National Space Plan

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1 Introduction

Preamble

This document is addressed to policy/decision makers to define a National Space Plan composed of a strategy for space and an associated programme. This is achieved by:

- defining the context of space and its activities;
- proposing guidelines and actions to maximise the return of the public investment.

Hence, this document does not contain detailed implementation plan that will have to be defined as a consequence of the approval of the National Space Plan.

This document does not discuss any aspects of space regarding commercial services and applications. It therefore does not discuss specific ways and impacts of use of space technologies in Earth observation applications, satellite telecommunication applications and satellite navigation applications and in integrated applications (including intelligent transport systems and services).

The document is structured in the following manner:

- **Chapter 1 – Introduction**
- **Chapter 2 – Institutional Aspects**, describes the institutions that are pertinent to space and their approach and role;
- **Chapter 3 – Uses of Space**, discusses briefly the different uses of space;
- **Chapter 4 – Capabilities and Perspectives**, reviews the current capabilities in the Czech Republic and their development;
- **Chapter 5 – Areas of Intervention**, presents the different areas where intervention is necessary to address this strategy and discusses the markets in which context they fall
- **Chapter 6 – Analysis of Programmes and Current Situation**, discussing the tools and instruments available to the Czech Republic to implement the strategy
- **Chapter 7 – Recommendations**. Long-term and medium-term objectives are proposed as well as the evaluation criteria to be able to measure whether the objectives are met. The actions and programmes to be implemented are also identified as well as a first estimate of their financial implications. Guidelines for future programmes in the time horizon of this document are also discussed.

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). At the conference “The ambitions of Europe in Space” which took place in Brussels in October 2009 and at the 1st EU-ESA International Conference on Human Space Exploration held in Prague in October 2009, leading representatives of EU and ESA emphasized the changes which the space sector has gone through. The space sector and its activities are no longer merely the concern of science; it concerns a sector with immense economic, 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 Systems Supervisory Authority (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. The activities of ESA (see Section 2.1 below) transcend the competencies of a single ministry. In this regard, space is an area of economic activity with the highest potential for innovation and represents a springboard to drive Czech economy's competitiveness. For EU, space is a political and economic challenge that can also address the current economic crisis and strengthen the position of EU in the global economy.

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 20 years the Czech Republic has undertaken enormous political, economic and social changes. In this period it has become a member of EU, sharing its strategic objectives, 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; and
- to secure unrestricted access to new and critical technologies, systems and capabilities in order to ensure independent European space applications.

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] and Eurostat[2] statistics show a high level of high technological content of its exports, comparable to Denmark or even Germany, while having a low number of patents and publications (20 and 30 times smaller than Denmark and Germany, respectively). This data suggests that the products

[1] OECD SCIENCE, TECHNOLOGY AND INDUSTRY OUTLOOK 2008 – ISBN 978-92-64-04991-8, OECD 2008.

[2] EUROSTAT, Patent Applications to the European Patent Office (EPO) - Number of applications per million inhabitants, http://epp.eurostat.ec.europa.eu/tgm/graph.do?tab=graph&plugin=1&language=en&pcode=tsiir060 and High-tech exports – Exports of high technology products as a share of total exports, http://epp.eurostat.ec.europa.eu/tgm/graph.do?tab=graph&plugin=1&language=en&pcode=tsiir160

manufactured in the Czech Republic have an intellectual propriety outside of the country. 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 economic impact considered as a "return-on-investment" in space activities is in the order of a factor of 4.5 as estimated by OECD in Norway[3] and Denmark[4], similar or even higher values have been previously reported elsewhere. The need to retain and absorb the intellectual capital that is created in its academia and industry is, as well, an essential requirement to ensure the "return-on-investment". Space exploration must not be considered as an end in itself but as an economic instrument for development and innovation.

Space activities are generally characterised by their high technological content, multi-disciplinarity, complexity, extreme visibility and often high cost. At this stage it is not conceivable for the Czech Republic to have an independent space programme with all its requirements; as this would entail substantial investments with dubious sustainability. For this reason the main tool for the Czech Republic to influence, develop and participate in space must be through its membership of ESA where all European-wide space-related research and developments are carried out leading to systems that are then commercialised and exploited by other European organisations (examples of this are EUMETSAT, Arianespace, Eutelsat, EGNOS or the future Galileo operator). On the other hand not all types of activities in the interest of the Czech Republic will be possible to implement under ESA or other international organizations. For this reason a national programme is necessary to complement especially the participation in ESA.

[3] The Space Economy at a Glance 2007, OECD 2007, pages 89-90, note that in this document the "return-on-investment" is called "spin-off effects". In practice what is meant is the number of Euros that a single Euro of investment in ESA programmes generates in the national the economy.

[4] Evaluation of Danish Industrial Activities in the European Space Agency (ESA), Danish Agency for Science, Technology and Innovation, 2008.

2 Institutional Aspects

This Chapter describes the institutions that are most relevant to space and their field of activities, responsibility, approach and role. Regulatory organisations with no research or development programmes such as the International Telecommunication Union or the International Maritime Organisation are not considered here.

2.1 European Space Agency

ESA was created in 1975. It is the result of the fusion of the satellite and launchers organisations, namely the European Space Research Organisation (ESRO) and the European Launcher Development Organisation (ELDO). ESA works as an intergovernmental organisation with the mission to provide and promote the peaceful exploitation of space science, space research and technology development and the deployment of space applications.

ESA in concert with EU, national bodies responsible for space, and international partners, manages the research and development programmes needed to maintain the position of Europe in space.

To achieve its mission ESA elaborates and implements 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 eighteen Member States (Czech Republic joined ESA in Nov. 2008[5]) and Canada as associate Member State. ESA activities are also financed by third parties for specific programmes, e.g. EUMETSAT.

These activities are performed within programmes of two different types:

- Mandatory activities, where the participation and contribution of each Member State is obligatory and proportional to its GDP,
- Optional programmes, where each Member State may (but need not) participate in and may contribute according to its own interests and financial resources.

The core elements of ESA's Mandatory activities are the Science Programme, the Technology Research Programme, the General Studies Programme and ESA's technical and operational infrastructure. The development of applications is provided via ESA's optional programmes, to which Participating States participate with a voluntary subscription.

Details of the different programmes of ESA, and other institutions will be discussed in Chapter 6; however it is worth pointing out that ESA's Science Programme funds only the platform (satellite), its launch, and operations. The on-board scientific instruments are funded nationally by the Member states involved. The exception is in observatory class single instrument satellites, as is the case of XMM, Herschel-Planck or Gaia.

[5]Convention for the establishment of a European Space Agency - Communication of Ministry of Foreign Affairs No. 92/2009 Coll. of International Agreements

In ESA mandatory activities and in each of its programmes ESA ensures that at least 84% of the Member State contribution, minus ESA's internal costs, will be returned to the State in the form of contracts covering ESA activities. ