competitive. They also can help the Czech capacities and capabilities to be more sustainable in a long term.

Recommendations

The national space programme in a suitable form should be established to support a sustainable growth of the capacities and capabilities of the Czech industry and academia, their competitiveness and their preparedness to participate in European or international programmes. It is essential to have a financing tool for activities that cannot be funded from traditional ESA optional programme. Looking at other ESA Member States and considering the experience from CIIS, the budget of such national programme needs to be started with funding in €3-5 million/year range in order to be effective for a period of at least 5 years.

6.1.2 INTERNATIONAL

6.1.2.1 ESA programmes

6.1.2.1.1 Mandatory Activities

A) Science

Science programme

Description and objectives

Space Science missions of ESA that are financed from mandatory contributions of ESA Member States and that are currently in the implementation phase are LISA Pathfinder, JWST, BepiColombo, Solar Orbiter, Euclid, JUICE, CHEOPS, PLATO and ATHENA. Czech scientists interested on these missions are funded from PRODEX optional programme (and have been involved in the past, mostly via PECS projects).

Future ESA missions under the umbrella of the ESA long-term plan Cosmic Vision 2015-2025 are subject of selection process that is currently running. The selection will be based on the scientific merit of the associated scientific objectives, budgetary requirements of the missions (with €650 million for large-sized mission L3 as well as €450 million cap for both medium-sized mission M4 and later M5/M6/M7), and the technology readiness level of all components critical to safe and effective mission implementation.

It should be noted that ESA's Science Programme funds only the platform (satellite), its launch, and operations. The scientific instruments on-board each of the Space Science satellites are funded nationally by the Member states involved except in the case of single instrument satellites as is the case of XMM-Newton, Herschel, Planck or Gaia.

Czech industry made several successful bids on Science programme tenders but the fair return from the science programme was not met by far (which is however problem of most small to medium sized ESA Member States).

Outlook

The programme operates with annual budget of €500 million which is a fixed amount covered by mandatory contribution of ESA Member States to ESA budget.

Analysis

The science programme causes industrial return problems to most ESA Member States, including the Czech Republic. Since the Czech Republic cannot opt out the programme, effort must be made to build Czech industrial capacities in order to allow the industry to bid for contracts to build the satellite platform components and equipment.

Recommendations

Participating in Science programme missions, industrial teams – in order to acquire high added value tasks that has the promise of building new industrial capabilities – need to be prepared well in advance in various optional programmes of ESA. National Space Programme would be good a tool to complement the development done within ESA programmatic frame.

B) Technology

ESA manages several technology R&D programmes to guarantee that the necessary technologies are mature enough in due time. From the mandatory contribution the following programmes and initiatives are covered. Other important technology programmes are GSTP and ARTES 3-4 and 5 that are addressed in optional programmes section.

- Technology Research Programme (TRP)
- Innovation Triangle Initiative (ITI)
- Science Core Technology Programme (CTP)
- General Studies Programme (GSP)
- European Component Initiative (ECI)
- Technology Transfer Programme (TTP)

Description and objectives

The TRP serves as the core for the development of promising technologies in their early stages of production up to the laboratory experiments or proof-of-concept stage. Amongst its goals is to assess innovative/prospective technologies incorporating high development risks but also a high potential pay-off and to demonstrate their usefulness for space applications, providing ESA with a long-term technological capability to define new space missions and applications.

TRP does not concentrate on a specific technology domain and is open to all space related technologies. This programme has a yearly budget of €43 million with 3-year work plans and yearly procurement plans.

The ITI is a specific a rather distinct part of the Technology Research Programme that aims at the transfer of innovation technologies used outside of the space sector to the applications in ESA projects (though completely novel technologies are also welcome). Project proposals can be submitted anytime and are evaluated periodically 3 to 4 times per year.

The CTP follows-up the TRP and focuses on developing and demonstrating the maturity of critical technologies necessary for candidate scientific missions. The demonstration of the feasibility of these critical technologies is an essential prerequisite to enable implementation of the planned missions at an acceptable level of risk in terms of cost and schedule.

The GSP interfaces in different ways with all of ESA's programmes, but its main role is to act as a “think-tank” laying the groundwork for the ESA’s future activities. The feasibility studies undertaken by GSP give the ESA Member States and the scientific community the necessary information on which to base their decisions about the implementation of new programmes and missions and the future direction of space activities. The GSP studies are selected from proposals submitted by ESA staff. GSP activities also reflect the views and suggestions of Member States and industry gathered through workshops, visits and hearings.

The ECI has the objective to reduce in a sustainable manner the European dependence on non-European single-sourced Electrical, Electronic and Electromechanical (EEE) components, particularly those that might become subject to export restrictions (e.g. ITAR or End User Certificate). ECI is an open cooperative programme where ESA and national space agencies participate each and contribute to the programme objectives with their own funding.

The TTP aims to bringing the space technology to non-space applications. It does so by identifying new non-space business opportunities for providers of space technology and systems and providing support to new companies (being start-ups or spin-offs) in the ESA Business Incubation Centres (BICs). Beyond ESA BICs the programme has several other tools including the Technology Transfer Network of brokers that assess the market needs in areas where there is a potential for exploitation of space technologies. Additionally the TTP Office also initiated the establishment of Open Sky Technologies Fund that provides the seed-capital investments and early-stage growth capital for companies. Finally TTP also markets the ESA-owned intellectual property the non-space industry.

Outlook

The above programmes are the integral part of ESA basic activities for years and as such they will serve as technology incubator in the future as well. Notable exception are the ESA BICs that are not fully funded from ESA mandatory contributions of Member States and require national or local co-funding. For this reasons ESA BICs can only be established and operational in any given Member State if and only if such co-funding is guaranteed.

Analysis

The TRP, CTP, GSP and ECI are funded from basic activities budget line of ESA mandatory activities. Czech share of annual contributions to these programmes are in the order of respectively 450, 100, 200, 65 and 50 (in thousands of €).[45]

The main advantage of the TRP is its focus on low TRL. For technologies at this stage of immaturity it is difficult to find funding elsewhere because their time to market is very long and risk of not being turned into useful products is high. Since ESA Member States would not be willing to fund these risky technologies voluntarily within a dedicated optional programme, it perfectly makes sense to incorporate them into the mandatory programme. On the other hand, since space projects do not use technologies that are below TRL6 to minimise technology risks to these missions, between TRL 3-4 and TRL 6 there is the so called “valley of death” where technologies are not developed due to its high costs and therefore are not subsequently included in the space missions. GSTP is the main tool in generic technologies that addresses this “valley of death”. The Czech industry participates in TRP projects with growing intensity. It is essential to have a programmatic tool to further support results of TRP projects. GSTP usually serves this purpose and it is therefore important to reserve part of GSTP subscription for maturation of technologies initiates in TRP.

The CTP programme is a vehicle to prepare for involvement in missions of the mandatory science programme where the Czech Republic (as most of the ESA Member States) experiences serious problems in the geo-return. Only by active involvement in the early activities funded from CTP the industry builds up capacities allowing for successful bids in Science programme tenders. Czech industry has been involved in five CTP projects so far.

The GSP programme main budget is spent on mission assessment and feasibility studies that are usually performed by European prime contractors. This explains why there was no Czech participation in the programme so far. Still, the interdisciplinary studies and to a lesser extend strategic studies are certainly of interest of Czech industry and academia.

The ECI helps to build capacities of component manufacturers and their suppliers as well as the test houses. Czech industry is involved in all these areas.

From the early days of the Czech membership in ESA the Czech industry and academia has not been a very active in the above programmes, mainly due to lack of awareness of the web-based procurement tools

[45] Status and Plans of the Technology Transfer and Business Incubation ESA/IPC(2014)48.

(EMITS) of ESA and its technology work plans. However this has changed in recent years resulting in number of projects.

The usefulness of ESA BICs was observed by the Czech delegation to ESA and action has been taken to establish it in the Czech Republic. ESA BIC in Praha has been operational since 2014 and is gradually being incorporated to European network of BICs and technology brokers.

Recommendations

There is apparent problem of "the valley of death" where developments started in low-TRL technology programmes are not matched with appropriate funding to reach high-TRL levels and eventually be used. This has to be controlled by coordination between all national players already from the early stages of their involvement in low-TRL activities like those in TRP programme.

ESA BIC and Technology Transfer Broker activities should be further supported to accelerate the technology transfer to and from the field of space activities and enable the establishment of new companies and the further development of the existing ones.

C) Others

These mentioned programmes are supported in their current forms:

Long Term Data Preservation Programme (LTDP)

Description and objectives

The general preservation of science- and environmental data collected from space systems has been recognized as major challenge of today and it is consider as crucial condition for managing the future. Preservation element was inserted as a dedicated line on the ESA's general budget to support LTDP activities. This element addresses the preservation and integrity of science data generated by payloads and instruments on-board space platforms from ESA and ESA-managed Third Party Missions collected by D/EOP, D/SRE and D/HSO Directorates. It moreover aims at facilitating and promoting the access and exploitation of these data following a coordinated approach with the Member States data holders.

Outlook

The budget allocated today to the overall LTDP programme represents some 24% of the original proposal, due to that its activities are limited to pressing issues. LTDP is truly important for the future, because data are only value, which remains after the ending of missions.

Analysis

LTDP is one of the smallest, but one of the most important ESA programmes. The necessity of LTDP was fully confirmed at ESA Council at ministerial level 2012 and a Long Term Data Preservation element was inserted as a dedicated line on the ESA's general budget to support LTDP activities.

Earthnet

Description and objectives

Earthnet ensures the access to non-ESA missions – Third Party Missions (TPM). TPM´s data covers data, which are collected by non-ESA missions and which bring the benefits mainly to the scientific community. At the same time the Earthnet plays the role of the framework for international cooperation in Earth Observation (e.g. Tiger or Dragon cooperation programmes).

The Earthnet priority is to ensure the access to TMP´s data with best cost/user ratio, continue long operational TPMs (if requested by users) and provide historic data, but seeking to reduce duplicate archives (e.g. US missions) for which cost reduction can be achieved, and seek to transfer others to LTDP.

The TPM´s are periodically assessed from user benefits and excellence, accessibility, cost/investment, data policy, strategic and programmatic point of view and on that basis is judged their inclusion to the programme.

Outlook

Earthnet is one of the most stable ESA programmes. Due to the common interest of ESA Member States to have access to the wider range of EO data, it is financed from general budget.

Analysis

Earthnet bring the huge benefit mainly to the scientific users, which could obtain the easy and free-of-charge access to the TPM´s EO data for scientific use. It is the unique source of primary data usable in very wide range of scientific sectors and that makes the Earthnet interesting for the Czech scientific entities.

Recommendations

Mainly the users from academia should maximise benefits from the opportunity of access to unique data collected in frame of Earthnet.

Recommendations (to 6.1.2.1.1)

Due to the nature of the mandatory activities focused on the development or use either very low or very high TRL, there is a need to significantly increase the contribution to ESA optional programmes to be able to develop capacities and capabilities especially in middle TRL and from this perspective to promote the sustainable participation in mandatory activities and ensure the balanced geo-return of the mandatory contribution of the Czech Republic to ESA.

6.1.2.1.2 Optional programmes

The following programmes are categorized according to the responsibility of each of the ESA programme boards.

A) Earth Observation

Earth Observation Envelope Programme (EOEP)

Description and objectives

The *Earth Observation Envelope Programme (EOEP)* is the backbone of all EO activities in ESA and one of the hugest programmes in ESA in general. The EOEP has two components:

- The **Earth Explorer Component (EE)** includes the definition, development, launch and commissioning of scientific missions aimed at the exploration of the Earth – both large missions (Core Missions) and smaller and less expensive missions (Opportunity Missions). EE includes both the platform and payload of the missions, as well as the associated ground segment.
- The **Development and Exploitation Component** (D&E) consists from 10 elements which covers the preparation of new missions, preparatory activities on EO science, technology and mission concepts (*EOPA*), definition of Earth Watch missions (*EWD*), pre-development of critical instrument elements and instrument models to a sufficient TRL (*IPD*), development activities for multi-mission ground segment (*GSD*), development of specific L2 products, incl. re-processing campaigns and Cal/Val (*L2 Products*), operations and maintenance of EE missions (*MOM*), supports the EO campaigns, new products and algorithms developments (*STSE*), support and expand the research community to exploit observations from future European EO missions (*SEOM*), supports the transfer of scientifically proven EO research results into an operational concept – bridge the gap between "expert accessible" and "user accessible" informations (*DUE*) and strengthening the competitive position of European value-adding sector by the development of EO services (*VAE*).

The EOEP is periodical programme. Current 4th period runs since 2013 to 2016.

Outlook

The programme is running in successive overlapping periods. The Czech Republic had joined to the EOEP-3 by the subscription €2.6 million on 2008, this participation was increased in frame of already running EOEP-4 up to the €4.26 million.

Analysis

Due to the very wide range of activities covered by the programme, there is lot of opportunities for both the companies and academia, where to participate. Academia could participate on new EE mission and instruments studies, scientific mission data processing, development of new algorithms, etc. The opportunities for industrial subjects are mainly in predevelopment activities and in preparation, as a

suppliers of mission components (could be joined to the calibration activities subsequently), incl. ground segment activities, development of new geoinformatics products, etc.

Involvement of Czech entities is mainly focused to data processing, except the SWARM micro accelerometer development. However EOEP offers the opportunity to participate on development of new technologies and the possibility to apply experiences and practices obtained in another ESA programmes. The industrial subjects should be more focused to this field. At the same time, there is the opportunity for larger-scale involvement of academia as well, especially on science supporting initiatives.

In overall context of ESA activities, the EOEP activities are in some cases very similar to mandatory activities (e.g. to Science Programme). There are technological capacities and skills needed to be more involved in the e.g. EE development.

Recommendations

With reference to the wide range of opportunities in frame of this programme and considering the capacities of Czech academia and industry, the Czech Republic should if possibly increase the share in EOEP in the future. EOEP is the backbone programme of EO activities in ESA. Most of the EO missions, both scientific (Earth Explorers) and operational (Earth Watch and Sentinels), start on elements of this programme. Considering the existing involvement and potential capacities of Czech subjects, keeping and possibly increasing the level of the current contribution should be considered as a necessary base for the future. The need to increase the contribution in this programme becomes even more important with the transfer of the Copernicus space assets (Sentinel satellites) to the EU.

In case of establishment of new element (resp. programme) dedicated to development of new services above EO data outside of EOEP, it is with reference to the trends in EO (see Chapter 4) strongly recommended to participate on it.

MetOp Second Generation (MetOp-SG)

Description and objectives

The MetOp-SG programme (referred to as EUMETSAT Polar System – Second Generation, EPS-SG, by EUMETSAT) aims at the development of the technologies and systems which will allow EUMETSAT to ensure continuation of the European meteorological service. MetOp-SG will enable the continuation of current EUMETSAT´s polar observation system without a gap in data provision to improve the accuracy / resolution of the measurements, and also to add new measurements / missions. The space segment consists of two series of MetOp-SG satellites, designated as Satellite “A” and Satellite “B”.

The roles and responsibilities of ESA and EUMETSAT regarding their cooperation on the development of the MetOp-SG satellites will reflect the roles and competences of ESA as a development organisation and of EUMETSAT as an operational organisation. ESA will develop the prototypes of both series and procure the additional recurrent satellites on behalf of EUMETSAT. EUMETSAT will finance the recurrent satellites, will be responsible for development of the ground segment and will operate whole system during its exploitation phase.

The MetOp-SG-A satellites will host Sentinel 5 modules on-board as In Kind Contribution of EU. The Sentinel missions are developing in frame of ESA´s GMES/Copernicus Space Component programme (period 3).

Outlook

The programme has been started in 2013 and will be finished in 2022. The pre-development was realized in frame of EOEP-3. Due to oversubscription of MetOp-SG financial envelope the pressure on the contracts and very competitive environment could be expected.

Analysis

The Czech Republic had joined to the MetOp-SG by the subscribing of €3 million in 2012. The structure and general goals MetOp-SG Programme are very similar to the structure and general goals of Meteosat Third Generation Programme (MTG), which is very successful from CZ industrial involvement point of view. Therefore, similar interest to bid MetOp-SG ITTs could be expected.

Recommendations

MetOp-SG programme is oversubscribed from very beginning. Currently (2014) it is recommended to the industry to join to the consortia and bid the tenders at the earliest stages possible. Due to the contribution of EUMETSAT it is very interesting programme from the return-on-investment point of view. Czech industry proved the capabilities to participate in this kind of programmes (see MTG). Due to the possible benefits (return-on-investment), the Czech contributions to this kind of programmes should significantly increase.

Meteosat Third Generation (MTG)

The objective of the MTG mission is to provide Europe and, by extension, the international community, with an operational satellite system able to support accurate prediction of meteorological phenomena and the monitoring of climate and air composition through operational applications for the period of time between 2018 and 2035.

The programme is implemented in co-operation with EUMETSAT. In the programme the Imager and the Sounder satellite will be developed. EUMETSAT will provide a contribution to the programme and will fund the recurrent satellites, the ground segment, the launch and LEOP services and the satellite routine operations.

Outlook

ESA´s MTG envelope is €934 million, EUMETSAT contribution is €230 million. The programme is currently in its C/D phase, best practices are completed from very most part.

Analysis

MTG is one of the most successful ESA programmes for Czech entities. There are expected strong synergy effects with EUMETSAT´s MTG programme.

Recommendations

This kind of programmes is very interesting from the return-on-investment point of view and Czech industry has been very successful in this programme. Due to the possible benefits, the Czech contributions to this kind of programmes should significantly increase.

Due to the current (2014) phase of MTG programme, when most of the MTG satellites are in the middle of construction should be recommended, the industry involved in MTG development projects should keep the touch with their partners in respective consortia to the future, because the recurrent satellites will be constructed.

GMES Space Component (GSC)

Description and objectives

The objective of the programme is the preparation of Sentinel satellites, which will be the backbone of Copernicus system Space Component. General target of the programme is to fulfil the space-based observation EU requirements in response to European policy priorities. National utilisation of Sentinel data by Participating States will be supported by the right of data access, with agreed priorities in terms of operations planning. For this purpose a high level operations plan will be prepared, in the context of the Sentinel data policy.

Sentinel missions which consolidates all such national requests (i.e. from public user organisations), in addition to those from Copernicus services. The GSC programme, within its available resources (through ground segment development), also aims at the operational provision of satellite data for other European and national services.

Each GSC mission identifies a specific Earth observation data stream required to satisfy user needs for the corresponding services and information.

GSC 1&2 covers development of Sentinels 1,2,3,4 and 5 Precursor, incl. its respective ground segment. GSC-3 will cover development of Sentinel 5 and Jason-CS (Sentinel 6) incl. its respective ground segment.

Outlook

The GSC Programme financial envelope as estimated at C-MIN 2008 regarding the Participating States contributions resulting from the merger between Segment 1 and Segment 2 is €1.5791 billion at 2006 e.c. Current merged periods 1&2 ends on 2018. The financial envelope of Segment 3 (GSC-3) is €405 million at

2012 e.c. and is not merged with the financial envelope of Segments 1 and 2. Segment 3 is funded in two Phases. Phase 2 starts on June 2014. Segment 3 will ends on 2020.

Analysis

ESA´s GSC programme covers just prototypes of Sentinels, the EU will finance recurrent units and the operation of Sentinels 1, 2, 3, 5 and Jason-CS as well as the operation of Sentinel-4 and Sentinel-5 Precursor and the launch of Sentinel-1,-2,-3 B satellites pursuant to an agreement to be concluded between ESA and the EU. Due to this synergy it is very perspective to participate at development of Sentinels, because of return the investment could be much higher than the contribution subscribed to the ESA´s GSC programme.

The C/D phase of Sentinels preparation already starts, when the Czech Republic joint to ESA. Due to this it was very difficult to start the participation on development of Sentinel 1,2 and 3. Some companies were involved to the development of Sentinel 4, because of the postponed schedule in comparison with Sentinels 1-3.

Recommendations

GSC is focused on definition of the overall system architecture, ensuring the technical coordination of the Copernicus Space Component and its evolution. The prototypes of Sentinels, dedicated Copernicus missions, are prepared in frame of this programme. Recurrent Sentinels will be covered by EU sources.

The Sentinels family comprise very diverse satellites. Each Sentinel has very different parameters to fulfil very different targets. It is expected starting of preparations activities for new generation of Sentinels to cover the needs of Copernicus beyond 2030.

Development of new specific technologies of European EO missions will continue. It could be expected part of this technologies will be used e.g. for next generation of Sentinels and other European EO satellites.

This kind of programmes is very interesting from the return-on-investment point of view. Czech industry proved the capabilities to participate this kind of programmes (see MTG). Czech contribution to this kind of programmes should be recommended in the future.

From this reason it is important to continue in participation in this programme and it is strongly recommended to increase the contribution to GSC.

B) Telecommunication

The Telecommunication optional programme is the *Advanced Research in Telecommunications Systems* (ARTES) and is divided in elements that can be subscribed separately.

The Czech Republic has subscribed to several ARTES programme elements with the objective to support the competitiveness of the European industry as well as to undertake demonstration projects leading to operational systems, in partnership with users and operators.

ARTES 1 ("Preliminary Studies and Investigations")

Description and objectives

ARTES 1 is dedicated to strategic analysis, market analysis, technology, and system feasibility studies and to the support of satellite communication standards. It is a preparatory element of the Telecommunications programme and is the basis for the definition of the strategy of ESA in this domain.

Outlook

As it is a strategic element for the whole ARTES programme, it is open for subscriptions in 3-4 year cycles at each C-MIN.

Analysis

For the periods 2009 – 2013 and 2013 – 2016 the Czech Republic has subscribed €0.12 million of €60 million (2008 e.c.) and €0.10 million of €40 million (2012 e.c.) respectively. The subscription should be higher, when taking into account the strategic nature of the element for the whole programme.

Recommendations

Given the strategic nature of the element and the potential to be "at the beginning" of activities, Czech Republic should contribute at least 0.5 % of the total envelope of the element.

ARTES 3-4 ("ESA Telecom – products")

Description and objectives

ARTES 3-4 is dedicated to the development, qualification, and demonstration (including flight heritage opportunities for innovative items (Atlas)), of new products and to the improvement and update of existing ones, assuring also the qualification of these improvements. The word "product" in this case has a wide meaning; it can be a piece of equipment, of either the platform or the payload of a satellite, it can also be a user terminal or a full telecom system integrating a network with its respective space segment. Telecommunication applications can also be undertaken under the terms of this element. It seeks to improve the near-term competitiveness of the satellite communication industry. Its activities are co-funded (50%) by industry.

Outlook

It is an ARTES element dedicated to continuous support to industry, which is open for subscriptions in 3-4 year cycles at each C-MIN.

Analysis

For the period 2009 – 2013 the Czech Republic has subscribed €1.7 million for ARTES 3-4 which are 0.31% of €550 million of the overall programme-element envelope (all in 2008 e.c.). The subscription was later decreased to €0.279 million, in favour of ARTES 5.1 and ARTES 20 elements, due to low interest from Czech entities. This is understandable due to co-funding scheme that has not encouraged Czech industry to run risks in market unfamiliar to them. However, the willingness to co-fund activities "close-to-market" will be increasing, as projects in ARTES 5.1 will be successfully concluded and ARTES 3-4 will be important tool for development, qualification and demonstration of innovative products soon.

Recommendations

When talking about functioning market within the space endeavour, it is the telecommunication market always mentioned as the most mature one. Element ARTES 3-4 is a well-defined tool for supporting close-to-market products. Even though co-funded by industry at least by 50 %, the subscription to this element should be at least at the same level as to the element ARTES 5, as it is ideal tool for continuation of activities concluded within ARTES 5.

ARTES 5.1 ("ESA Telecom – Technology")

Description and objectives

The objectives of ARTES 5 are to ensure the long-term readiness of the industry to respond to coming commercial or institutional opportunities by focusing the ARTES 5 activities on technological innovation in equipment and systems for satellite communication. The space, ground and user segments are supported in the programme as well as overall system related activities.

The ARTES 5 supports the early development steps up to and including the step where the subject of the development has been built in a configuration representative of the final product and critical performances have been verified by test, while formal qualification and industrialisation are still to be done. The ARTES 3-4 Element is ideally suited for a continuation of an ARTES 5 development to complete the step required to have a product ready for commercial exploitation.

The ARTES 5 programme element is split into two sub-elements. The "Competitive Workplan Activities" sub-element 5.1 is 100% funded by ESA. The workplan contains objectives and descriptions of the individual activities and it is updated yearly by ESA on the basis of a Call for Ideas. The "Non-competitive Industry Initiated Activities" sub-element 5.2 is funded to a maximum level of 75% by ESA.

Outlook

It is an element dedicated to continuous support to industry, which is open for subscriptions in 3-4 year cycles at each ESA Council at ministerial level.

Analysis

For the periods 2009 – 2013 and 2013 – 2016 the Czech Republic has subscribed to sub-element ARTES 5.1 €1 million of €60 million (2008 e.c.) and €1 million of €40 million (2012 e.c.) respectively. ARTES 5 element

ensure participation of Czech entities in the earlier stages of development of telecommunication satellite equipment, leading to commercial products at later stages. It is strongly recommended to at least double or triple ARTES 5.1 support and enter the sub-element ARTES 5.2 with equivalent amount, as it stimulates industry to propose own technologies directly.

Recommendations

Being the core and generic technology element of the whole ARTES programme, it might be perceived as the most important one. It is strongly recommended to multiply the contribution by factor of 2-4 the ARTES 5.1 subscription and enter the sub-element ARTES 5.2 with equivalent amount, as it stimulates industry in proposing own ideas.

ARTES 10 (Iris)

Description and objectives

The ARTES 10 Element aims at supplying a validated satellite-based communication solution for the European Air Traffic Management System (EATMS).

The use of satellite communications should be analysed and assessed, including the service, operational, financial and commercial perspectives, in close relation with the exiting framework of ATM in Europe, namely the Single European Sky Air Traffic Management Research (SESAR) programme launched in 2006, by the European Community and EUROCONTROL.

The Development Phase (Phase II), approved in 2008, is divided in two sub-phases:

- Phase II.1 corresponding to system design, development of the technical specifications of the communication standard, and their verification. To this end, while confirming the final target to provide a verified communication system and to support the relevant standardizations, the Executive has redefined Iris 2015-2017 workplan re-aligned with the updated ATM master plan milestones. The work plan is largely based on the results achieved in Iris Phase II.1 (ANTARES in primis) and which includes synergy with Iris Precursor system (representing a stepping-stone for the evolution of ATM communication via satellite). The adaptation of the Swiftbroadband system of Inmarsat for an Iris Precursor service is the subject of dedicated sub-element 1.
- Phase II.2 corresponding to development and deployment of the validation infrastructure of the new satellite-based air-ground communication system for Air Traffic Management (i.e. Phase C/D/E1), for validation of the end-to-end performance.

Phase III should support in-orbit verification and certification of the pre-operational system, technical support to deployment of the full system, and preliminary work leading to an enhanced future role for satellites.

To this aim and further to Expert Group recommendations on how to best structure of future activities of the Iris Programme, the workplan 2015-2017 will focus on:

- Standardization at ICAO and EUROCAE for a global inter-operability, including studies, developments, testing;
- System validation, by developing technology in support of
    - Standardization;
    - SESAR end-to-end operational validation.

Outlook

The Iris Programme is currently in Phase II.1, which started in 2009 and shall be completed by 2017. A set of conditions to move from Phase II.1 to Phase II.2 is defined and revolves around identifying the entities in charge of co-financing the system deployment and providing the operational service.

Analysis

The Czech Republic has subscribed €4.277 million for the period 2009 – 2013 which is 9.72% of the overall programme-element envelope of €44.02 million (all in 2008 e.c.) – by far the largest Czech contribution to an optional programme both in terms of absolute amount of money and share of the subscription. Activities in the element has among others enabled development of user terminal prototype to TRL 3-4 and strengthen position of the developing entity at the European level. It is recommended to support the workplan 2015-

2017 and beyond to keep a momentum as a key player of the EATMS. However, recent development in competing systems will have to be taken into account in final decision-making.

Recommendations

In order to secure already made investments and keep a momentum, at least 10% share of the total envelope should be kept within the element, with focus on multi-purpose user terminal as minimum, if IRIS leads to an operating system and if the terminals are a Czech product.

ARTES 14 (Neosat, NGP)

Description and objectives

The aim of ARTES Element 14 is to support and enable the development, qualification and demonstration in orbit of Next Generation (Geostationary) Platform (NGP) lines allowing European prime satellite integrators already established in the 3 to 6 tons launch mass segment to address future satellite operators' needs.

In that context, the objective of ARTES Element 14 is to provide basic R&D activities so to develop and qualify NGP lines that could eventually enter the market from 2018 onwards.

Other contributors to the overall effort are (not only) large system integrators, that will co-fund activities covered by ARTES Element 14 and assume responsibility for introducing the NGP product lines on the satellite market.

The NGP lines will be flexible enough to accommodate a very wide range of future telecommunication missions.

Outlook

The ARTES Element 14 begins in 2013 and is expected to be completed in 2020. Activities for the development of the Next Generation Platform lines and procurement of PFMs are foreseen to last from 2013 to 2018.

Activities related to the in-orbit verification of the Next Generation Platform lines are foreseen to last from 2016 to 2020.

Analysis

The Czech Republic has subscribed €2.0 million for the entire programme duration, which is 0.66% of the overall programme-element envelope of €300 million (all in 2012 e.c.). This subscription should possibly enable involvement of some Czech entities in the programme up to TRL 6. Additional subscription will be needed to penetrate supplier chains of one or both European satcom primes (Airbus and Thales) with qualified products.

Recommendations

If a promising opportunity (leading to qualified product) emerges exceeding the current subscription during the course of the programme, additional subscription shall be made, as enabled by implementing rules of the element currently in force.

ARTES 20 (Integrated applications promotion, IAP)

Description and objectives

The concept of integrated applications is not new, but the IAP Programme introduces the novelty of a systematisation of the search for and promotion of new services while combining the different capabilities of space and terrestrial systems based on a bottom-up, demand-driven approach. The programme is based on two elements: Basic activities (raising the level of awareness of the potential users, identification of potential new services and preparation of new projects for demonstration) and demonstration activities (projects that lead to pre-operational services). Service providers, industry and user institutions are involved in projects with a view to their taking over the service when the activity is mature enough to lead to sustainable operational services.

The IAP Element focuses on the use of existing space assets and technologies, leading to a better exploitation of the already developed space systems and know-how, while requesting only limited technology adaptations. It also aims at providing inputs to the future space developments based on the acquired knowledge of user needs.

Outlook

It is an ARTES element dedicated to promotion of integrated applications among users, which is open for subscriptions in 3-4 year cycles at each C-MIN.

Analysis

The Czech Republic has subscribed €0.47 million (2008 e.c.) for the period 2009 – 2013 (Phase 1) and €0.50 million (2012 e.c.) for the period 2013 – 2016 (Phase 2), which is 0.59% of the overall programme-element envelope of €80 million (2008 e.c.) or 0.42% of €120 million (2012 e.c.) respectively. Activities within the programme should lead to integrated solutions, bringing added value to users well identified throughout the project implementation.

Recommendations

The element is a genuine tool for supporting integrated applications - that is not only telecom, but also EO and navigation downstream technologies. At least 1% of the total envelope should be subscribed, with focus on Czech or (Central) European solutions.

C) Navigation

European GNSS Evolution Programme (EGEP)

Description and objectives

The European GNSS Evolution Programme (EGEP) was extended to 2014 to maintain the competences of industry and ESA in navigation technologies for the future evolution of the European global navigation satellite system infrastructure (EGNOS V3 and Galileo Second Generation). This allows continued technology research, development and verification related to GNSS.

The programme functions to ensure the ongoing evolution of these systems in terms of technology and performance so they can adequately meet future demands in the short, medium and long terms. The programme includes R&D activities composed of system definition and support studies, technology R&D, test-beds and system pre-developments and accompaniment activities.

Outlook

Transition from ESA financed European GNSS Evolution Programme (EGEP) to the EU funded Horizon 2020 Satellite Navigation Programme (HSNAV) is taking place in 2014-15. It means that all GNSS R&D activities from 2015 on will be financed through Horizon 2020. ESA will remain the implementing agency.

Analysis

The Czech Republic has subscribed €0.925 million for the years 2009 – 2015, which is 0.45% of the overall programme envelope of €204.2 million (all in 2006 e.c.). Due to transition to EU funded HSNAV programme where no geo-return rule is applied, Czech Republic must closely follow and raise awareness about the opportunities within the new programme.

Recommendations

As the satellite navigation R&D is in transition to the EU funded HSNAV programme starting 2015, attention should be paid to awareness raising about the opportunities within this programme. It should be noted that in HSNAV the geo-return policy will not be used. If the EGEP programme is after all extended, the Czech Republic should subscribe it with amount at least equal to 1% of the programme´s envelope.

D) Technology

General Support Technology Programme (GSTP)

Description and objectives

The programme serves wide range of functions which all relate to increase of technology maturity in all ESA themes (except satellite telecommunication), development of space products, conduct in-orbit demonstration activities, promote a spin-in of multiple use technologies for utilization in space and to provide the opportunity for technology transfer.

Main focus of the programme is to ensure the necessary continuity in the development of identified technologies, after their feasibility has been demonstrated in the basic TRP, by supporting pre-developments

and demonstrating flight suitability, before these technologies can be included at acceptable levels of risk in the future programmes of ESA. As such it is the essential tool to turn a promising technology into space-qualified product, bridging the so called "valley of death"

Programme implementation rules allows Member States to precisely control which technologies are being supported as well as it provides guarantees the industrial return of the subscription.

Outlook

The programme has been started in 1993 and continues since then. The programme is sliced into periods. The current period 6 is planned till 2017. The next Period 7 is foreseen to be opened for subscription in 2016.

Analysis

The Czech Republic had joined the programme by the subscribing of €3.23 million in 2008 and €5 million in 2012.

It is one of the most popular programmes of ESA both among the industry and delegations. Companies enjoy less competition then in other programmes and in some elements of the programme the companies can even propose their own co-funded projects to ESA.

Delegation enjoys flexibility of the programme that allows to fund variety of activities from technology development, through product qualification and in-flight demonstrations to technology transfer. The demand for projects from industry and academia exceeds the available resources. In absence of the national space programme, the GSTP is often used as such. This however diminishes available resources for projects for which it is targeted.

Recommendations

The GSTP programme plays essential role in turning a promising technology to a qualified product. In addition it is a tool for doing this in an international cooperation which is essential for Czech industry given many Czech products are being developed in close partnership with foreign companies. For this reason, the GSTP must be a complementary counterpart of the national space programme with about the same level of funding i.e. €12-15 million per 3-year interval.

E) Launchers

Future Launchers Preparatory Programme (FLPP)

Description and objectives

The general objective of the FLPP is to prepare the technical and programmatic elements for making an informed decision on the best launch system to respond to the future institutional needs, while maintaining competitiveness on the commercial market. This includes system studies, contribution to other ESA launcher development and exploitation programmes, implementation of future launcher developments, and contribution to progressive restructuring of the industrial organization for the next generation launcher.

In the latest two periods the focus is on technology development through integrated demonstrators. The technologies developed in FLPP may find their application in one or more of the future launchers and launcher evolution like Ariane 5ME, Ariane 6, and Vega. The programme is vehicle for industries in ESA Member States to build their capacities and prepare for technologies for application on more that one launcher. The developed technologies, if found mature enough and desired by specific launcher needs, are turned into particular products using other more specific launcher development programmes such as Ariane 6.

FLPP also funds studies of new launcher concepts – in the past it included studies of the Next Generation Launcher (today known as Ariane 6) while in the future it may include very small launcher.

Outlook

Programme has been started in 2004 and is run in successive overlapping periods. The current Period-3 is foreseen to be fostered by additional subscription of ESA member states in late 2014. Thus the developments already started will be further matured and demonstrated.

Analysis

The programme is a gateway to specific development programmes of ESA launchers. Many technologies will be used in Ariane 6 and its evolution as well as in the Ariane 5ME rocket. Other technologies may be applied in the evolution of Vega launcher. There are also generic technologies that might be useful for more launchers including non-European ones.

The Czech Republic had joined the programme by the subscribing of €0.5 million in 2008 and €1 million in 2012. This subscription was sufficient for only few projects with really low TRL levels. This was in strong contrast with real interest of Czech entities in the programme that was in many cases backed by strong support of Ariane 5ME, Ariane 6, and Vega development teams. Additional subscription will be needed to reach higher TRL levels and to penetrate supplier chains with qualified products. For the Czech Republic, it is favourable – both technically and economically – to support development of technologies that can be used across whole portfolio of launchers Ariane 5ME, Ariane 6 or and Vega.

Recommendations

The demand for projects from industry and academia exceeds the available resources, but these projects (if successful) can bring large long-term financial benefits and strongly increase competitiveness of Czech industry and thus secure its financial stability and sustainability.

It is strongly recommended to at least triple FLPP support (€3-4 million) allowing for completion of the already started activities. Further it is recommended to subscribe to Ariane 5ME, Ariane 6 and Vega, with amount of €6-8 million combined, to allow to industry to penetrate supplier chains of ESA launchers with qualified products.

F) Human Space Flights, Microgravity and Exploration

European Programme for Life and Physical Sciences and Applications in Space (ELIPS)

Description and objectives

The ELIPS programme covers a wide field of basic and applied research in disciplines such as fundamental physics, fluid and combustion physics, materials sciences, biology, human physiology, and astro/exobiology, atmospheric and environmental research and planetary exploration. The programme allows Europe to capitalize on its investments into the ISS infrastructure and also to use independent mission platform assets such as sounding rockets, parabolic flights, a drop tower, number of studies (bed-rest, isolation, biological effects of radiation) and ground based facilities.

Apart from preparation of human exploration of space and fundamental research, in both physical and life sciences the programme also contributes to applied research and industry-driven R&D, development of advanced technologies to support the optimum utilization of ISS and future space infrastructures and last but not least to educational and outreach activities exploiting the ISS and using the European astronauts as ambassadors of science and technology.

The programme is science- and applications-driven meaning activities to be performed are proposed by user of the programme rather than by ESA.

Outlook

The programme has been started in 2002. It is structured as an envelope programme and is foreseen to last as long as the ISS is operational.

Analysis

The Czech Republic had joined the programme by the subscribing of €2.77 million in 2008 to Period 3 and €1 million in 2012 to Period 4 of the programme. Out of the 2008 subscription, only €0.45 million has been returned to Czech Republic in activities. The 2012 subscription has not been used yet.

Recommendations

Even after decrease of the subscription in 2012, the overall amount subscribed in ELIPS is high and limited in terms of accessibility to companies-newcomers. This is also a scientific and technological area with the smallest “return-on-investment”. For this economic reason the subscription should be further decreased for the next subscription period, however the subscription should be kept non-zero in order to enable

participation of Czech industry in ESA tenders allowing access to funds contributed to earlier in 2008 and 2012.

Mars Robotic Exploration Preparation (MREP)

Description and objectives

The MREP programme is designed to prepare Europe for the future missions to Martian system. Its focus is on development of technologies needed for the two candidate European mission (excluding the scientific instrumentation) and technology activities of relevance for a European potential contribution to an international Mars sample return mission and complementary to the technology developments for the two European candidate missions.

Outlook

The programme has been started in 2009 and will continue to at least 2015 when a decision was foreseen at the occasion of post-2014 Council at ministerial level on the next mission to Mars. Such a decision will be driven by the affordability of Member States and by the international context of Mars exploration.

Analysis

The Czech Republic had joined the programme in its second period (MREP-2) by the subscribing of €0.8 million equally divided into two sub-elements. The Czech entities so far only participated in one tender and in relatively small volume but number of the tenders of Czech interest are yet to come.

Unfortunately this subscription will only enable involvement of some Czech entities in the programme up to very low TRL levels. Additional subscription will be needed to penetrate supplier chains with qualified products.

Moreover, the current Czech subscription would require further investments to the future Mars mission in order to be effectively and efficiently used. Such investment would need to be an order of magnitude higher than the current subscription.

Recommendations

The programme contains wide range of technological projects – some with very low return-on-investment potential and some with rather high one. Further support to the programme and exploration missions in general should be made if and only if specific high-return-on-investment technologies are identified well in advance the subscription hand in hand with programme management. Small subscription allowing for opportunistic participation can be made if funds are available but generally is not desirable vis-à-vis other opportunities in ESA. Recalling the funding problems of ExoMars mission, the subscriptions to exploration programmes are only advisable if affordability of Member States allows for end-to-end mission funding.

G) Space Situational Awareness

Space Situational Awareness (SSA)

Description and objectives

The objective of the Space Situational Awareness (SSA) initiative is to support the European independent utilisation of and access to space for research or services, through providing timely and quality data, information, services and knowledge regarding the environment, the threats and the sustainable exploitation of the outer space.

For this purpose, the SSA objectives could be carried out in successive programmatic steps with a view to achieve a full operational capability over a framework of ten years. ESA will be responsible for the technical definition and the developments of the European SSA system up to the operational stage. The operational stage is expected to be taken over by the EU.

Period 2 (2013-2016) of the programme includes activities related to the Near Earth Objects (NEOs), Space Weather (SWE) and Space Surveillance and Tracking (SST) domains.

Outlook

Extension of the programme beyond 2016 could be expected at the C-MIN.

Analysis

The Czech Republic has subscribed €0.700 million for the Period 2, which is 0.92% of the overall programme envelope of €75.5 million (all in 2012 e.c.). Involvement of Czech academia and industry in all three domains is expected, leading to increase of expertise of involved entities.

Recommendations

Participation in SST may use the funds today available in SSA.

The institutional setting among ESA, EU and their Member States is currently not very clear for an operational system. This has to be taken into account when considering the involvement of the Czech Republic.

Depending on capabilities of Czech entities within the Period 2, corresponding subscription shall be made for Period 3 foreseen for 2017 onwards.

H) Space science-oriented

Programme for the Development of Scientific Experiments (PRODEX)

Description and objectives

The PRODEX is a programme that provides for the industrial development of scientific instruments or experiments, proposed by institutes or universities in the Czech Republic, that are selected by ESA for one of its programmes in the various fields of space research (science, microgravity, earth observation, etc.). The PRODEX programme can also be used for funding of such activities for non-ESA missions.

These scientific instruments or experiments may be hardware or software projects, the development of which is carried out in collaboration with industry. This helps to strengthen relations between academia and industry.

Outlook

The programme has been started in 1986 and is run since then. It is not expected to be discontinued anytime soon.

Analysis

The Czech Republic had re-joined the programme after its accession to ESA in 2008. Since 2008 it gradually increased its subscription to the programme to €11.5 million for period up to 2020. In the coming years it represents €1.5 million annually.

It is the most popular programme of ESA among the Czech scientists as it is their prime vehicle to participate in missions of ESA Science Programme. Budget of the programme is used to develop hardware and software for an instrument and this contribution allows the Czech scientists to claim their position in instrument science team, which grants them an early access to scientific data.

Companies enjoy little competition in the programmes (tenders are restricted to the Czech Republic) which seems favourable to them in short-term because earning contracts is much easier than in pan-European competition. It is needed to assess innovation potential of such contracts. Long-term focus of companies to less competitive tenders combined with low innovation potential can negatively affect competitiveness in long-run and as a consequence depreciate interests of Czech Republic in space activities (i.e. competitiveness and economic growth). Over 60% of the committed programme budget for 2009 – 2020 period is still available for contracts.

Recommendations

The programme should be further supported and subscribed. Within the current funding level it is rather difficult to take role of principal investigator of a major scientific instrument. Has the Czech Republic such an ambition, the funding should be increased. In any case the contribution should be maintained at the level of €1.5 to 2 million per year. Financial resources of PRODEX programme should be used to develop and implement scientific payloads (HW and SW) while data analysis funding should be obtained from the normal national R&D budgets.

The possibility to use the internal financial resources of academia to co-fund PRODEX activities should be further explored.

6.1.2.2 EU programmes

6.1.2.2.1 Galileo and EGNOS

Description and objectives

According to GNSS Regulation,[46] the European satellite navigation programmes (EGNSS), Galileo and EGNOS, shall cover all the activities needed to define, develop, validate, construct, operate, renew and improve the European satellite navigation systems, namely the system established under the Galileo programme and the EGNOS system, and to ensure their security and interoperability.

Those programmes shall also aim to maximise the socio- economic benefits of the European satellite navigation systems, in particular by promoting the use of the systems and fostering the development of applications and services based on those systems.

The Union budgetary appropriations assigned to the Galileo and EGNOS programmes for the period 2014-2020 shall be granted to finance activities relating to the completion of the deployment phase of the Galileo programme, the exploitation phase of the Galileo programme, the exploitation phase of the EGNOS programme and the management and monitoring of the Galileo and EGNOS programmes.

Outlook

EGNSS activities beyond 2020 shall be covered from the next EU multiannual financial framework, for the period 2021-2027.

Analysis

The financial envelope for the implementation of the EGNSS activities and for covering the risks associated with them is set at €7,071.73 million (2013 e.c.) for the period from 1 January 2014 to 31 December 2020. Involvement of Czech industry in the programme activities has been at very low level so far. The situation could be improved through increasing competiveness of the industry, coming from participation in the ESA programmes.

Recommendations

Increasing competitiveness of the industry stemming from participation in the ESA programmes should lead to gradual involvement in the activities of the programme. Important aspect would be involvement in activities of HSNAV programme within the Horizon 2020, which highly increase the chances to be successful in EGNSS bids. Therefore, industry should be encouraged to get involved in both programmes as soon as their competiveness increase.

6.1.2.2.2 Copernicus

Description and objectives

Copernicus, known as GMES till December 2012, is the programme of EU on global monitoring of environment and security.

The objectives of Copernicus is to provide accurate and reliable information in the field of the environment and security, tailored to the needs of users and supporting other EU's policies, in particular relating to the internal market, transport, environment, energy, civil protection, cooperation with third countries and humanitarian aid.

Copernicus should be considered as a European contribution to building the Global Earth Observation System of Systems (GEOSS) developed within the framework of the Group on Earth Observations (GEO).

The programme has been based on Baven initiative on 1998 and developed in common effort of EC and ESA, where the EC formulates the whole project scope, services and data requirements and ESA is in charge of the space component including satellite development, associated ground segment and data provision from third party suppliers.

The Copernicus consists from 3 components:

[46] Regulation (EU) 1285/2013 of the European Parliament and of the Council on the implementation & exploitation of European Satellite Navigation Systems.

- Space Component comprising dedicated Sentinel missions and related ground segment and Third Party Space Data.
- In-situ Component comprising "non-space" sensors (e.g. ground, airborne, maritime, etc.).
- Service Component comprises Core services defined in Copernicus regulation. In addition it should be taken note downstream services based on Copernicus data.

Governance and data policy

Copernicus is under management and responsibility of EC, but in general it is defined as user driven programme, thus requiring the continuous, effective involvement of users, particularly regarding the definition and validation of service requirements. There are defined the Copernicus core services in Regulation.

Dedicated mission data and Copernicus information shall be made available through Copernicus dissemination platforms, under pre-defined technical conditions, on a full, open and free-of-charge basis, subject to some, mostly security limitations.

Outlook

Copernicus should be fully operational since 2014. The programme envelope €3.786 billion (2011 e.c.) is financed from EU´s Multiannual Financial Framework 2014-2020. Development and building of dedicated missions and technical coordination of Copernicus Space Component ensures ESA. Operation of Sentinels is divided between ESA and EUMETSAT.

Analysis

There are lot of opportunities in the field of development of downstream sector due to the propitious Copernicus data policy. Free of charge and opened Copernicus data will boost its usage in applications which are due to the price of data to expensive at the time being. This services should brings new benefits to the wide range of industrial and scientific sectors.

From the building of Copernicus infrastructure point of view, the companies could participate on development of Copernicus dedicated satellites, through the ESAs Copernicus Space Component programme.

Recommendations

The Czech Republic should maximise the benefits of Copernicus. It is strongly recommended use the Copernicus data across the sectors (public, business, academia). Enabling this purpose the „National supportive tools" should be able to support the development of new high-added value services and applications. For securing the best possible Sentinels data access on national level the appropriate measures should be taken (e.g. build the Sentinels data mirror site covering the needs of Czech users, ensuring the technical equipment needed for using of data and services on public sector, etc.).

Especially in the field of environment, transport, agriculture, urban development, etc. the Copernicus data and services could be the tool for fulfilling of the targets of national policies.

To maximise the benefits from Copernicus core services is needed to build appropriate national structure for activation and exploitation of respective core service, especially in case of Emergency Management Service.

6.1.2.2.3 Horizon 2020 - Space

Description and objectives

Space research is supported in Horizon 2020 under the priority „Industrial Leadership", in the line with the main objective and challenge to foster a cost-effective, competitive and innovative space industry (including SMEs) and research community to develop and exploit space infrastructure to meet future EU policy and societal needs.

Building on the successes of the Seventh Framework Programme (FP7), Horizon 2020 will enable the European space research community to develop innovative space technologies and operational concepts "from idea to demonstration in space", and to use space data for scientific, public, or commercial purposes. This will anchor and structure space research and innovation at the European level and address key aspects

identified in the Commission Communication "EU Space Industrial Policy: Releasing the Potential for Growth in the Space Sector".

Actions will be carried out in conjunction with research activities of the Member States and ESA, aiming at building up complementarity among different actors. For this purpose an enhanced coordination between these actors is envisaged. Important element of EU and ESA cooperation is for example transition plan of ESA EGEP programme into Horizon 2020 upstream Satellite Navigation RTD Activities (HSNAV), which aims to support RTD actions in preparation of Galileo/EGNOS evolution steps.

The Commission proposal for Horizon 2020 sets the following motto for EU Space R&D for 2014 to 2020 'Prepare for the increasing role of space in the future and reap the benefits of space now'.

The work programme has been structured to address these challenges by:

- Prioritising the existing two EU Space flagships of European Global Navigation Satellite System (EGNSS) and Earth Observation reaping the benefits they can generate in the coming years and ensuring their state-of-the-art also in the future. This includes transition plan of ESA EGEP programme into Horizon 2020 upstream Satellite Navigation RTD Activities (HSNAV);
- Ensuring support for the third priority of the EU space policy: the protection of space infrastructure, and in particular the setting up of a Space Surveillance and Tracking system (SST) at European level;
- Ensuring support to EU industry to meet the objectives defined in the Commission Communication on Space Industrial Policy, notably to maintain and enhance industry's competitiveness and its value-chain in the global market;
- Ensuring that Europe's investments made in space infrastructure are exploited to the benefit of citizens, as well as supporting European space science;
- Enhancing Europe's standing as an attractive partner for international partnerships in space science and exploration.

A novelty in Horizon 2020 is the Open Research Data Pilot which aims to improve and maximise access to and re-use of research data generated by various projects.

Outlook

Horizon 2020 started January 1st 2014 and will run till the end of 2020. However, projects initiated during this period may run beyond 2020. There are several calls expected, based on annual or shorter call periods. Based on the experience from FP7, space is very competitive field, where key players are usually coordinating themselves very efficiently and it may be quite difficult to succeed without close cooperation with those key players on the European level. Currently four major calls are in operation or are considered by EC for coming years:

- Applications in satellite navigation (EGNSS-Galileo, EGNOS, SME)
- Earth observation (space enabled applications, atmospheric and climate change)
- Protection of European assets in and from space (space weather, NEO, space debris)
- Competitiveness of the European space sector: technology and science, including scientific exploitation of astrophysics, comets, and planetary data
- SME instrument

Analysis

The Czech Republic has been participating in previous FP7 SPACE with comparable success in relation to other central and eastern EU countries. However, FP7 SPACE was highly distorted by presence of GMES/COPERNICUS development which used some 85% of the total budget. Therefore, the final picture was determined by our capabilities to enter GMES projects. For Horizon 2020, similar capacities are needed for both Galileo and Copernicus applications. Still for some other topics like protection of space assets, space weather, NEOs and space technology and science there is much larger room then in FP7, although in case of scientific exploration the Czech Republic was relatively very successful in FP7. EGNSS, Copernicus, new space technologies (SME) are firmly anchored in the SPACE work programme and will be supported by substantial budget in frame of Horizon 2020.

Recommendations

The Czech Republic should examine all possible ways how to increase the participation of Czech entities in Horizon 2020. The set-up of a link, for leverage, between ESA optional programmes and EU activities supported by Horizon 2020 has to be implemented. The Czech Republic should better coordinate the preparation of its official positions concerning the implementation of the Horizon 2020 to be able to maximize the potential use of Czech capacities and capabilities in line with the NSP.

6.1.2.3 EUMETSAT programmes

The Czech Republic through its membership in EUMETSAT formally participates in all of the mandatory programs of this organization. Presently, from the operational perspective, the main and most important EUMETSAT programmes are the Meteosat Second Generation Programme (MSG) and EUMETSAT Polar System Programme (EPS). Prime utilization of data from these two mandatory programs at the national level is within the duties of the Czech Hydrometeorological Institute (CHMI). The Czech Republic does not participate in any of the optional programmes of EUMETSAT. Among the future mandatory programmes, preparation for the next generations of EUMETSAT satellites – Meteosat Third Generation (MTG) and EUMETSAT Polar System – Second Generation (EPS-SG) are being carried out by EUMETSAT and its Member States recently; however the Czech Republic does not actively participate in these preparatory programmes at the EUMETSAT level (in form of contracts).

6.1.2.3.1 Meteosat Second Generation

Description and objectives

The Meteosat Second Generation (MSG) is presently the most important EUMETSAT programme, providing operational weather and climate data not only to the EUMETSAT Member States, but contributes with these also to the global Earth weather and climate observations. The MSG programme consists of four geostationary satellites, MSG-1 to MSG-4. MSG-1 (renamed to Meteosat-8 once in orbit) was launched in 2002, MSG-2 (Meteosat-9) in 2005, and MSG-3 (Meteosat-10) in 2012. MSG-4 is due to be launched in July-August 2015. Expected lifetime of the MSG system is approximately until 2020 - 2022. From 2018 on, the MSG programme is planned to be gradually replaced and upgraded by Meteosat Third Generation (MTG) satellites.

The main advantage of geostationary satellites is their regular, frequent imaging of the entire globe or its parts - for MSG satellites the repeat cycle is 15 minutes for the global coverage, and 5 minutes for the regional Europe coverage; for MTG satellites it will be 10 and 2.5 minutes respectively.

Outlook

The programme has been started with launch of the MSG-1 satellite in August 2002, and is expected to be terminated in 2020–2022 depending on the physical shape of MSG-3 and MSG-4 satellites. The MSG programme will be replaced by Meteosat Third Generation (MTG), which is presently under development (in cooperation with ESA), and which is scheduled to physically start with launch of the first MTG satellite in 2018. The MTG data will become the prime information data source for weather forecasting and warnings for all of the European weather services, as well as one of the elementary weather-related data sources for the European Copernicus programme. CHMI plans to adapt to the new MTG data as soon as possible, after these become available. However, this will require a new reception and processing system, to handle the increase of anticipated data volume.

Analysis

The Czech Republic began to actively benefit of the MSG programme about two years after the launch of MSG-1 satellite (a period necessary to consolidate and fully test the brand new satellite) from December 2004. The main use of MSG data within the Czech Republic is for operational purposes and duties of CHMI (namely for weather forecasting and warnings), serving thus not only the purposes of the ME, but also contributing to many other segments of the Czech government, general security, industry, transportation, and individual civic purposes. Besides the operational use of the MSG data at national level, CHMI actively contributes to this programme namely through its development and research activities carried out within the Convection Working Group (aimed at severe storms), where the Czech specialists belong to leading scientists of this group.

Recommendations

Until the end of the MSG programme and in the frame of CHMI official duties, it is necessary to continue in operational utilization of the image data and retrieved data products from the MSG satellites. In collaboration with other national institutions, as well as within the frame of EUMETSAT R&D activities, the progress towards the transition from MSG to MTG programmes should be facilitated. Transfer to the MTG data and retrieved data products utilization should be ensured as quickly as possible (within the frame of CHMI official duties), after these become operationally available.

6.1.2.3.2 EUMETSAT Polar System

Description and objectives

The EUMETSAT Polar System (EPS) began with launch of MetOp-1 satellite in 2006, followed by MetOp-2 launch in 2012, and will be completed with MetOp-3, scheduled for launch in 2017. The MetOp satellites share a low-Earth orbit with similar NOAA-POES (presently NOAA-18, NOAA-19, and NPP) U.S. polar satellites, forming thus a "joint polar system". While the polar satellites do not provide as frequent Earth observations as the geostationary satellites, the polar orbiting weather satellites provide additional important daily observations, not presently available from the geostationary satellites (namely advanced atmospheric soundings, which are one of the key inputs for numerical weather prediction models).

Outlook

The EPS system is to be replaced by EPS Second Generation (EPS-SG) programme (MetOp-SG satellites) in 2020-2022, depending on the system preparations. While MTG satellites will serve namely to weather forecasting and warning systems, the EPS-SG satellites will contribute through additional instruments to high-resolution Earth observations, serving not only to meteorology and climatology, but also to other European projects and programmes, such as Copernicus (through some of the Sentinel instruments to be flown aboard MetOp-SG satellites). The EPS-SG (MetOp-SG) satellite and system details are presently (2014) under evaluation of EUMETSAT and its Member States, in close collaboration with ESA.

Analysis

CHMI began with reception of MetOp data from the very beginning of their availability, as its older satellite reception system (initially designed for NOAA-POES direct readout data) was fully compatible with MetOp direct readout data format. The CHMI polar system should remain operational (with some minor necessary upgrades) until the end of availability of NOAA-POES and EPS satellites. The present CHMI polar system will not be able to cope without a major upgrade to the EPS-SG data once it becomes operationally available; however new means of data and product delivery are already investigated and developed by EUMETSAT which should ease the transition to EPS-SG.

Recommendations

Until the end of the EPS programme and within the frame of CHMI official duties, it is necessary to continue in operational reception and utilization of the direct readout image data from the MetOp satellites and to implement data products (namely from the new atmospheric sounders), which have not been utilized in CHMI so far.

6.2 GENERAL SUPPORTIVE TOOLS

6.2.1 NATIONAL

6.2.1.1 Operational programmes

Description of operational programmes mentioned in this chapter reflects the current status of their preparation (to the one of July 2014). The concrete support schemes will be defined in the framework of their implementation.

6.2.1.1.1 Operational Programme Enterprise and Innovation for Competitiveness

Description and objectives

The operational programme Enterprise and Innovation for Competitiveness 2014 - 2020 (OPEIC) is a document prepared by the OPEIC Managing authority (MIT) in cooperation with partners. The document sets up the objectives and priorities for the efficient use of the European Regional Development Fund to achieve competitive and sustainable knowledge- and innovation-based economy. The OPEIC is implemented under the Investment for Growth and Jobs goal within the EU cohesion policy. Within the Investment for Growth and Jobs goal the OPEIC implementation will contribute to the fulfilment of thematic objectives 1 through 4 and thematic objective 7 as defined in Article 9 of the draft common provisions regulation. The OPEIC has 5 priority axes (PA). PA 1 is called R&D Development for Innovation, PA 2 is Developing Entrepreneurship and Enhancing the Competitiveness of Small and Medium-Sized Enterprises, PA 3 is Energy efficiency, developing the energy infrastructure and renewable sources of energy, supporting new technologies in energy and secondary raw materials and PA 4 is called Developing High-Speed Internet Access Networks and Information and Communication Technologies. PA 5 is Technical assistance. The financial allocation to the operational programme amounting to €4.316 billion (ERDF contribution) is proposed in relation to the identified activities under the specific objectives of the priority axes with regard to their relevance for the achievement of the programme objectives and with regard to the programme's relevance for the achievement of the Europe 2020 strategy.

The focus of the research and other relevant projects from priority axes PA 1, PA 4 and partly from PA 2 supported from OPEIC will need to be in agreement with Strategy for Smart Specialization of the Czech Republic.

Outlook

The Government Resolution n. 867 from November 28, 2012 decided that MIT will be in charge of the OPEIC. The main goal of the projects in the OPEIC is concentration and effectiveness of using the financial support from European Structural and Investment Fund.

Analysis

The OPEIC is focused on the research, innovations, developing of small and medium-sized enterprises, low carbon economy and information and communication technologies. The programme document of the OPEIC refers to space activities that may be supported by relevant projects especially in PA 1, which will be in accordance with the terms of the relevant OPEIC support programme in the field of R&D.

6.2.1.1.2 Operational Programme Research, Innovation and Education

Description and objectives

The Operational Programme Research, Innovation and Education (OP RI&E) is focused on the connected topics of education and research and preparation of human resources for R&D. The budget of the programme is assumed in amount of 3.3 billion €. The OP RI&E is an operational programme subsidized by the European Structural & Investment funds (ESIF) and has 4 PA. PA 1 is called Strengthening capacities for high-quality research and is aimed at supporting the high-quality internationally competitive research that is far from commercial application. PA 2 is called Development of higher education institutions and human resources for R&D and is focused to increase the quality and openness of education at higher education institutions and prepare and develop high-quality human resources for R&D. PA 3 is called Equal access to high-quality pre-school, elementary, and secondary education and is focused to improve the regional education system. PA 4 is Technical assistance.

The research supported from OP RI&E is aimed at the research that is far from commercial application, is of high quality and is internationally competitive. The research which is close to the commercial application will be supported from OP EIC. The focus of the research projects supported from OP RI&E will need to be in agreement with Strategy for Smart Specialization of the Czech Republic.

Outlook

The MEYS will be in charge of the OP RI&E. The OP RI&E is an operational programme for the programming period from 2014 - 2020. The main goal of the projects in the OP RI&E is concentration and effectiveness of using the financial support from European Structural and Investment Fund (ESIF).

Analysis

The OP RI&E is focused on the high-quality research which is far from commercial application, preparation of human resources for R&D and education. There is no field specialization of the OP RI&E. The projects supported from the OP RI&E will need to be in agreement with Strategy for Smart Specialization of the Czech Republic.

6.2.1.1.3 Operational Programme Transport

Description and objectives

Operational Programme Transport 2 (OPT2) is a tool for fulfilling of strategic investment needs and dealing with key issues in the field of transport in the Czech Republic. The budget of the programme is assumed in amount of 5.5 billion €. There are 4 PA in frame of programme. The infrastructure for rail and other sustainable transport (PA1) is dedicated for improvement of railway infrastructure, supporting of multimodal transport, improvement of traffic management and improving traffic safety in cities, etc. The Road infrastructure in the TEN-T and public infrastructure for clean mobility (PA2) focused on improving of connectivity between centres and regions and to increasing the safety and efficiency of road transport and for development and implementation of ITS (inf. GNSS, EO and Telcom applications). Road infrastructure apart from the TEN-T (PA3) is aimed to the improvement of regions´ accessibility, increasing of safety and fluency of transport and impact mitigation of transport to the public health. The last PA - Technical assistance (PA4) will ensures managing and inspection of the programme, evaluation and another technical supportive activities.

Outlook

The MT will be in charge of the OPT2. The OPT2 is an operational programme for the programming period 2014 – 2020. The main goal of OPT2 is to contribute dealing with the key transport issues, mainly from infrastructure point of view, but not only.

Analysis

For space activities are relevant specific goals focused more on ITS and development and implementation of transport applications in general. There should be the opportunity for development of applications based on space systems products as GNSS, Earth Observation or Telecommunication and their practical implementation.

6.2.1.1.4 Operational Programme Environment

Description and objectives

The main objective of the Operational Programme Environment 2014-2020 (OPE 2014-2020) is to protect and ensure the quality and healthy living environment for residents of the Czech Republic to promote the efficient use of resources and the elimination of negative impacts human activities on the environment and the related mitigation of climate change. OPE 2014-2020 also serves as an important instrument for implementation of costly requirements of Directive EC/EU. The budget of the programme is assumed in amount of 3 billion €. Based on the analysis of current developments and the current state of the environment in the Czech Republic was taking into account the expected trends determined 5 priority axes:

- PA1: Improving water quality and reduce flood risks
- PA2: Improving air quality in human settlements
- PA3: Waste and material flows, environmental impact and risk
- PA4: Conservation and management of nature and landscape
- PA5: Energy savings

Within the priority axis laid down the relevant specific objectives. OPE 2014-2020 is based on the fundamental principles laid down in the Treaty on the Functioning of the European Union (Article 191), namely the precautionary principle, principle of risk minimization at source and is focused on meeting the priority goals of the 7th action programme of the EU:

- To protect, preserve and increase the natural wealth of the Union
- Convert the Union in the green and competitive low carbon resource efficient economy
- To protect EU citizens from environmental pressures and risks affecting their health and welfare
- Improve the knowledge and evidence base in the field of environmental policy

- Maximize the benefits of the legislation on the basis of effective implementation
- Providing investment policy in the field of environment and climate

The OPE 2014-2020 is aimed at contributing to the achievement of the basic objectives of the Europe 2020 strategy for reducing emissions, improving energy efficiency and increasing the share of energy from renewable sources.

Outlook

Preparation and management of the OPE 2014-2020 was appointed by Government Resolution No. 867 of November 28, 2012 by the ME. Activities are provided by the Managing Authority of OPE. Within the space activities, the ME understand its role primarily in support of the passive use of space systems. Relevant field of space activities for the ME is satellite monitoring of the Earth's surface to allow monitoring of changes in individual components of the environment and exploitation of space systems for environmental policy.

Analysis

The basis for the possible use of space systems is defined under the section "Binding priority to strategic documents" chapter devoted to the Regulation (EU) No 377/2014 of the European Parliament and of the Council of 3 April 2014 establishing the Copernicus Programme and repealing Regulation (EU) No 911/2010. Primary support for environmental monitoring in the framework of the OPE 2014 - 2020 exhaustively mentions specific Objective 2.3 Improve the monitoring , evaluation and forecasting trends in air quality, weather and climate and the ozone layer of the Earth under Priority Axis 2 - Improving air quality in human settlements. Other priority axes have priority focus on improving direct measures of the components of the environment. Activities associated with monitoring and collecting information about the environment are of secondary importance. Services of space systems is therefore possible to use in projects OPE except for air only as a supplement. Development of specific objectives, which could be taken into account space systems is expected in the implementation documents that will be processed in the following period.

The main focus and available resources, with regard to the thematic focus of the priority axes, the OPE will support projects aimed not to monitor, but to direct corrective measures in the field of environmental quality. Priority axis are also set especially for the support of public institutions, respectively for recipients. OPE can therefore be in direct support of space activities considered only as a supplementary source of grant funding. For the ME in terms of participation in the resort's space activities in particular promoting the use of services Copernicus, here is offered as the most beneficial support from public resources, particularly the construction and operation of a central repository and access point for images of the country. With regard to the future direction of eGovernment in the Czech Republic and the nature of the project, the repository of satellite images, appears as the most appropriate source of funding the Integrated Regional Operational Programme (IROP) by the MI.

6.2.1.1.5 Employment Operational Programme

Description and objectives

The Employment Operational Programme (EOP) is focused on minimization of unemployment by means of active policy on the labour market, equal opportunities for women and men, adaptability of workers and employers, social inclusion and combating poverty, improvement of public administration quality and international cooperation and social innovation in the areas of employment, social inclusion and public administration. There is also reflecting improvement of the HR in the field of administrative and technical skills. The budget of the programme is assumed in amount of 2.5 billion €. Priority axis of the EOP are set up in frame of:

- Promoting employment and adaptability of the workforce
- Social inclusion and combating poverty
- Social innovation and international cooperation
- Effective Governance

Outlook

The Ministry of Labour and Social Affairs (MLSA) will be in charge of the EOP. EOP is an operational programme for the programming period from 2014 to 2020. This programme is funded by the European

Social Fund (ESF), part of the European Structural & Investment funds (ESIF). Total approximate amount of CZK 70 billion is reserved for the EOP from EU and National funds.

Analysis

Increasing adaptability of workers and enterprises competitiveness are the main opportunity for the companies involved into space business in the EOP. Concrete objects of the income support will be specified in particular calls.

6.2.1.1.6 Integrated Regional Operational Programme

Description and objectives

The priority of the Integrated Regional Operational Programme (IROP) is to enable a balanced territorial development, improve public services and public administration and ensure sustainable development in cities, towns and regions (excluding Prague region). The budget of the programme is assumed in amount of 5.5 billion €. The objective is to reduce regional disparities, improve infrastructure and enhance competitiveness in the regions. There is also focus on strengthening public services, employment and education and strengthening the institutional capacity of the public administration.

To achieve the goals, IROP priority axis are:

- Increasing competitiveness in the regions
- Improving the quality of public services in the regions
- Strengthening the institutional capacity of the public administration in the regions

Outlook

The MRD will be in charge of the IROP. IROP is an operational programme for the programming period from 2014 to 2020. This programme is funded by the European Regional Development Fund, part of the European Structural & Investment funds (ESIF).

Analysis

This tool can be used by subjects involved into space activities, which need to improve their employment and education policy. In this case IROP can be used only as a supporting tool for the infrastructure for education. The concrete support schemes will be defined in the framework of the individual calls.

6.2.1.1.7 Operational Programme Prague - Growth Pole of the Czech Republic

Description and objectives

Interventions and actions to be supported in the next programming period in Prague, and which will be supported through the Operational Programme Prague – Growth Pole of the Czech Republic (OP PPR), include the use of quality human and innovation potential for research, development and innovation; promoting SMEs; energy efficiency and shift towards low-carbon economy; education and equal opportunities. The budget of the programme is assumed in amount of 0.4 billion €.

Structure of priority axes and specific objectives of the programme are focused on:

- Strengthening research, technological development and innovation
- Promoting cooperation in research and innovation activities and improving conditions for entrepreneurship based on innovation.
- Sustainable transport and energy efficiency
- Energy efficient city buildings using also suitable renewable energy sources, energy efficient technologies and smart management systems, improving the attractiveness of urban public transport use.
- Promoting social inclusion and combating poverty
- Strengthening of the social infrastructure for integration, community-based services and prevention, strengthening of social entrepreneurship infrastructure, strengthening of activities for integration, community-based services and prevention, promoting social enterprises and entrepreneurship.
- Education and education level
- Achieving a sufficient capacity and quality of early-childhood, primary and secondary education, Equal access to education.

Outlook

The MRD in cooperation with the Prague City is the coordinator of the OP PPR, which is dated for the programming period from 2014 to 2020. This programme is conceived as a multi-fund programme, subsidized by the European Structural & Investment funds (ESIF). Total amount of the support from EU is €202 million.

Analysis

Actions to be supported by OP PPR under priority Strengthening research, technological development and innovation (thematic objective 1) are promoting cooperation in research and innovation activities and improving conditions for entrepreneurship based on innovation. This type of support is available for subjects with the headquarters in Prague.

Recommendations

The Czech Republic should use the operational programmes as a tool of support of the further development of the Czech capacities and capabilities in the field of space activities to increase the global competitiveness of the Czech Republic (e.g. infrastructure, **instrumental and technological** equipment and training).

6.2.1.2 Support of Industry

Description and objectives

Industry accounts for a significant part of the Czech economy and the Government's goal is to create attractive conditions for Czech and foreign investors and encourage them to maintain long-term business activities and to reinvest in the Czech economy. At the same time the Government will stimulate the introduction of products with high added value and advanced technologies contributing to the modernization and sustainability of industrial production. An important part of economic policy is to maximize economic diplomacy that will create favourable conditions for the growth of trade in foreign markets.

The Government views positively the main message contained in the Communication from the European Commission of 22nd January 2014 For a European Industrial Renaissance, which is the recognition of the fundamental importance of industry to create jobs and promote growth, and continues to support EU efforts to increase the share of industry in European GDP up to 20% in 2020. From the perspective of the Government it is crucial that the discussion on topics of the competitiveness of industry and new climate and energy policy that are fundamental for the EU is interconnected.

The priorities that the Government considers key to the improvement of both the EU and the Czech Republic industrial competitiveness are the realistically set climate and energy framework 2030, competitive energy prices, strengthening and stability of the internal market, development of human capital, support of research, development and innovation and modernized state aid rules.

Space activities are a dynamically developing field, the advances of which are reflected in many sectors of industry and human activities. The Government is aware of the importance of space activities for the national economy and the importance of close cooperation with the ESA and the European GNSS Agency (GSA), particularly for the improvement of the technological level of the Czech industry and its competitiveness.

Outlook

In this context the Government is preparing measures to help Czech companies to get more involved in the above activities and will allow further improvements in the coordination of space activities at the national and global level. This form of coordination will not only contribute to a more efficient use of funds, but ultimately, to the increased return of investments and competitiveness of the country.

Investments in ESA optional programmes must be conducted in accordance with the increasing capacity of Czech industry in this area and achieved partial results in the transfer of know-how to the commercial industrial sector. Through investment in space activities, the government can effectively promote the competitiveness of Czech industry and research excellence, and contribute to sustainable economic growth.

Analysis

The Government sees space activities as a strategic and political discipline with a significant economic impact. Companies and institutions that are developing new technologies, software, hardware and services with high added value are getting increasingly involved in space activities. Applications in the field of space technology and satellite navigation stimulate further development in a broad spectrum of various industries.

Recommendations

The Czech Republic should support the industry to further develop its capacities and capabilities in the field of space activities to increase its competitiveness. The support should be provided primarily to areas of high potential of sustainability bringing benefits to national economy.

6.2.1.3 Support of R&D and Innovations

The support of R&D and innovations is based on the Revised National Research, Development and Innovation Policy of the Czech Republic in 2009 – 2015 with the prospect to 2020 and the National priorities of oriented research, experimental development and innovations.

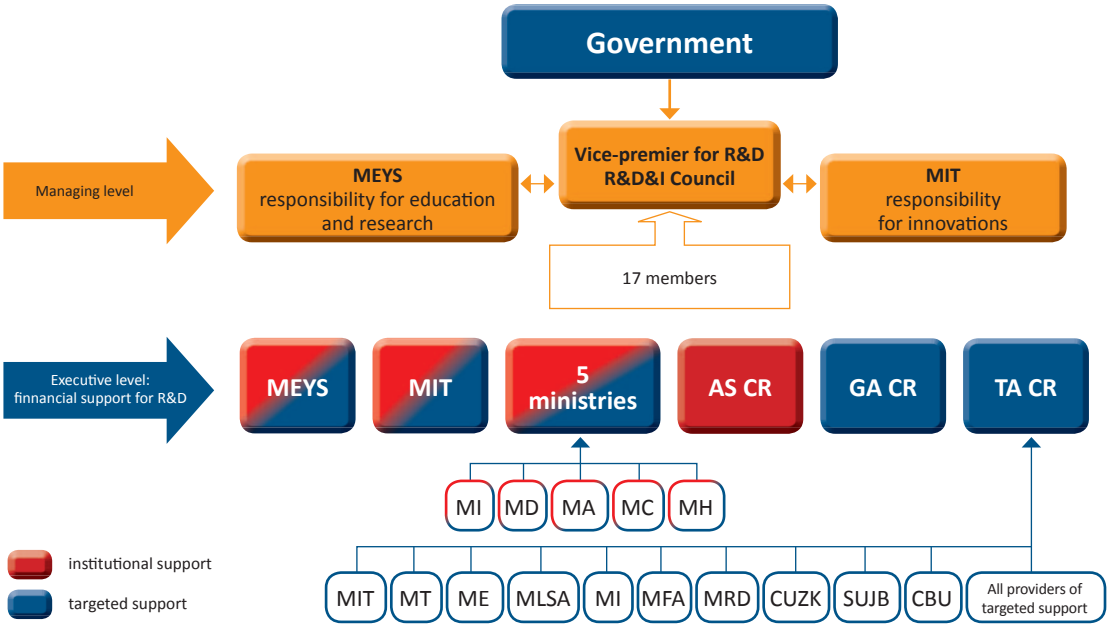

Figure 27: Structure for support of R&D and Innovations in the Czech Republic. Source: TA CR

6.2.1.3.1 Support of Basic Research

Description and objectives

GA CR provides specific grants to enable work on projects in frame of several groups of grant projects. The space research could be supported by all of them. The groups of projects are following:

- standard grants projects focused on basic (frontier) research;
- postdoctoral grant projects purposed to support basic research projects of young scientists;
- junior grants targeted on creating opportunities for excellent young researchers in order to build up an independent group with a few co-workers and modern equipment, boosting the current structure of basic research in the Czech Republic;
- international (bilateral) projects aimed to promote international cooperation in basic research, based on bilateral agreement, the candidate projects are assessed independently by both of national agencies.
- International “Leader Agency” grants (LA grants) projects aimed to promote international cooperation in basic research, based on agreements among agencies, the candidate projects are assessed by the Leading Agency only, the other agencies adopts this assessment.
- Grant projects to promote excellence in basic research, which focus on excellent basic research, for whose implementation can´t be create conditions within existing groups of the grant projects.

- EUROCORES aimed to promote the participation in international EUROCORES programmes coordinated by European Science Foundation.

Outlook

The calls are opened on the basis of public tender, financial support for research projects submitted by individuals or organizations. The main source of the funds available is the state budget, but contributions from other sources are also possible. Overall budget of GA CR for 2013 was 3.2 billion CZK. The calls are issued on yearly bases. Length of standard project is 3 years at maximum (2014).

Analysis

GA CR could be considered as a strong tool for supporting of basic space research (incl. excellence) and for supporting of international cooperation and encouragement of young scientist. This tool should be connectable to subsequent specific tools focused on transfer/application of the GA CR project results, in case when it is suitable or when they are the parts of some complex project.

Recommendations

Since there is a low chance to obtain funding from GA CR to support space related projects in general and there is practically no direct continuation of this basic stage of research in its further stages, the use of the funding for space activities is very limited. The systematic approach to support the space R&D is needed in the Czech Republic because no complex tool of support of the space activities respecting their specificities exists nowadays.

6.2.1.3.2 Support of Applied Research and Development

Description and objectives

The TA CR programmes (support schemes) approved by the government are: ALFA (with project financing started in 2011, overall expected state budget expenses: 9.3 billion CZK), BETA (with public tenders financed since 2012, overall expected state budget expenses: 640 million CZK), Competence Centres (projects financed since 2012, overall expected state budget expenses: 6.297 billion CZK), OMEGA (projects financed since 2012, overall expected state budget expenses: 309 million CZK), GAMA (projects financing starting in 2014, overall expected state budget expenses: 1.798 billion CZK), DELTA (projects financing starting in 2014, overall expected state budget expenses: 768.8 million CZK) and EPSILON (projects financing starting in 2015, overall expected state budget expenses: 9.69 billion CZK).

The **ALFA** Programme aims to support applied research and experimental development especially in the field of advanced technologies, materials and systems, energy resources and the protection and creation of the environment and the sustainable development of transport. The ALFA programme is divided into 3 sub-programmes:

- 1. Advanced technologies, materials and systems
- 2. Energy resources and environmental creation and protection
- 3. Sustainable development of transport

In the **BETA** Programme, R&D is supported in the form of public tenders fulfilling mainly the research needs stated by those state authorities which are not providers of R&D support themselves.

The aim of the **OMEGA** Programme (focused on social sciences) is to support projects of applied R&D, the results of which have a high potential for application in many areas of Czech society. The knowledge gained will help to define the factors and processes that determine and affect the functioning and development of Czech society in the context of the ongoing European integration and world globalization.

The aim of the **Competence Centres Programme** is to increase the competitiveness of the Czech Republic. Therefore the programme will stimulate the creation and operation of centres of research, development and innovation that will be innovative, competitive and sustainable, have a market potential and will centralize the research and application capacities of the public and private sectors.

GAMA is a programme specifically focused on a late stage of research and on commercialization of its outputs. Rather small projects will be supported. The programme is divided into two sub-programmes with different methods of implementation and recipients.

DELTA is a programme meant for international cooperation support and the precondition of support from TA CR is the approval of a foreign agency to support costs of the foreign subject cooperating in the project.

EPSILON is a new programme oriented on support of projects of applied R&D, whose results have a high potential for a quick application in new products, production processes and services, particularly in the following priority areas:

- Competitive knowledge-based economy;
- Sustainability of energy and material resources;
- Environment for quality of life.

It shall serve as a substitute for programme ALFA and for the programme TIP of MIT (both programmes do no more accept new support applications). Supported can be projects falling mainly under priorities 1, 2, 3 and some chosen parts of the priority 6 (of National Priorities of Oriented R,D&I). As identified fields with high potential are in EPSILON programme mentioned: development of new progressive materials, development of biotechnologies, nanotechnologies, space technologies or transport vehicles of the future.

Outlook

TA CR will continue supporting the collaboration between research organisations and industry, including the international cooperation. The attention should be paid specifically to applications for the space industry. TA CR will focus on support of the complete innovation process considering also a thorough evaluation of national economy impacts.

Analysis

Among TA CR programmes, projects relevant to space activities are supported currently in the ALFA Programme (2011-2019) and in the Competence centres Programme (2012 -2019), which provide support to a wide range of applied research and experimental development fields. None of them will open any new call for projects.

In the programmes where new calls for projects are expected in 2014 and following years, the support of space R&D is possible mainly in EPSILON Programme and it is not excluded also in GAMA and DELTA programmes. However none of them specifies any amount of financial allocation determined exclusively for space relevant projects.

Recommendations

The systematic approach to support the space R&D is needed in the Czech Republic because no complex tool of support of the space activities respecting their specificities exists nowadays.

6.2.1.3.3 Support of Security Research and Development

Description

The Security R&D programmes (support schemes) approved by the government has two main sub-programmes. The main goal of the programme is to support R&D activities in the homeland security and the security of the citizens in the field of prevention, suppression and minimization of security threats.

The first sub-programme is oriented on application submitted by individual legal entities based on their own proposals. Applications submitted in this sub-programme must be in compliance with defined programme priorities and goals stated in following documents: “Security Strategy for the Czech Republic”, “National priorities of oriented research, experimental development and innovation” and “Inter-ministerial strategy for security R&D research and development in the Czech Republic until 2015”. This sub-programme is proposed for the period 2015-2020. Project financing shall start in 2014, overall expected state budget expenses: 2.2 billion CZK.

For the other sub-programme the term of reference is prepared by the relevant authority according to its research needs. The best bid must fulfil defined research needs of individual authority. Therefore the financial contribution from the state is expected in the rate of 100%. This sub-programme is proposed for the period 2016-2021. Project financing shall start in 2015, overall expected state budget expenses: 800 million CZK.

Responsible authority for the programme management and financial support provider is the MI.

Outlook

The calls for projects in both above mentioned sub-programmes are still at present under preparation.

Analysis

In the both sub-programmes where new calls for projects are expected in 2014, resp. in 2015, and following years, the support of space R&D is not excluded in Security R&D programmes. However none of them specifies any amount of financial allocation determined exclusively for space relevant projects.

Recommendations

The systematic approach to support the space R&D is needed in the Czech Republic because no complex tool of support of the space activities respecting their specificities exists nowadays.

6.2.1.3.4 Support of Defence Applied Research and Development

Description

The Defence Applied R&D programme (support scheme) approved by the government supports the R&D activities in the homeland security and the security of the citizens in the field of prevention, suppression and minimization of security threats. Support is expected especially for the following areas: development of new weapons and defence systems, military transportation and mobility, command and control support, development of communication and information systems and cyber security.

Priorities of this programme titled „Development of the Czech Republic Armed Forces“ are in accordance with requirements of the Czech Republic Armed Forces which are set out in the “Security Strategy for the Czech Republic”, “Military Strategy of the Czech Republic” and in the “Defence White Paper”.

The programme is proposed for the period 2015-2022. Project financing shall start in 2015, overall expected state budget expenses: 1,733 million CZK.

Responsible authority for the programme management and financial support provider is the MD.

Outlook

The calls for projects are still at present under preparation.

Analysis

In the programme where new calls for projects are expected in 2015 and following years, the support of space R&D is not excluded. However this programme does not specify any amount of financial allocation determined exclusively for space relevant projects.

Recommendations

The systematic approach to support the space R&D is needed in the Czech Republic because no complex tool of support of the space activities respecting their specificities exists nowadays.

6.2.1.3.5 Support of International cooperation in R&D

Description

There are several programmes dedicated for support of international cooperation in R&D managed by the MEYS. The programme **COST CZ** (2011 – 2017) is dedicated to support projects of Czech research organisations in basic research within the programme COST (European Cooperation in Science and Technology), which is managed by the European Science Foundation (ESF). The programme **EUREKA CZ** (2011 – 2017) supports the international cooperation in applied R&D with emphasis on SMEs within the programme EUREKA (Europe-wide Network for Market-Oriented Industrial R&D and Innovation). The goal of the programme **INGO II** (2011 – 2017) is to support cooperation between Czech research organisations with research institutions, either international or located abroad, including contributions to international non-governmental organisations or associations in R&D. The support for R&D cooperation with non-EU countries – currently USA, Russia, China, Japan, Korea, India and Israel – is provided within the programme **KONTAKT II** (2011 – 2017), while cooperation with Israel in market-oriented applied R&D is supported by the programme **GESHER/MOST** (2010 – 2016). The programme **EUPRO II** (2011 – 2017) is intended for support of information services in the area of international cooperation in R&D.

Outlook

There is currently (2014) running the call for ideas started on 2013. Before the programmes will finish it is expected the last call which should start on 2015. Currently there is no decision about the continuation of mentioned programmes after 2017, but some continuation is expected.

Analysis

The programmes for support of international cooperation in R&D are focused on broad range of activities and there is no field specialization of these programmes, i.e. these programmes can be also used for support of space R&D.

These programmes are used to fund e.g. Czech Space Office which is private non-profit organisation which duplicates activities that are in responsibilities of public authorities.

Recommendations

Since the present programmes also support activities which in practice duplicate the activities of public authorities in space, there is the need to avoid this trend in future.

There is also the need to more efficiently use the present frameworks of support of the international cooperation in R&D to motivate Czech entities to cooperate with their foreign counterparts and create stable consortia to be further active e.g. in programmes of EU or ESA.

6.2.2 INTERNATIONAL

6.2.2.1 EU

6.2.2.1.1 Horizon 2020 (excluding Space)

Description

Horizon 2020 is the new EU's research and innovation programme for period 2014 – 2020. Horizon 2020 is built around three pillars:

- Support for "Excellent Science" – including grants for individual researchers from the European Research Council and Marie Skłodowska-Curie fellowships (formerly known as Marie Curie fellowships);
- Support for "Industrial Leadership" – including grants for SMEs and indirect finance for companies through the European Investment Bank and other financial intermediaries;
- Support for research to tackle "societal challenges". During negotiations between the European Parliament and Council it was decided to support research towards meeting seven broad challenges:
    - Health, demographic change and wellbeing
    - Food security, sustainable agriculture and forestry, marine, maritime and inland water research, and the bioeconomy
    - Secure, clean and efficient energy
    - Smart, green and integrated transport
    - Climate action, environment, resource efficiency and raw materials
    - Inclusive, innovative and reflective societies
    - Secure & innovative societies

In addition, part of the Horizon 2020 budget goes towards funding the European Institute of Innovation and Technology (EIT), research activities carried out under the Euratom Treaty and non-nuclear research carried out by the Joint Research Centre, the European Commission's in-house science service.

Horizon 2020 is worth nearly €80 billion over seven years, including funding for nuclear research under Euratom. The theme “Space” is included in the pillar 2) Support for "Industrial Leadership".

Outlook

The Horizon 2020 represents the biggest funding source for R&D in the Czech Republic. The calls are being prepared and announced continuously and the Czech Republic can partly influence their contents to correspond to its capacities and capabilities.

Analysis

There is wide range of opportunities how develop area of space activities from Horizon 2020 outside of theme "Space". Space activities are cross-sectional and therefore almost each of the seven challenges may be used to develop the capacities and capabilities in space activities.

Czech entities were not very successful in the previous period (FP7) in general and therefore there is a need to promote the Horizon 2020 as a tool which brings a lot of opportunities to support promising projects and international cooperation.

Recommendations

Also other priorities of Horizon 2020 can be used to support of space R&D. The concrete opportunities should be further explored by Czech entities.

6.2.2.1.2 EDA programmes

In the field of space related activities EDA covers two key European defence capability programmes in the areas of Remotely Piloted Aircraft Systems (RPAS) and Governmental Satellite Communications (GOVSATCOM).

Description and objectives

The EDA RPAS activity aims at harnessing synergies in both military and civil domains, maximising dual-use technologies and overcoming the limitations of greater RPAS - use imposed by the lack of a harmonised framework allowing them to operate in civil airspace. RPAS have proven their value in the military sphere in recent operations demonstrating their operational capacities, particularly for surveillance and information gathering. However RPAS can also offer a wide range of civil applications such as infrastructure surveillance, firefighting, disaster or environmental monitoring, as well as border control and management. The activity contains the following four pillars:

- Air traffic insertion
- RPAS certification
- Future European Medium Altitude Long Endurance (MALE) programme
- European military cooperation.

The aim of EDA´s GOVSATCOM initiative is to provide its Member States and European actors with appropriate capabilities through an innovative and sustainable cooperation model of satellite communications which are a key enabler for civil and military missions/operations in particular in remote and austere environments with little or no infrastructure. The objective of EDA's proposal for GOVSATCOM is to prepare the next generation in the 2025 timeframe. The Programme will include:

- identifying and producing Common Staff Targets for future mission requirements,
- on this basis, undertake a gap analysis and an updated Strategic Research Agenda,
- coordinating civil and military requirements,
- preparing a project for Member States interested in due course.

Outlook

Both initiatives are performed and coordinated in close cooperation with the EC and ESA. At the same time they represent a new partnership with European defence and space industry and can contribute to the competitiveness of Europe.

Analysis

The Programme Arrangement of R&T Joint Investment Programme on RPAS with the focus on Air traffic insertion signed in 2013 covers cooperation of 11 countries (including the Czech Republic). The Programme will focus on technological priorities such as sense and avoid, taxi, automatic take-off and landing, air traffic management interfaces, safe automated monitoring and decision architecture. The objective of the Programme is to contribute to building a future regulatory framework for the seamless integration of RPAS in non-segregated airspace. The Programme has no financial commitment as only specific projects will be directly funded by participating Member States.

The Czech Republic considers its membership in the European Satellite Communication Procurement Cell (ESCPC) within the GOVSATCOM initiative framework (8 contributing Member States in 2013). The ESCPC

established for the pooled procurement of commercial satellite communication services in military operations has proven its operational and financial value by delivering concrete support to Member States (orders of more than €1 million and reducing costs by up to 20 % in 2013).

6.3 BILATERAL COOPERATION

Description and objectives

The Czech Republic has concluded a number of international agreements in the field of economic or scientific cooperation. The agreements are of general nature. The list of the agreements is enclosed in Annex G.

Outlook

The Czech Republic has not concluded any international bilateral agreement related to the space activities so far. However, the Czech Republic, led by the MT, and the France, led by French National Space Agency (CNES), are finalising a Treaty between the Czech Republic and France related to the cooperation in the area of exploration and use of outer space for peaceful purposes.

In 2010 the MOT and the Brazilian Space Agency (AEB) signed the Letter of Intent aiming to explore opportunities for co-operation in national and international space technologies.

The MT has been preparing a Memorandum of Understanding with the Office of National Space Policy of Japan related to the cooperation in the area of space activities.

The MT has been preparing a Memorandums of Understanding with the Ministry of Transport of Lower Saxony in Germany, Ministry of Transport of Bavaria in Germany and the Ministry of Transport of Austria related to the cooperation in the field of intelligent transport systems and satellite navigation. The Memorandum of Understanding on cooperation on use of global navigation satellite systems with Russia is being prepared as well.

7 RECOMMENDATIONS

In this Chapter the recommendations stemming from all information, discussion and considerations from the NSP are presented. The analysis reflects the strategy proposed and the situation at the time of writing of this document.

7.1 VISION

The long-term vision for the Czech Republic should encompass several long-term objectives to ensure that the Czech Republic:

- Has an international image of industrial and scientific excellence,
- Is a high value-added economy,
- Is competitive and innovative,
- Is capable of absorbing and retaining the intellectual capital it creates,
- Is an example of a virtuous complementarity and cooperation between its industrial and academic tissues,
- Is an expert user of space resources and infrastructure in operational products and services (EO, Navigation, etc.).

7.2 MID-TERM OBJECTIVES (2019)

To ensure that Czech Republic is on the way to accomplish the Vision above it will be necessary to achieve the following mid-term objectives by 2019:

- Czech investment in space has an appropriate return.
- The Czech Republic has the necessary competences (industrial, academic, project management) and infrastructures exist to sustain the long-term vision.
- The objectives of 2016 were very successful (they have been achieved in 2013) however this success is sensitive to single Czech entities – for this reason the depth of industrial participation of Czech companies must be increased.
- The interaction between academia and industry is well balanced respecting their specific missions and roles.
- Czech companies have a sustained presence in the supply chain of European space industry.
- The Czech Republic recognizes space as a strategic element of national policy and has the effective tools to implement it.

7.3 EVALUATION CRITERIA (2019)

To evaluate whether the mid-term objectives were achieved in 2019 it is necessary to define quantifiable evaluation criteria. The following are proposed:

- The contribution to ESA optional programmes (excluding PRODEX)[47] is at least twice as high as the mandatory contribution and an overall return-on-investment (economic impact factor) on such ESA contributions including mandatory activities of a factor of 2.
- Balanced participation of academia and industry in space projects with at least 90% of the budget of the ESA mandatory activities and optional programmes (excluding PRODEX) spent in Czech industry respecting the ratio spent by ESA in European space industry.
- At least one incubation scheme and associated technology transfer being implemented.
- At least one Czech Co-PI in a space-based scientific instrument assuming the funding of the payload projects of space missions is stable and sustainably growing.
- A minimum of one Czech-owned-IPR sustainable space product being supplied or about to be supplied.
- At least two companies that are suppliers to European primes and 3 companies supplying European sub-primes in sustainable fashion.

[47] Since the driving force of this criterion is the Return of Investment, the PRODEX programme is excluded from this factor.

- a formalized training support scheme exists and space engineering competences in Czech university degrees were introduced.
- The Czech Republic has a formalised national space agency with clear competences, tools, budget and resources to implement the NSP, including a national space programme.

7.4 Evaluation and Review of Objectives

The NSP implementation will be regularly monitored. Evaluation will be based on both performance monitoring and factual assessment of progress and achieved results (using qualitative and quantitative methods). In case of the need, the recommendations will be revised and further elaborated.

The way how the mid-term objectives of Section 7.2 are being met should be evaluated in 2016 and the review should be reported to the Government of the Czech Republic. In 2019, the mid-term objectives should be evaluated under the light of the evaluation criteria of Section 7.3 and the review should be reported to the Government of the Czech Republic. At this date a new or revised NSP should be formulated.

7.5 Actions To Be Implemented

To achieve the vision and the mid-term objectives it will be necessary to undertake a number of actions. Below the actions are divided by theme.

7.5.1 General Actions

Space exploration must not be considered as an end in itself but as an economic instrument for development and innovation. Due to objective, largely economic reasons, the Czech Republic cannot undertake all space activities. Therefore, it will aim its support mainly at those activities or programmes with the potential to bring the largest added value to the Czech Republic, its national economy and its physical and legal entities from the strategic, economic and security point of view. Generally, those space activities or programmes that will lead to higher potential benefits across several areas of the space activity will be favoured.

7.5.1.1 Return-on-Investment

Space-related activities are a unique tool to influence economic development by creating virtuous examples and best-practices to be used in other sectors of the economy. The economic impact considered as a "return-on-investment" in space activities is in the order of a factor of 4 - 5. The need to retain and absorb the intellectual capital that is created in the Czech Republic is also an essential requirement to ensure the "return-on-investment".

Space and ESA activities in particular should be seen as an opportunity to develop technologies, products and services that will be then exploited elsewhere, maximizing the "return-on-investment".

Assuming that, in some special cases, academia is able to pursue a technology up to TRL 6 or above, then the problem is one of maximizing the return on investment to develop the technology.

In these cases, the difficulty is in transforming the technology into a product and in retaining the scientists or engineers that performed R&D in academia. The return-on-investment in this case is very small, translating into having the personnel employed during the course of the activity and little else.

An exception is the development of scientific payloads where institutes of the ASCR are the end users of the product and often participate in its development, together with industrial partners, from conception to operational phase. In such cases, when permanent academic staff is involved in the development, the know-how and continuity can be preserved both by the academic and industrial partners.

In an industrial setting it is easier to achieve a product that can be exploited commercially, because market considerations will be taken into account that will influence its design, manufacturing and production. Also in industry, it is usually easier to retain the scientists or engineers that performed the R&D. This is very often what renders a development with a high return-on-investment because the market for the new product becomes economically sustainable.

The collaboration between academia and industry, exploiting their natural roles and missions, is a key for a successful technological development and innovation with a high content of added value and pre-

condition to economic sustainability. This collaboration between academia and industry should be supported using national schemes.

Furthermore, in order for Czech entities to actively participate in the development of new technologies and their ultimate implementation/application, it is desirable that they participate in relevant projects from their initial stage when directions and goals are defined.

7.5.1.2 Synergies, Knowledge Transfer and Technology Transfer

The Czech Republic is a member state of a number of international organisations which implement their own space missions and activities or have a stake in space activities from technological, science or another point of view or which are usually users of space systems or their technologies. **In this respect the Czech Republic should exploit all opportunities connected with its membership in international organisations and motive Czech entities to use their capacities and capabilities and participate in activities of these international organisations.**

Synergies among various activities identified in the NSP have to be actively identified to enable use and further development of industrial capacities and capabilities and maximize the return on public investment of the Czech Republic to space related activities.

The Czech Republic should also aim at creating an environment for knowledge transfer acquired through space activities including results from research, technology development and services into other fields. Furthermore, the Czech Republic should focus on establishing an environment for knowledge transfer from other sectors to the space sector. **Knowledge transfer should be supported using national schemes.**

ESA BIC and Technology Transfer Broker activities should be further supported to accelerate the technology transfer to and from the field of space activities and enable the establishment of new companies and the further development of the existing ones.

7.5.1.3 Intellectual Property Rights, including Patenting

All activities under NSP should consider the protection of the IPR and the exploitation of these rights.

All R&D activities funded with public funds should aim towards developing and protecting their own IPR and the exploitation of these rights should take place in the Czech Republic. This does not exclude that, for the purpose acquisition of know-how, fully licensed products may be manufactured and/or exploited in the Czech Republic.

It does not exclude funding of activities where ESA retains the ownership of the IPR for operational or continuity reasons, like maintenance, upgrade or development of the systems developed, as they ensure a competitive advantage for participating academia or industry.

For both low and high TRL technologies, the role of IPR is crucial to ensure the property of the technology at the base of future products, applications and services that can bring benefits across the whole of the Czech economy.

For this purpose a scheme to support academia and industry to ensure protection of the IPR, including the registration of patents, must be devised urgently with a specific strategy.

The property of the technology however, is not the only condition necessary to achieve these benefits. It is also necessary to ensure, to the maximum possible, that these technologies are exploited in the Czech Republic. The collaboration or teaming of academia with Czech industry is a very important factor, especially in the middle-low TRL, in this process. For this purpose projects that encourage this collaboration, in the respect of their roles, should be encouraged.

7.5.1.4 Market and Trends

The Czech Republic should not support development of industrial capacities and capabilities which have very low chance to be successful on European or global market. When evaluating whether or not to grant the support to the project proposals, the great emphasis should be laid on compliance with technology and market trends, competitive advantages and orientation on niches.

The Czech Republic should also support scientific research of planned missions and development of scientific instruments for space science missions to enable Czech academia teams to pursue their own projects proving their scientific excellence worldwide.

7.5.2 ORGANIZATIONAL AND FINANCIAL ACTIONS

These actions aim at ensuring that the area of space activities has stable ground and is sustainably supported by the public authorities of the Czech Republic.

7.5.2.1 Establishment of the National Space Agency

The establishment of the Coordination Council for Space Activities was a significant improvement of the situation as it was before 2011 by ensuring transparency and participation to all institutional stake-holders and this concept has shown its positive results so far. However, the Czech Republic should further optimize the way that the public sector approaches the area of space activities – in particular to eliminate current fragmentation of execution powers, increasing the effectiveness and efficiency of public administration and public expenditures, improving communication between public and private sector, and using synergies with other areas and concentrate the expertise. This is a point already recognised in 2010 NSP. **Therefore another step forward should be taken and a public national space agency should be established.**

The future National Space Agency should be also responsible for identification and exploitation of possible synergies.

7.5.2.2 Establishment of National Space Programme

Nowadays, there is no specific national tool in the Czech Republic which would be used directly to support space activities.

From the date of accession to the ESA (2008) a special ESA transitional programme was implemented to create necessary Czech capabilities for a successful Czech participation in ESA Space activities. This programme is called Czech Industry Incentive Scheme (CIIS) and will end at the end of 2014. In this period the Czech Republic has enjoyed special support from ESA that will not be available after 2014. The funds allocated to this special programme amount to 45% of the mandatory contributions to ESA.

This special programme has been very successful and was instrumental in achieving all the objectives of the 2010 NSP 3 years before its target. During its lifetime the CIIS has allowed specific targeted in the Czech Republic that will not be available after 2014.

This change after 2014 will require specific measures from the Czech Republic as to allow Czech industry to continue its development avoiding destruction of capabilities already created with substantial investment of time and money.

The national space programme in a suitable form should be established to support a sustainable growth of the capacities and capabilities of the Czech industry and academia, their competitiveness and their prepared preparedness to participate in European or international programmes. It is essential to have a financing tool for activities that cannot be funded from traditional ESA optional programme. From this point of view, the national space programme would be a good tool to complement the development done within ESA programmatic frame. Looking at other member states of ESA and considering the experience from CIIS, the budget of such national programme needs to be started with funding in €3-5 million/year range in order to be effective for a period of at least 5 years.

7.5.2.3 Increase of the Financial Participation of the Czech Republic in ESA Optional Programmes

After the Czech Republic acceded to ESA in 2008, also Romania (2011) and Poland (2012) joined ESA. There are also other EU Member States wishing to become ESA Member States in near future (Hungary and Estonia probably in 2015). Since the transitional period of 6 years will be completed by the end of 2014, the Czech Republic will not benefit any longer from the protection ESA and its Member States granted to it. The ESA rules on geographical return in connection with the massive contributions of states joining ESA after the Czech Republic will help these states to create and incubate capacities and capabilities in their respective

industries, which will be soon ready to compete with the Czech industry. Without significant increase of contribution to ESA optional programmes, the Czech Republic will lose the competitive advantage which has been systematically built so far. It could also lead to devaluation of current investments of the Czech Republic to its space capabilities and capacities and loss of its positions in the European and global space market.

Since the usual proportion between investments to mandatory activities and optional programmes is approx. 25% to 75% to be able to increase the geographical return from mandatory activities and in general to launch the sustainable return on investment, the low contribution of the Czech Republic to optional programmes (43% of its total contribution) may be considered as the major obstacle for the further development of the space industry and academia in the Czech Republic.

Having in mind this fact, **the Czech Republic's contribution to ESA optional programmes has to be at least doubled** (in comparison with 2014). These contributions to ESA should be seen as leverage to increase the return of the Czech contributions to the space activities of the EU and EUMETSAT procurements (Galileo, Copernicus and MSG, MTG, MetOp) and in development in Horizon 2020.

7.5.2.4 EUMETSAT

Given the fact that data from the EUMETSAT weather satellites are one of the key information elements of modern meteorology (namely for weather forecasting and warnings, as well as in climatology), and taking into account very close, mutual links between EUMETSAT, ESA and Copernicus activities and programmes**, it is highly desirable and recommendable to support present and future Czech activities within EUMETSAT. Besides supporting EUMETSAT mandatory programmes (MSG, MTG, MetOp, EPS-SG) through the regular membership of the Czech Republic in EUMETSAT, the Czech Republic should also continue to play an active role in various R&D activities of EUMETSAT and its programmes. Beyond this, Czech companies and institutions should broaden their involvement in various tenders of EUMETSAT, benefiting on their experience with similar ESA tenders and programmes (namely MTG and MetOp-SG/EPS-SG related programmes). All of this assumes and requires that the Czech Republic maintains its full membership in EUMETSAT.**

7.5.2.5 ECMWF

The Czech Republic should become a Member State of the ECMWF in the near future. That would give the national meteorological service the opportunity to co-decide on a long-term strategy for the development of the global medium-range forecasting systems developed and operated by the ECMWF.

7.5.3 CAPACITIES AND CAPABILITIES DEVELOPMENT ACTIONS

7.5.3.1 General

In the Czech Republic there are several technologies that are sufficiently advanced to be applicable relatively easily to space programmes or applications. However, only the companies with the determination and motivation to overcome the initial hurdles will be able to move into the space arena. Among the reasons are strict project management, standards and documentation requirements, the limited profit margins that ESA contracts allow, as well as the relatively small contribution of the Czech Republic towards ESA. The size of the Czech contribution to the ESA budget, the general trend, and specific recent practical experience, point to the realisation that the space business in the Czech Republic must focus especially on innovative SME. Specific measures to support SME and their innovative behaviour should be devised. These measures should also contemplate protection of IPR, including patent registration, support.

For stimulation of new applications development some suitable platform or scheme should be established (e.g. "Czech Copernicus Masters"). It is necessary to make easier the transfer of ideas of new promising applications to the market. In this case the ESA BIC is one of suitable supportive tools.

It is recommended to implement the following actions in order to stimulate the downstream segment in the Czech Republic:

- Intensive awareness raising;

- Continuation of a dialogue with promising end-user communities;
- Demonstration of successful applications;
- Stimulating demand (through a mix of workshops, success stories). Promotion of capacity building and business incubation);
- Stimulation of new application development through suitable platform or scheme at national level;
- Closer cooperation among public sector, research institutes and companies should be established;
- Stimulation of the sector by participation of the Czech Republic in respective ESA and EU programmes as it is the key to European and global markets;
- Specifically for EO:
  -Copernicus implementation plan should be formulated;
  -National Sentinels data storage should be established (could be extended for another EO data).

7.5.3.2 Awareness Raising

In order to ensure a high level of awareness in general public and knowledge of the professional community concerning the importance of space activities, their benefits for individuals and entire society and respective opportunities, there is a need for close collaboration and involvement of various player both of public and private sector and their one way approach.

7.5.3.2.1 General Public – Adults

Information for the general public must be presented in a simple form, preferably on real examples of the use of space technology and applications in the daily lives of people and real and measurable socio-economic benefits that space activities and applications bring to the whole society.

It is necessary to be focused on the identification and subsequent establishment of cooperation with appropriate **media** (TV, radio, newspapers, journals, etc.) and to build and maintain an active network of contacts to ensure dissemination of space-related information to the general public. It is also necessary to promote new awareness raising events and support the existing ones, broaden the range of visitors and extent the existing informative web portals supported by the social networks.

Another important action is to strengthen cooperation with cultural facilities systematically engaged in awareness raising in the area of the space activities like observatories and planetariums, science centres and parks for general public, etc.

7.5.3.2.2 General Public – Children & Youth

Awareness raising in the area of space activities towards children and youth shares the same recommendations contained in the previous case with emphasis to active use of **social network channels**. Space topics should be more involved in educational curriculums and extracurricular activities in order to motivate children to further study space related subjects and be involved in space activities in their professional lives.

7.5.3.2.3 Professional Public

The range of the **informative support provided to industry and academia on opportunities and possibilities for development of their capacities and capabilities in the field of space activities**, with a particular focus on the activities of ESA and EU, might be further developed through seminars, conferences, information and industrial days, web portals, newsletters and other media channels. The close cooperation between relevant entities on national and international level should be established or intensified in this respect.

It is also necessary to seek for the opportunities in the field of strengthening the international cooperation. In this respect it seems to be necessary to further spread awareness about the national space policy of the Czech Republic on international level and display the capacities and capabilities to other states and relevant entities as large system integrators.

More attention should also be paid to awareness raising about current issues concerning the space activities and their benefits for the national economy towards decision makers.

It is also necessary to raise awareness about the opportunities offered by the ESA BIC platform.

7.5.3.3 Education and Training

7.5.3.3.1 Primary, Secondary and High Schools

Teaching STEM subjects at primary, secondary and high schools should be adequately complemented by extracurricular activities with overlap in space activities (e.g. courses, workshops and leisure activities on astronomy, astronautics, physics, etc.) **leading to a deeper understanding of the particularities of scientific and technical disciplines.** Concerning the high school students it is also essential that the foreign courses and hands-on projects opportunities in the field of astronautics can be identified. In this case, **it is necessary to** continuously raise awareness about these activities among high school students and teachers (e.g. through the ESERO), **intensify international cooperation with foreign institutions** (especially within ESA) and fulfil the opportunities offered in this field.

7.5.3.3.2 Universities and Ph.D. Studies

It is necessary to set up and strengthen the international cooperation with the foreign institutions (having its own educational corporate programme) **and universities to promote broader list of opportunities for Czech graduates and undergraduates students** (e.g. ESA´s Student Placement Programme and hands-on projects of ESA Education Office)**.** The objective is also to find the funds for preparation of scholarship programmes for Czech students, to encourage short and long-term internships, courses, support and realization of hands-on student activities with high added educational value (e.g. full realization of CubeSat projects). More attention should also be paid to promote better communication between Czech universities and relevant stakeholders.

To make the skills training required by space-enabled research more sustainable, two steps should be introduced. Firstly, **Ph.D. students aiming to space sector should get access to separate educational institutions and industry inside or outside country giving them relevant specialist and business skills that are needed in both the upstream and down-stream space sectors. To ensure this challenge it is necessary to develop new framework for Ph.D. studies, actively involving Czech universities, Czech industry and foreign companies/institutions.** Best practices of similar Ph.D. framework which is beneficial for all parties, can be found across the Europe.

Second one is a **comprehensive package of measures to support the entire space sector, with a single point of access, comprising improved project management tools, skills training, and mentoring.**

7.5.3.3.3 Young Professionals & Life-long Education and Training

More attention should be paid to raise awareness among Czech graduates and postdocs about ESA's Young Graduate Trainee programme and Postdoctoral Research Fellowship programme and student programmes provided by the International Space University. With regard to demanding tuition fees, supporting tools like student loans or scholarships should be offered to the applicants.

The Czech framework should be established, supplemented by the internship/trainee framework for the young professionals across the Czech and foreign industry together with Czech Trainee programme within ESA. Also the possibility offered by the forthcoming operational programmes in the field of further education needs to be exploited.

Also life-long educational space-oriented vocational training courses or schemes should be introduced.

7.5.4 PROGRAMMATIC ACTIONS

There is a number of tools which can be used to support the development of space capacities and capabilities. However, the only existing tools specifically oriented to space activities in which the Czech Republic participate today are the activities of international organisation of which it is a Member State, such as ESA, EU and EUMETSAT. Other tools on both national and international level are of general or nature or relates to space just partially and therefore their use for support of the development of space capacities and capabilities is rather limited.

7.5.4.1 National

Since there are no specific national tools to support space activities in the Czech Republic nowadays and the establishment of the national space programme is discussed in section 7.5.2.2, the further actions are focused just on general supportive tools.

Operational Programmes

The Czech Republic should use the operational programmes (OP Enterprise and Innovation for Competitiveness, OP Research, Innovation and Education, OP Transport, OP Environment, OP Employment, Integrated Regional OP and OP Prague - Growth Pole of the Czech Republic) **as a tool of support of the further development of the Czech capacities and capabilities in the field of space activities to increase the global competitiveness of the Czech Republic (e.g. infrastructure, instrumental and technological equipment and training).**

Support of Industry

The Czech Republic should support the industry to further develop its capacities and capabilities in the field of space activities to increase its competitiveness. The support should be provided primarily to areas of high potential of sustainability bringing benefits to national economy.

Support of Basic Research

Since there is a low chance to obtain funding from GA CR to support space related projects in general and there is practically no direct continuation of this basic stage of research in its further stages, the use of the funding for space activities is very limited. **The systematic approach to support the space R&D is needed in the Czech Republic because no complex tool of support of the space activities respecting their specificities exists nowadays.**

Support of Applied, Security and Defence Applied Research

The systematic approach to support the space R&D is needed in the Czech Republic because no complex tool of support of the space activities respecting their specificities exists nowadays.

Support of International cooperation in R&D

Since the present programmes also support activities which in practice duplicate the activities of public authorities in space, there is the need to avoid this trend in future.

There is also the need to more efficiently use the present frameworks of support of the international cooperation in R&D to motivate Czech entities to cooperate with their foreign counterparts and create stable consortia to be further active e.g. in programmes of EU or ESA.

7.5.4.2 ESA

7.5.4.2.1 Mandatory activities

Participating in science missions, industrial teams – in order to acquire high added value tasks that have the promise of building new industrial capabilities – need to be prepared well in advance in various optional programmes of ESA.

Due to the nature of the mandatory activities focused on the development or use either very low or very high TRL, there is a need to significantly increase the contribution to ESA optional programmes to be able to develop capacities and capabilities especially in middle TRL and from this perspective to promote the sustainable participation in mandatory activities and ensure the balanced geo-return of the mandatory contribution of the Czech Republic to ESA.

There is apparent problem of "the valley of death" where developments started in low-TRL technology programmes are not matched with appropriate funding to reach high-TRL levels and eventually be used. This has to be controlled by coordination between all national players already from the early stages of their involvement in low-TRL activities like those in TRP programme.

Earthnet

Mainly the users from academia should maximise benefits from the opportunity of access to unique data collected in frame of Earthnet.

7.5.4.2.2 Earth Observation

Earth Observation Envelope Programme (EOEP)

With reference to the wide range of opportunities in frame of this programme and considering the capacities of Czech academia and industry, **the Czech Republic should if possible increase the share in EOEP in the future.** EOEP is the backbone programme of EO activities in ESA. Most of the EO missions, both scientific (Earth Explorers) and operational (Earth Watch and Sentinels), start on elements of this programme. Considering the existing involvement and potential capacities of Czech subjects, keeping and possibly increasing the level of the current contribution should be considered as a necessary base for the future. The need to increase the contribution in this programme becomes even more important with the transfer of the Copernicus space assets (Sentinel satellites) to the EU. In this situation the only leverage available to the Czech Republic in Copernicus will be through EOEP.

MetOp Second Generation (MetOp-SG)

MetOp-SG programme is oversubscribed from very beginning. Currently (2014) it is recommended to the industry to join to the consortia and bid the tenders at the earliest stages possible. Due to the contribution of EUMETSAT it is very interesting programme from the return on investment point of view. Czech industry proved the capabilities to participate in this kind of programmes (see MTG). Due to the possible benefits, **the Czech contributions to this kind of programmes should significantly increase.**

Meteosat Third Generation (MTG)

This kind of programmes is very interesting from the return-on-investment point of view and Czech industry has been very successful in this programme. Due to the possible benefits, **the Czech contributions to this kind of programmes should significantly increase.** Due to the current (2014) phase of MTG programme, when most of the MTG satellites are in the middle of construction should be recommended, the industry involved in MTG development projects should keep the touch with their partners in respective consortia to the future, because the recurrent satellites will be constructed.

GMES Space Component (GSC)

GSC is focused on definition of the overall system architecture, ensuring the technical coordination of the Copernicus Space Component and its evolution. The prototypes of Sentinels, dedicated Copernicus missions, are prepared in frame of this programme. Recurrent Sentinels will be covered by EU sources.

The Sentinels family comprise very diverse satellites. Each Sentinel has very different parameters to fulfil very different targets. It is expected starting of preparations activities for new generation of Sentinels to cover the needs of Copernicus beyond 2030.

New specific technologies for European EO missions should be developed. It could be expected part of this technologies will be used e.g. for next generation of Sentinels and other European EO satellites.

This kind of programmes is very interesting from the return on investment point of view. Czech industry proved the capabilities to participate this kind of programmes (see MTG). **Czech contribution to this kind of programmes should be recommended in the future.**

From this reasons it is recommended to increase the contribution to GSC and it is necessary to continue the Czech participation in this programme in the future.

7.5.4.2.3 Telecommunications

ARTES 1 (Preliminary Studies and Investigations)

Given the strategic nature of the element and the potential to be “at the beginning” of activities, **Czech Republic should contribute at least 0.5% of the total envelope of the element.**

ARTES 3-4 (ESA Telecom – products)

When talking about functioning market within the space endeavour, it is the telecommunication market always mentioned as the most mature one. Element ARTES 3-4 is a well-defined tool for supporting close-to-market products. **Even though co-funded by industry at least by 50 %, the subscription to this element should be at least at the same level as to the element ARTES 5, as it is ideal tool for continuation of activities concluded within ARTES 5.**

ARTES 5.1 (ESA Telecom – Technology)

Being the core and generic technology element of the whole ARTES programme, it might be perceived as the most important one. **It is strongly recommended to multiply the contribution by factor of 2-4 the ARTES 5.1 subscription and enter the sub-element ARTES 5.2 with equivalent amount, as it stimulates industry in proposing own ideas.**

ARTES 10 (Iris)

In order to secure already made investments and keep a momentum, at least 10% share of the total envelope should be kept within the element, with focus on multi-purpose user terminal as minimum, if IRIS leads to an operating system and if the terminals are a Czech product.

ARTES 14 (Neosat, NGP)

If a promising opportunity (leading to qualified product) emerges exceeding the current subscription during the course of the programme, additional subscription shall be made, as enabled by implementing rules of the element currently in force.

ARTES 20

The element is a genuine tool for supporting integrated applications - that is not only telecom, but also EO and navigation downstream technologies. **At least 1% of the total envelope should be subscribed, with focus on Czech or (Central) European solutions.**

7.5.4.2.4 Satellite Navigation

European GNSS Evolution Programme (EGEP)

As the satellite navigation R&D transition to the EU funded HSNAV programme starting 2015, attention should be paid to awareness raising about the opportunities within this programme. It should be noted that in HSNAV the geo-return policy will not be used. If the EGEP programme is after all extended, the Czech Republic should subscribe it with amount at least equal to 1% of the programme´s envelope.

7.5.4.2.5 Technology

General Support Technology Programme (GSTP)

The GSTP programme plays essential role in turning a promising technology to a qualified product. In addition it is a tool for doing this in an international cooperation which is essential for Czech industry given many Czech products are being developed in close partnership with foreign companies. For this reason, **the GSTP must be a complementary counterpart of the national space programme with about the same level of funding i.e. €12-15 million per 3-year interval.**

7.5.4.2.6 Launchers

Future Launchers Preparatory Programme (FLPP)

The demand for projects from industry and academia exceeds the available resources, but these projects (if successful) can bring large long-term financial benefits and strongly increase competitiveness of Czech industry and thus secure its financial stability and sustainability. **It is strongly recommended to at least triple FLPP support (€3-4 million) allowing for completion of the already started activities. Further it is recommended to subscribe to Ariane 5ME and/or Ariane 6 and Vega, with amount of €6-8 million combined, as it stimulates industry to penetrate supplier chains of ESA launchers with qualified products.**

7.5.4.2.7 Human Space Flights, Microgravity and Exploration

European Programme for Life and Physical Sciences and Applications in Space (ELIPS)

Even after decrease of the subscription in 2012, the overall amount subscribed in ELIPS is high and limited in terms of accessibility to companies-newcomers. This is also a scientific and technological area with the smallest "return-on-investment". For this economic reason **the subscription should be further decreased for the next subscription period, however the subscription should be kept non-zero in order to enable participation of Czech industry in ESA tenders allowing access to funds contributed to earlier in 2008 and 2012.**

Mars Robotic Exploration Preparation (MREP)

The programme contains wide range of technological projects – some with very low return-on-investment potential and some with rather high one. Further support to the programme and exploration missions in general should be made if and only if specific high- return-on-investment technologies are identified well in advance the subscription hand in hand with programme management. **Small subscription allowing for opportunistic participation can be made if funds are available but generally is not desirable vis-à-vis other opportunities in ESA. Recalling the funding problems of ExoMars mission, the subscriptions to exploration programmes are only advisable if affordability of Member States allows for end-to-end mission funding.**

7.5.4.2.8 Space Situational Awareness

Space Situational Awareness (SSA)

Participation in SST may use the funds today available in SSA.

The institutional setting among ESA, EU and their Member States is currently not very clear for an operational system. This has to be taken into account when considering the involvement of the Czech Republic.

Depending on capabilities of Czech entities within the Period 2, corresponding subscription shall be made for Period 3 foreseen for 2017 onwards.

7.5.4.2.9 Space science oriented

PRODEX

The programme should be further supported and subscribed. Within the current funding level it is rather difficult to take role of principal investigator of major scientific instrument. Has the Czech Republic such an ambition, the funding should be increased. In any case the contribution should be maintained at the level of €1.5 to 2 million per year. Financial resources of PRODEX programme should be used to develop and implement scientific payloads (HW and SW) while data analysis funding should be obtained from the normal national R&D budgets.

The possibility to use the internal financial resources of academia to co-fund PRODEX activities should be further explored.

7.5.4.3 EU

Copernicus

The Czech Republic should maximise the benefits of Copernicus. It is strongly recommended use the Copernicus data across the sectors (public, business, academia). Enabling this purpose the „National supportive tools" should be able to support the development of new high-added value services and applications. For securing the best possible Sentinels data access on national level the appropriate measures should be taken (e.g. build the Sentinels data mirror site covering the needs of Czech users, ensuring the technical equipment needed for using of data and services on public sector etc.).

Especially in the field of environment, transport, agriculture, urban development etc. the Copernicus data and services could be the tool for fulfilling of the targets of national policies.

To maximise the benefits from Copernicus core services is needed to build appropriate national structure for activation and exploitation of respective core service, especially in case of Emergency Management Service.

Galileo

Increasing competitiveness of the industry stemming from participation in the ESA programmes should lead to gradual involvement in the activities of the programme. **Important aspect would be involvement in activities of HSNAV programme within the Horizon 2020, which highly increase the chances to be successful in EGNSS bids. Therefore, industry should be encouraged to get involved in both programmes as soon as their competiveness increase.**

Horizon 2020

The Czech Republic should examine all possible ways how to increase the participation of Czech entities in Horizon 2020. The set-up of a link, for leverage, between ESA optional programmes and EU activities supported by Horizon 2020 has to be implemented. The Czech Republic should better coordinate the preparation of its official positions concerning the implementation of the Horizon 2020 to be able to maximize the potential use of Czech capacities and capabilities in line with the NSP.

Also other priorities of Horizon 2020 can be used to support of space R&D. The concrete opportunities should be further explored by Czech entities.

7.5.4.4 EUMETSAT

The membership in EUMETSAT is for the Czech Republic of the key importance due to the unique opportunity to obtain data, images and basic satellite products for meteorology and climatology, to use services which it provides and to participate in other EUMETSAT activities.

Meteosat Second Generation (MSG)

Until the end of the MSG programme and in the frame of CHMI official duties, it is necessary to continue in operational utilization of the image data and retrieved data products from the MSG satellites. **In collaboration with other national institutions, as well as within the frame of EUMETSAT R&D activities, the progress towards the transition from MSG to MTG programmes should be facilitated. Transfer to the MTG data and retrieved data products utilization should be ensured as quickly as possible** (within the frame of CHMI official duties**), after these become operationally available.**

EUMETSAT Polar System (EPS)

Until the end of the EPS programme and within the frame of CHMI official duties, **it is necessary to continue in operational reception and utilization of the direct readout image data from the MetOp satellites and to implement data products** (namely from the new atmospheric sounders) which have not been utilized in CHMI so far.

8 ANNEX

A. LIST OF SOURCES

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SpaceTec, European Earth Observation and Copernicus Downstream Services Market Study – Executive summary, 2012

SpaceTec, European Earth Observation and Copernicus Midstream Market Study (Final Extended Executive Summary), 2013

B. ABBREVIATIONS

A/C	Aircraft
ALV	Association of Aerospace Manufacturers of the Czech Republic
AMSP	Association of Small and Medium-Sized Enterprises and Crafts of the Czech Republic
ARTES	Advanced Research in Telecommunications Systems
ASCR	Academy of Sciences of the Czech Republic
ASD	AeroSpace and Defence Industries Association of Europe
ATM	Air Traffic Management
B2G	Business-to-government
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CENIA	Czech Environmental Information Agency
CERN	European Organization for Nuclear Research
CIIS	Czech Industry Incentive Scheme
CM	ESA Council at ministerial level
CMZR Bank	Czech-Moravian Guarantee and Development Bank
CNES	French National Space Agency
COI	Community of Interest
COPUOS	UN Committee on the Peaceful Uses of Outer Space
CSA	Czech Space Alliance
CTO	Czech Telecommunication Office
CTP	Science Core Technology Programme
CZEPOS	Czech network of GPS stations
EATMS	European Air Traffic Management System
EC	European Commission
ECI	European Component Initiative
ECMWF	European Centre for Medium-Range Weather Forecasts
ECSS	European Cooperation for Space Standardization
EDA	European Defence Agency
EDRS	European data relay system
EE	Earth Explorer Component
EGAP	Export Guarantee and Insurance Corporation
EGEP	European GNSS Evolution Programme
EGNOS	European Geostationary Navigation Overlay Service
EISC	European Interparliamentary Space Conference
ELIPS	European Programme for Life and Physical Sciences and Applications in Space
EO	Earth Observation
EOEP	Earth Observation Envelope Programme
EOP	Employment Operational Programme

EPO	European Patent Office
EPS	EUMETSAT Polar System
ESA BIC	ESA Business Incubation Centres
ESA LTP	ESA Long Term Plan
ESA	European Space Agency
ESERO	European Space Education Resource Office
ESIF	European Structural & Investment funds
ESO	European Southern Observatory
ESOs	European Standardization Organizations
ESTEC	European Space Research and Technology Centre
ETSI	European Telecommunications Standards Institute
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EUSC	European Union Satellite Centre
FLPP	Future Launchers Preparatory Programme
GA CR	Czech Science Foundation
GDP	Gross domestic product
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GMDSS	Global Maritime Distress and Safety System
GMES	Global Monitoring for Environment and Security
GNI	Gross National Income
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSA	European Global Navigation Satellite System Agency
GSC	GMES Space Component
GSP	General Studies Programme
GSTP	General Support Technology Programme
GTO	Geostationary transfer orbit
HSNAV	Horizon 2020 Satellite Navigation Programme
CHMI	Czech Hydrometeorological Institute
ICAO	International Civil Aviation Organization
ICTs	Information and communication technologies
IMO	International Maritime Organization
IMSO	International Mobile Satellite Organization
INSPIRE	Innovation in Science Pursuit for Inspired Research
IP	Intellectual Property
IPR	Intellectual Property Rights
IROP	Integrated Regional Operational Programme
ISS	International Space Station
ITAR	International Traffic in Arms Regulations
ITI	Innovation Triangle Initiative

ITS	Intelligent Transport Systems
ITSO	International Telecommunications Satellite Organization
ITU	International Telecommunication Union
JAXA	Japan Aerospace Exploration Agency
LBS	Location-Based Services
LEO	Low Earth Orbit
LTCR	Long Term Capability Requirement
LTDP	Long Term Data Preservation Programme
MetOp	EUMETSAT Polar System
MetOp-SG	EUMETSAT Polar System Second Generation
MEYS	Ministry of Education, Youth and Sports
MF	Ministry of Finance
MFA	Ministry of Foreign Affairs
MIT	Ministry of Industry and Trade
MA	Ministry of Agriculture
MC	Ministry of Culture
MD	Ministry of Defence
ME	Ministry of the Environment
MH	Ministry of Health
MI	Ministry of Interior
MLSA	Ministry of Labour and Social Affairs
MOP	Meteosat Operational Programme
MT	Ministry of Transport
MRD	Ministry of Regional Development
MREP	Mars Robotic Exploration Preparation
MSG	Meteosat Second Generation Programme
MSI	International Maritime Organization
MTG	Meteosat Third Generation
NAC	North Atlantic Council
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NEOs	Near Earth Objects
NG	Next Generation
NGP	Next Generation Platform
NOAA	National Oceanic and Atmospheric Administration
NSA	National Security Authority
NSP	National Space Plan
OBPS	On-board platform systems
OECD	Organisation for Economic Co-operation and Development
OP PPR	Operational Programme Prague – Growth Pole of the Czech Republic
OP RI&E	Operational Programme Research, Innovation and Education
OPE	Operational Programme Environment
OPEIC	Operational Programme Enterprise and Innovation for

	Competitiveness
OPT2	Operational Programme Transport 2
PECS	Programme for European Co-operating States
PRODEX	Programme de Développement d'Expériences scientifiques
R&D	Research and Development
ROI	Return on Investment
RPAS	Remotely Piloted Aircraft Systems
RPAS	Remotely Piloted Aircraft Systems
S/C	Spacecraft
SARPs	Standards and Recommended Practices
SBAS	European Satellite Based Augmentation System
SDT	Association for Transport Telematics
SESAR	Single European Sky Air Traffic Management Research
SME	Small and medium enterprises
SSA	Space Situational Awareness
STG	Scientific and technical group
STO	Science and Technology Organization
TA CR	Technology Agency of the Czech Republic
TPM	Third Party Missions
TRL	Technological Readiness Level
TRP	ESA's Technology Research Programme
TTP	Technology Transfer Programme
UNOOSA	UN Office for Outer Space Activities
VHR	Very High Resolution
WMO	World Meteorological Organization
WRC	World Radiocommunication Conference
WTO	World Trade Organization
YGT	Young Graduate Trainee Programme

C. LIST OF FIGURES

D. PARTICIPATION OF THE CZECH REPUBLIC IN THE ESA OPTIONAL PROGRAMMES (CM08 AND CM12)

ESA Optional Programmes (CM08)	Commitments from 2008 (in mil. €)	Programme period
MTG (Meteosat Third Generation)	2.240	2009 - 2020
EOEP-3 (Earth Observation Envelope Programme)	2.610	2009 – 2012
GSC 1&2 (GMES Space Component)	1.760	2009 - 2018
ARTES 1.V (Element 1: Preliminary Studies and Investigations)	0.120	2009 - 2013
ARTES 3-4.I (Element 3: Products)	0.261	2009 - 2013
ARTES 5.1.I (Element 5: ESA Telecom Technology), Sub-element 5.1	1	2009 - 2013
ARTES 10.II-1 (Element 10: Iris)	4.279	2009 - 2011
ARTES 20.I (Element 20: Integrated Applications Promotion)	0.470	2009 - 2013
FLPP 2 (Future Launcher Preparatory Programme)	0.500	2009 - 2012
ELIPS-3 (European Programme for Life and Physical Sciences and Application in Space)	2.770	2009 - 2012
ETHE (The European Transportation and Human Exploration Preparatory Activities Programme)	0.190	2009 - 2012
EGEP (European Global Navigation Satellite Systems Evolution Programme)	0.480	2009 - 2011
GSTP-5 (General Support Technology Programme)	3.230	2009 - 2012
PRODEX (Scientific Experiment Development Programme)	3	2009 - 2015

ESA Optional Programmes (CM12)	Commitments from 2012 (in mil. €)	Programme period
MetOP-SG (Met-Op Second Generation Programme)	3	2013 - 2022
EOEP-4 (Earth Observation Envelope Programme)	4.230	2013 - 2016
ARTES 1 (Element 1: Preliminary Studies and Investigations)	0.1	2013 - 2016
ARTES 5 (Element 5: ESA Telecom Technology), Sub-element 5.1	1	2013 - 2016

ARTES 14 (Element 14: Next Generation Platform Element)	2	2013 - 2016
ARTES 20 (Element 20: Integrated Applications Promotion)	0.5	2013 - 2017
FLPP 3 (Future Launcher Preparatory Programme)	1	2015 - 2015
ELIPS-4 (European Programme for Life and Physical Sciences and Application in Space)	1	2013 - 2015
MREP-2 (European Space Exploration Programme – Aurora, Mars Robotic Exploration Preparation Component)	0.8	2013 - 2017
EGEP (European Global Navigation Satellite Systems Evolution Programme)	0.5	2013 - 2015
SSA- SWE/NEO (Space Situational Awareness Programme)	0.7	2013 - 2016
GSTP-6 (General Support Technology Programme)	5	2013 - 2017
PRODEX (Scientific Experiment Development Programme)	10,5	2013 - 2020

E. PARTICIPATION OF THE CZECH REPUBLIC IN THE NEW OPTIONAL ESA PROGRAMMES

No.	Project	Participant	Value [k €]	Programme relation
1	Euclid PLM thermal analyses	L.K.Engineering	426	Science programme
2	RPW - Radio and Plasma Wave Instrument - Low Voltages Power Supply and Power Distribution Unit (Solar Orbiter) Phase C/D	Astronomical Institute, AS CR; CSRC	1500	Science programme
3	STIX - Spectrometer/Telescope for Imaging X-rays (Solar Orbiter) - Phase C/D	Astronomical Institute, AS CR; CSRC	955	Science programme
4	LISA - High-power Laser Head for a Gravitational Wave Observatory Mission	CSRC	208	Science programme
5	Assessment of existing plastic optical fibres and associated connectors for launcher application	Optokon	200	TRP
6	Infrared advanced polarizer for space applications	BBT	200	TRP
7	Support to Topology (STO)	GISAT	20	TRP
8	Ultra-Wideband as a multi-purpose and reliable wireless communication technology for tests, spacecraft and launchers	Honeywell International	760	TRP
9	Flex/Sentinel-3 Tandem Mission Photosynthesis study	CzechGlobe	25	GSP
10	Flex phase A/B - Fluorescence sensor verification campaign	CzechGlobe	25	GSP
11	Generic adhesive for Space application	5M	200	CIIS, relation to TRP
12	New acousto-optic device based on Calomel for hyperspectral imaging in space applications NAOMI	BBT	200	CIIS, relation to EOEP
13	PalDMC	Iguassu Software Systems	200	CIIS, relation to EOEP
14	Integrated snow monitoring with uncertainty analysis (ISTAS)	GISAT	100	CIIS, relation to EOEP
15	Distributed Raster Processing Framework (DRPF)	Iguassu Software Systems	195	CIIS, relation to EOEP
16	Processing systems for continuous monitoring of Terrestrial Exosystem Dynamics from Sentinel-2	GISAT	174	CIIS, relation to EOEP
17	Solar Array Deployment Mechanism Industrialization	Frentech Aerospace	344	CIIS, relation to ARTES 5
18	Calibration system for the transportable laser communication terminal	ProjectSoft HK	186	CIIS, relation to ARTES 7
19	Autonomous alignment system for transportable advances laser communication ground stations	Projectsoft HK	199	CIIS, relation to ARTES 8
20	New Generation Multimedia Antenna Deployment and Pointing Mechanism	Frentech Aerospace	1000	CIIS, relation to ARTES 14
21	5M composite technology evaluation	5M	54	CIIS, relation to ARTES 14
22	Real-time Performance Monitoring Tool	Iguassu Software Systems	200	CIIS, relation to EGEP
23	User Autonomous Integrity Monitoring	Honeywell International	100	CIIS, relation to EGEP
24	Multi-Constellation Long-Term GNSS Assesment	Iguassu Software Systems	199	CIIS, relation to EGEP
25	Evolution and industrialization of a SBAS Real-Time Perfomance Monitoring Tool (EVORA)	Iguassu Software Systems	200	CIIS, relation to EGEP

26	Preparatory Activities for MTG Participation	CSRC	120	CIIS, relation to ELIPS
27	The qualification of the system of pyroneutralisation cutting charges for Ariane-5 launcher	Explosia	351	CIIS, relation to FLPP
28	Epoxy Core Development	Synpo	200	CIIS, relation to FLPP
29	Urban Atlas+	GISAT	183	CIIS, relation to GSC
30	Study of SCOS-2000 deployment over WAN for a concept of CMCP	ANF DATA	173	CIIS, relation to GSTP
31	Hermetically Sealed Low ESR Tantalum Capacitor (Flight Hardware Activity)	AVX Czech Republic	454	CIIS, relation to GSTP
32	Real-time Extrapolation Methods for Thermal Testing/Transient Extrapolation Activities	L.K. Engineering	80	CIIS, relation to GSTP
33	Transient Objects for M&C in GSSC/GMMI	ANF DATA	100	CIIS, relation to GSTP
34	SMT Assembly Verification Programme According to ECSS-Q-ST-70-38	CSRC	120	CIIS, relation to GSTP
35	Study on alternative Technologies for Gyroscopes	Honeywell International	100	CIIS, relation to GSTP
36	Design of Spacecraft Components for additive manufacturing	L.K. Engineering, VUT Brno	180	CIIS, relation to GSTP
37	ESA qualification process of SMD hand soldering of flight level printed circuit boards manufactured by G.L. Electronics	G.L. Electronics	145	CIIS, relation to GSTP
38	Technology development of flexible tape spring boom for large appendages deployment	5M	200	CIIS, relation to GSTP
39	Upgrade of the lightweight monitoring system (LMS) for the GSMC-EMC	Siemens Convergance Creators	97	CIIS, relation to GSTP
40	MEMS Gyroscope Breadboard	Honeywell International	200	CIIS, relation to GSTP
41	Development of Epoxy based Syntactic Foam Encapsulant	Toseda	200	CIIS, relation to TRP a GSTP
42	Development of a new generation hinge for large appendices	Frentech Aerospace	832	CIIS, relation to GSTP, ARTES
43	Langmuir Probe Experiment (LPE)	Astronomical Institute, AS CR	30	CIIS, relation to PRODEX
44	Preparatory Study Of Digital Plasma Wave Analyser Technology For Cosmic Vision Spacecraft	Institute of Atmospheric Physics, AS CR	83	CIIS, relation to PRODEX
45	Neutron Facilities in the Czech Republic for Calibration and Testing of ESA Compliant Neutron Sensitive Devices	Institute of Experimental and Applied Physics, Czech Technical University (CTU)	85	CIIS, relation to PRODEX
46	Laboratory Wide Dynamic Range Gamma-Ray Calibration Facility	Institute of Experimental and Applied Physics, CTU	148	CIIS,relation to PRODEX
47	Highly Miniaturized and Sensitive Thermal Neutron Sensor	Institute of Experimental and Applied Physics,CTU	178	CIIS, relation to PRODEX
48	DSLP operations on Proba 2 - raw data processing and archiving	Astronomical Institute, AS CR	50	CIIS, relation to PRODEX
49	SATRAM: Space Applications of Timepix-Based Universal Radiation Monitor	CSRC	948	CIIS, relation to PRODEX
50	Portable calibration gamma-ray source	Institute of Experimental and Applied Physics, CTU	64	CIIS, relation to PRODEX
51	Contribution to ASPIICS coronagraph on board Proba 3 mission of ESA	VZLU	150	CIIS, relation to PRODEX
52	Design of the Power SCOE for EUCLID	Siemens Convergance Creators	350	CIIS, relation to Science programme

53	Design of the SVM Electrical Simulator for EUCLID	Iguassu Software Systems, CSRC	300	CIIS and Science programme
54	Design, manufacturing and qualification of mechanical elements for EUCLID	5M (Contract negotiation in process)	400	CIIS and Science programme
55	Qualification of MAG boom for JUICE	Frentech Aerospace, 5M, Serenum, L.K. Engineering, VZLU, (Contract negotiation in process)	1500	CIIS and Science programme
56	Qualification of shielding applied to structural panel for JUICE	5M, VZLU, TTS (Contract negotiation in process)	350	CIIS and Science programme
57	Control and Tracking System for ground station antenae	ProjectSoft HK	256	CIIS, relation to SSA
58	Development of Test facility dedicated to passive components	EGGO Space	92	CIIS, relation to TRP
59	Embedded SMD Tantalum Capacitor Development	AVX Czech Republic	199	CIIS, relation to TRP
60	Cement factory monitoring in Ethiopia for European Investment Bank	GISAT	50	EOEP
61	EOWORLD, Services For World Bank Projects	GISAT	99	EOEP
62	GOCE+ GeoExplore II	University of West Bohemia	70	EOEP
63	Innovative EO Derived Information Services for Operational European and International Agencies	GISAT	95	EOEP
64	Magnetic signatures of barotropic and baroclinic Ocean Flows in Swarm Data	Charles University	100	EOEP
65	SWARM microaccelerometers	VZLU	1415	EOEP
66	MTG - GeoSAR	Evolving Systems Consulting	180	MTG
67	Cryogenics for MTG (Cryostat Structure)	Frentech Aerospace	1864	MTG
68	CryoCooler Supporting Assembly	Frentech Aerospace s.r.o.	2177	MTG
69	Data Handling Satellite SCOE	Siemens Convergance Creators	150	MTG
70	Payload Data Downlink SCOE	Siemens Convergance Creators	175	MTG
71	GMES Sentinel-4/UVN Phase B and C/D UVN Data Evaluation EGSE (UDEE)	Siemens Convergence Creators	207	GSC
72	GMES Sentinel-4/UVN, Performance Assessment Tools	Evolving Systems Consulting	229	GSC
73	Platform Interface Simulator Assembly (PISA) of the Sentinel-4 UVN Instrument	Siemens Convergence Creators	123	GSC
74	Emerging system concepts for UAS command and control (C2) via satellite: a pre-WRC-2011 system study	Honeywell International	54	ARTES 1
75	Detailed survey of the telecommunication industry of the Czech Republic and of the ESA European Cooperating States	BIC - R&D	15	ARTES 1
76	Propagation models for interference and frequency coordination analyses	CTU, Czech Metrology Institute	252	ARTES 5
77	Evaluation of supercapacitors and impacts at system level	EGGO Space, CSRC	277	ARTES 5
78	High performance tanks with in-situ health monitoring	Honeywell International, CTU	116	ARTES 5

79	Iris System Design Phase B (ANTARES)	Honeywell International	2 350	ARTES 10
80	Iris System Design Phase B (ANTARES)	Iguassu Software Systems	198	ARTES 10
81	Iris System Design Phase B (ANTARES)	Evolving Systems Consulting	411	ARTES 10
82	Iris Airborne Terminal Prototype	Honeywell International	300	ARTES 10
83	3InSat	AŽD Praha	120	ARTES 20
84	SAFETREE – Satellite support to ForEsT fiREs airbornE patrol	GISAT, Sprinx Systems	110	ARTES 20
85	Improvement of the Safety at Railway Level Crossings	CGI	20	ARTES 20
86	Safety and Information Services for Ski Resorts	BIC - R&D, GINA Software	130	ARTES 20
87	DROMAS - agricultural DROught Monitoring and Assessment driven by Satellites	GISAT, Ekotoxa, Czech University of Life Sciences Prague	140	ARTES 20
88	Design and Development of Interference Monitor System for GNSS Reference Stations	Iguassu Software Systems	116	EGEP
89	SBAS Simulator Upgrade	Iguassu Software Systems	149	EGEP
90	SatellitE Navigation Data mIning (SENDAI)	Iguassu Software Systems	149	EGEP
91	Adhesive Bonding of Thermoplastic Composites	5M	100	FLPP
92	Advanced Nozzle Extension Design Methodology	CTU	78	FLPP
93	Expander Technology Integrated Demonstrator	CTU	190	FLPP
94	Flutter Design & Analyses Engineering	L.K. Engineering	69	FLPP
95	Flutter Test Execution in Wind Tunnel Test facilities	VZLU	139	FLPP
96	Leak resistant liners for LH2 and LOX	Synpo	100	FLPP
97	Resin development for cryogenic applications	Toseda	100	FLPP
98	Thermo-Mechanical Evaluation of Lunar Lander Thruster Platform	L.K. Engineering	130	ETHE
99	ERC dynamic stability via balloon drop tests	Frentech Aerospace	45	MREP
100	European Laser Timing (ELT)	CSRC, CTU	449	ELIPS
101	Advanced Integration and Test Services (AITS)	ANF DATA	100	GSTP
102	Decision Support and Real Time EO Data Management (DREAM)	GISAT, ANF DATA	350	GSTP
103	New acousto-optic device based on Calomel for hyperspectral imaging in space applications - NAOMI	BBT, CTU	390	GSTP
104	IMA for Space: Development of Inflight Hosted prototype Application (IMA-DEV)	Evolving Systems Consulting	179	GSTP
105	On-Board Software Reference Architecture Consolidation	Evolving Systems Consulting	100	GSTP
106	On-Board Software Reference Architecture Consolidation	Charles University	10	GSTP

107	Open-standard Online Observation Service (O3S)	ANF DATA , Iguassu Software Systems	141	GSTP
108	Operational Data Off-line Analysis Correlation and Reporting System	ANF DATA	180	GSTP
109	Requirements and i/f definition for future OBCP building block	Evolving Systems Consulting	68	GSTP
110	Tailor-designed carbon nanotubes for superior composites	Synpo	150	GSTP
111	SABIP (Space based ADS-B Payload Development for Air Traffic Surveilance)	CSRC	178	GSTP
112	NEO observations with Cooperating Sensors	Observatory Klet	60	SSA
113	Demonstration Test-Bed for the Remote Control of an Automated Follow-Up Telescope (SSA-TBT)	Iguassu Software Systems	80	SSA
114	ASPIICS - Solar Optical Coronagraph (Proba-3) - Phase B	Astronomical Institute, AS CR	25	PRODEX
115	ASPIICS (PROBA-3, phase C/D)	Astronomical Institute, AS CR	720	PRODEX
116	Assessment level studies of the radio and plasma waves instrument (EJSM/Laplace)	Institute of Atmospheric Physics, AS CR	25	PRODEX
117	JUICE - RPW/LFR (phase A/B1)	Institute of Atmospheric Physics, AS CR	91	PRODEX
118	JUICE - RPW/LFR (commitment C/D)	Institute of Atmospheric Physics, AS CR	1015	PRODEX
119	JUICE - RPW/LVPS (phase A/B1)	Astronomical Institute, AS CR	173	PRODEX
120	JUICE - RPW/LVPS (commitment C/D)	Astronomical Institute, AS CR	1003	PRODEX
121	METIS - (Solar Orbiter) - Phase B	Astronomical Institute, AS CR	85	PRODEX
122	METIS - (Solar Orbiter) - Phase C/D	Astronomical Institute, AS CR; Institute of Plasma Physics AS CR (TOPTEC)	413	PRODEX
123	PAS/SWA - Development of Detector Electronics for the Proton/Alpha Sensor of Solar Wind Plasma Analyzer (Solar Orbiter) - Phase B	Charles University	38	PRODEX
124	PAS/SWA - Development of Detector Electronics for the Proton/Alpha Sensor of Solar Wind Plasma Analyzer (Solar Orbiter) Phase C/D	Charles University	116	PRODEX
125	RPW - Radio and Plasma Wave Instrument - Low Voltages Power Supply and Power Distribution Unit (Solar Orbiter) - Phase B	Astronomical Institute, AS CR, CSRC	150	PRODEX
126	RPW - Radio and Plasma Wave Instrument - Low Voltages Power Supply and Power Distribution Unit (Solar Orbiter) Phase C/D	Astronomical Institute, AS CR	92	PRODEX
127	RPW - Radio and Plasma Wave Instrument - Time Domain Sampler (Solar Orbiter) - Phase B	Institute of Atmospheric Physics, AS CR	102	PRODEX
128	RPW - Radio and Plasma Wave Instrument - Time Domain Sampler (Solar Orbiter) - Phase C/D	Institute of Atmospheric Physics, AS CR	680	PRODEX
129	Scientific and payload assessment study (EJSM-JGO)	Astronomical Institute, AS CR	25	PRODEX
130	STIX - Spectrometer/Telescope for Imaging X-rays (Solar Orbiter) - Phase B	Astronomical Institute, AS CR, CSRC	250	PRODEX
131	STIX - Spectrometer/Telescope for Imaging X-rays (Solar Orbiter) - Phase C/D	Astronomical Institute, AS CR	711	PRODEX

F. 7TH FRAMEWORK PROGRAMME SPACE

No.	Project	Participant	Activity relation
1	MACC	Czech Hydrometeorological Institute	Global Monitoring of Environment and Security
2	GEOLAND2	GISAT	Global Monitoring of Environment and Security
3	AEROFAST	Kybertec	Strengthening Space Foundations
4	SAFER	GISAT	Global Monitoring of Environment and Security
5	COSMOS	Technology Centre of AS CR	Coordinating and Support Actions
6	PROVISG	Czech Technical University in Prague	Strengthening Space Foundations
7	G-MOSAIC	GISAT	Global Monitoring of Environment and Security
8	ISP-1	Czech Technical University in Prague	Strengthening Space Foundations
9	PROVISCOUT	Czech Technical University in Prague	Strengthening Space Foundations
10	RASTAS SPEAR	Kybertec	Strengthening Space Foundations
11	SP4ESP	Charles University in Prague	Coordinating and Support Actions
12	HELM	CENIA, Czech Environmental Information Agency; GISAT	Global Monitoring of Environment and Security
13	ATMOP	Kybertec	Strengthening Space Foundations
14	PANGEO	Czech Geological Survey	Global Monitoring of Environment and Security
15	SPARTAN	Brno University of Technology	Strengthening Space Foundations
16	MAGDRIVE	CAN SUPERCONDUCTORS	Strengthening Space Foundations
17	GRAAL	GISAT	Global Monitoring of Environment and Security
18	SWIFF	Astronomical Institute AS ČR	Strengthening Space Foundations
19	COSMOS+	Technology Centre of AS CR	Coordinating and Support Actions
20	SHOCK	Astronomical Institute AS ČR; SPRINX Systems	Strengthening Space Foundations
21	MAARBLE	Institute of Atmospheric Physics AS CR	Strengthening Space Foundations
22	PROVIDE	Czech Technical University in Prague	Strengthening Space Foundations
23	G-NEXT	GISAT	Global Monitoring of Environment and Security
24	SHEE	Sobriety; Space Innovations	Strengthening Space Foundations
25	STRONGGRAVITY	Astronomical Institute AS ČR	Strengthening Space Foundations
26	F-CHROMA	Astronomical Institute AS ČR	Strengthening Space Foundations

G. INTERNATIONAL AGREEMENTS AND TREATIES RELATED TO SPACE

1) International Treaties Related to 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

Convention on Registration of Objects Launched into Outer Space

Convention for the Establishment of a European Space Agency

Agreement between the Czech Republic and the European Space Agency concerning the Accession of the Czech Republic to the Convention for the Establishment of a European Space Agency and Related Terms and Conditions

Agreement between the States Parties to the Convention for the Establishment of a European Space Agency and the European Space Agency for the Protection and the Exchange of Classified Information

Treaty on European Union and Treaty on the Functioning of the European Union

Convention for the Establishment of a European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)

Protocol on Privileges and Immunities of the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)

Amending Protocol to the Convention for the Establishment of a European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)

Convention establishing the European Organisation for Astronomical Research in the Southern Hemisphere

Agreement between the Government of the Czech Republic and the European Organisation for Astronomical Research in the Southern Hemisphere concerning the Accession to the Convention Establishing a European Organisation for Astronomical Research in the Southern Hemisphere and Related Terms and Conditions

Protocol on the Privileges and Immunities of the European Organisation for Astronomical Research in the Southern Hemisphere

Agreement between the Ministry of Education, Youth and Sports of the Czech Republic and the European Organization for Astronomical Research in the Southern Hemisphere concerning the Payment Schedule of the Czech Republic for the European Extremely Large Telescope

Agreement on the establishment of the International System and Organization of Space Communications

Co-operation Agreement between the European Centre for medium-range weather forecasts and the Czech Republic

International Convention on Cooperation for the Safety of Air Navigation EUROCONTROL

Convention of the World Meteorological Organization

Convention on the International Maritime Organization

Convention on International Civil Aviation

Convention on the International Mobile Satellite Organization

Revised Protocol on the privileges and immunities of the International Mobile Satellite Organization

International Telecommunication Constitution and Convention

Agreement relating to the International Telecommunications Satellite Organization.

Convention establishing the European Telecommunications Satellite Organization.

2) Agreements on the Scientific and Technical Cooperation

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the Democratic Republic of Afghanistan on Scientific and Technical Cooperation

Protocol to the Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the Democratic Republic of Afghanistan on Scientific and Technical Cooperation

Agreement between the Government of the Czechoslovak Republic and the Government of the People's Republic of Albania on the exploration and utilization of iron-nickel deposits in the areas of Elbasan - Pishkash - Pogradec Albania's Republic of China

Agreement between the Czechoslovak Socialist Republic and Algeria, Democratic People's Republic on scientific and technical cooperation

Protocol between the Government of the Czechoslovak Socialist Republic and the Government of the Algerian Republic of the method of implementation of cooperation provided in Article 2, paragraphs a and b of the Agreement on scientific and technical cooperation between the two governments

Agreement on Scientific and Technological Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the People's Republic of Angola

Basic Agreement on Scientific and Technological Cooperation between the Czechoslovak Socialist Republic and the Republic of Argentina

Agreement on Scientific and Technological Cooperation between the Ministry of Education, Youth and Sports of the Czech Republic and the National Council for Scientific and Technological Research of the Argentine Republic

Agreement on Scientific and Technological Cooperation between the Ministry of Education, Youth and Sports of the Czech Republic and the Ministry of Education, Science and Technology of the Argentine Republic

Programme for Scientific and Technological Cooperation - Joint Research and Development Projects 2010-2011 (between the Ministry of Education, Youth and Sports of the Czech Republic and the Ministry of Science, Technology and Productive Innovation of the Argentine Republic)

Agreement between the Government of the Czech Republic and the Government of the Republic of Azerbaijan on economic, scientific and cultural cooperation

Agreement on the Scientific and Technical Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the People´s Republic of Bangladesh

Programme of Cooperation in Science and Technology between the Ministry of Education, Youth and Sports of the Czech Republic and the State Committee for Science and Technologies of the Republic of Belarus

Agreement on Scientific and Technological Cooperation between the Czechoslovak Socialist Republic and the Republic of Bolivia

Agreement between the Government of the Czechoslovak Socialist Republic and the Federal Executive Council Skupština Socialist Federal Republic of Yugoslavia on Scientific and Technological Cooperation

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the Republic of Botswana on Scientific and Technical Cooperation

Basic Agreement on Scientific and Technological Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the Federative Republic of Brazil

Agreement between the Government of the Czechoslovak Socialist Republic and the Federal Executive Council Skupština Socialist Federal Republic of Yugoslavia on Scientific and Technological Cooperation

Statute of the Commission for Scientific and Technological Cooperation between the Czechoslovak Republic and the People's Republic of China

Agreement between the Government of the Czech Republic and the Government of the People´s Republic of China on Scientific and Technological Co-operation

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the United Arab Republic on the Establishment of a "Committee for Economic, Scientific and Technical Cooperation" between the Czechoslovak Socialist Republic and the United Arab Republic

Agreement on Scientific and Technological Co-operation between the Czechoslovak Socialist Republic and the United Arab Republic

Basic Agreement on Scientific and Technological Cooperation between the Czechoslovak Socialist Republic and the Republic of Ecuador

Agreement between the Government of the Czechoslovak Socialist Republic and the Provisional Military Government of Socialist Ethiopia on Scientific and Technical Cooperation

Agreement on Scientific and Technical Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the Republic of the Philippines

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the French Republic on scientific and technical cooperation

Agreement on Scientific and Technical Co-operation between the Czechoslovak Socialist Republic and the Republic of Ghana

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of Grenada on Scientific and Technical Cooperation

Agreement between the Government of the Czechoslovak Republic and the Government of the Republic of Guinea on Scientific and Technological Cooperation

Agreement on Scientific and Technological Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the Republic of Guinea-Bissau

Basic Agreement on Scientific and Technological Cooperation between the Czechoslovak Socialist Republic and the Republic of Chile

Agreement between the Government of the Czechoslovak Socialist Republic and the Federal Executive Council Skupština Socialist Federal Republic of Yugoslavia on Scientific and Technological Cooperation

Agreement between Czechoslovakia and India on Scientific, Technical and Industrial Cooperation

Programme of Scientific and Technological Cooperation between the Ministry of Education, Youth and Sports of the Czech Republic and the Department of Science and Technology, Ministry of Science and Technology of the Republic of India

Agreement between the Government of the Czechoslovak Republic and the Government of the Republic of Indonesia on Scientific and Technical Co-operation

Agreement between the Government of the Czech and Slovak Federal Republic and the Government of the Italian Republic on Scientific and Technological Cooperation

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of Japan on Co-operation in the Field of Science and Technology

Agreement on Technical and Scientific Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the Yemen Arab Republic

Agreement on scientific and technological cooperation between the Czechoslovak Socialist Republic and the Cambodian People's Republic

Agreement on Scientific and Technical Co-operation between the Government of the Czechoslovak Socialist Republic and the Government of Kenya

Basic Agreement on Scientific and Technological Cooperation between the Czechoslovak Socialist Republic and the Republic of Colombia

The Agreement between the Government of the Czech Republic and the Government of the Republic of Korea on the Scientific and Technological Co-operation

Agreement between the Government of the Czechoslovak Socialist Republic and the Federal Executive Council Skupština Socialist Federal Republic of Yugoslavia on Scientific and Technological Cooperation

Basic Agreement on scientific and technical cooperation between the Czechoslovak Socialist Republic and the Republic of Costa Rica

Agreement on the establishment of the Czechoslovak-Cuban Committee for Economy and Scientific and Technical Cooperation

General conditions for scientific and technological cooperation between the Czechoslovak Socialist Republic and the Republic of Cuba

Agreement between the Federal Ministry of Transport of the Czechoslovak Socialist Republic and the Ministry of Transport of the Republic of Cuba on direct scientific and technical cooperation

Long-term programme of economic, scientific and technological cooperation and socialist economic integration between the Czechoslovak Socialist Republic and the Republic of Cuba in 2000

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the State of Kuwait on Scientific and Technical Cooperation

Agreement on Scientific and Technical Co-operation between the Government of the Czechoslovak Socialist Republic and the Government of the Republic of Cyprus

Agreement on scientific and technological cooperation between the Czechoslovak Socialist Republic and the Lao People's Democratic Republic

Agreement between the Czechoslovak Socialist Republic and the Libyan Arab Republic on Scientific and Technical Cooperation

Arrangements for direct scientific and technological cooperation between the Federal Ministry of Transport of the Czechoslovak Socialist Republic and the Ministry of Transport of the Hungarian People's Republic

Agreement between the Government of the Czech Republic and the Government of the Republic of Hungary on Scientific and Technological Cooperation

Agreement between the Government of the Czechoslovak Socialist Republic and the Federal Executive Council Skupština Socialist Federal Republic of Yugoslavia on Scientific and Technological Cooperation

Agreement between the Czechoslovak Socialist Republic and the Republic of Mali on scientific and technical cooperation

Agreement on economic, scientific and technical cooperation between the Czechoslovak Socialist Republic and the Kingdom of Morocco

Basic Agreement on Scientific, Technical and Technological Cooperation between the Government of the Czech Republic and the Government of the United Mexican States

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the People´s Republic of Mozambique on Scientific and Technical Cooperation

Statutes of the Intergovernmental Joint Commission for Economic and Scientific-Technical Cooperation / Czechoslovak Socialist Republic - Mozambique /

Agreement between the Government of the Czech and Slovak Federal Republic and the Government of the Federal Republic of Germany on Scientific and Technological Cooperation

Agreement on scientific and technical cooperation between the Czechoslovak Socialist Republic and the Republic of Niger

Agreement on Scientific and Technical Co-operation between the Czechoslovak Socialist Republic and the Federation of Nigeria

Agreement on Economic, Scientific and Technical Co-operation between the Government of the Czechoslovak Socialist Republic and the Government of the Federal Republic of Nigeria

Agreement on Scientific and Technological Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the Republic of Nicaragua National Recovery and Protocol

Basic Agreement on Scientific and Technological Cooperation between the Czechoslovak Socialist Republic and the Republic of Panama

Agreement between the Czechoslovak Socialist Republic and the Islamic Republic of Pakistan on Scientific and Technical Cooperation

Agreement on Scientific and Technological Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the Republic of Peru

Agreement between the Government of the Czech Republic and the Government of the Republic of Poland on Scientific and Technological Cooperation

Agreement between the Government of the Czech Republic and the Portuguese Republic on economic, industrial and scientific cooperation

Protocol on direct scientific and technological cooperation and collaboration between the Federal Committee for Technical and Investment Development CSSR and the National Council of Scientific Research of the Socialist Republic of Romania

Agreement between the Government of the Czech Republic and the Government of the Republic of Komi on economic and trade relations and scientific and technical cooperation

Agreement on scientific and technological cooperation between the Czechoslovak Socialist Republic and the Republic of Rwanda

Agreement on Scientific and Technical Cooperation between the Czechoslovak Socialist Republic and the Hellenic Republic

Agreement between the Government of the Czech Republic and the Slovak Republic on Scientific and Technological Cooperation

Agreement on Scientific and Technological Cooperation between the Government of the Czech Republic and the Government of the Republic of Slovenia

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the Somali Democratic Republic on Scientific and Technical Co-operation

Memorandum of Understanding on Science and Engineering Cooperation between the Ministry of Education, Youth and Sport of the Czech Republic and the National Science Foundation of the United States of America

Agreement between the Czech Republic and the United States of America for Scientific and Technological Cooperation

Agreement between the Government of the Czechoslovak Socialist Republic and the Federal Executive Council Skupština Socialist Federal Republic of Yugoslavia on Scientific and Technological Cooperation

Agreement on the Scientific and Technical Co-operation between the Czechoslovak Socialist Republic and the Republic of Sri Lanka

Agreement on Scientific and Technical Cooperation between the Czechoslovak Socialist Republic and the Syrian Arab Republic

Basic Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the Kingdom of Spain on Scientific and Technological Cooperation

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the Kingdom of Sweden on scientific and technical co-operation

Agreement on Scientific and Technological Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the Republic of Tunisia

Agreement for Co-operation in the Field of Applied Science and Technology between the Government of the Czechoslovak Socialist Republic and the Government of the United Kingdom of Great Britain and Northern Ireland

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the Socialist Republic of Vietnam on cooperation in the development of science and technology in 1990

Agreement between the Czechoslovak Socialist Republic and the Republic of Zambia on Scientific and Technical Co-operation

Programme on Economic, Scientific and Technical Cooperation between the Czechoslovak Socialist Republic and the Republic of Zambia

Agreement on Scientific and Technical Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the Republic of Zimbabwe

Agreement between the Ministry of Education, Youth and Sports of the Czech Republic and the Ministry of Education and Science of the Republic of Albania on Cooperation in the Field of Education and Science for the years 2012 – 2015

Agreement between the Ministry of Education, Youth and Sports of the Czech Republic and the Ministry of Education, Youth and Science of the Republic of Bulgaria on Cooperation in the Field of Education and Science for the years 2011 - 2014

Programme for Cultural, Educational and Scientific Co-operation between the Government of the Czech Republic and the Government of the Republic of Finland

Agreement between the Ministry of Education, Youth and Sports of the Czech Republic and the Ministry of Education and Science, Youth and Sports of Ukraine on cooperation in the field of Education and Science for the years 2012-2015

3) Agreements on the Economic Cooperation

Agreement on Economic Cooperation with Afghanistan

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of Democratic and People´s Republic of Algeria on Economic Cooperation

Basic Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the People´s Republic of Angola on Economic, Industry and Technical Cooperation

Programme of Technical-economic and Business Cooperation between the Czechoslovak Socialist Republic and the People´s Republic of Angola

Agreement between the Government of the Czech Republic and the Government of the Republic of Argentina on Economic and Industry Cooperation

Agreement between the Government of the Czechoslovak Socialistic Republic and the Government of People´s Republic of Bangladesh on Economic Cooperation

Agreement between the Government of the Czech Republic and the Government of the Belarusian Republic on Economic, Industry and Scientific and Technical Cooperation

Agreement on Technical and Economic Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of People´s Republic of Benin

Agreement between the Government of the Czech Republic and the Government of the Federal Republic of Brazil on Economic and Industry Cooperation

Agreement on Economic Cooperation between the Government of the Czech Republic and the Government of People´s Republic of China

Agreement between the Czechoslovak Socialist Republic and the Kingdom of Denmark on Economic, Industry and Technical Cooperation

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the United Arabian Republic on Foundation „Economic, Scientific and Technical Cooperation Committee between the Czechoslovak Socialist Republic and the United Arabian Republic

Agreement on Economic Cooperation between the Government of the Czechoslovak Socialist Republic and the Interim Government of the Socialist Ethiopia

Long-term Agreement on Economic, Industry and Technical Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the Republic of France

Agreement on Economic Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of Ghana

Economic Agreement between the Czechoslovak Republic and the Republic of Guinea

Agreement on Economic Cooperation between the Government of the Czech Republic and the Governmnet of the Republic of India

Agreement between the Government of the Czech Republic and the Government of the Republic of Indonesia on Economic Cooperation

Memorandum on Understanding and Cooperation in Small and Middle Bussiness Field between the Ministry of Industry and Trade of the Czech Republic and the Ministry of Production of the Italian Republic

Agreement between the Government of the Czech Republic and the Government of the Republic of South Africa on Economic Cooperation

Agreement on Economic Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the People´s Democratic Republic of Yemen

Agreement on Economic Cooperation between the Government of the Czechoslovak Socialist Republic and the Royal Government of Cambodia

Agreement on Provision Economic and Technical Aid to the Democratic People´s Republic of Korea by the Czechoslovak Republic in years 1954-1960

Economic Agreement between the Czechoslovak Republic and the Republic of Cuba

Trade Agreement between the Government of the Czechoslovak Republic and the Governemnt of the Republic of Malta

Agreement on Economic Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the Socialist Republic of the Union of Myanmar

Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the Federal Republic of Germany on futher Development Economic, Industry and Technical Cooperation

Trade Agreement between the Government of the Czechoslovak Socialist Republic and the Federal Military Government of the Federal Republic of Nigeria

Agreement on Economic Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of Nicaragua National Recovery

Agreement between the Government of the Czech Republic and the Government of the Portuguese Republic on Economic, Industry and Scientific and Technical Cooperation

General Agreement between the Government of the Czech Republic and the Government of the Kingdom of Saudi Arabia

Agreement on Economic Cooperation between the Government of the Czech Republic and the Council of Ministers of the Serbia and the Montenegro

Agreement on Economic Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the Democratic Republic of Sudan

Long-term Trade Agreement between the Government of the Czechoslovak Socialist Republic and the Government of the Syrian Arab Republic

Trade Agreement between the Czechoslovak Republic and the Swiss Confederation

Agreement on Economic Cooperation between the Government of the Czech Republic and the Government of the Tunisian Republic

Long-term Agreement on Economic, Technical, Industry and Scientific Cooperation between the Government of the Czechoslovak Socialist Republic and the Government of the Republic of Turkey

Agreement between the Government of the Czech Republic and the Government of the Socialist Republic of Vietnam on Economic Cooperation

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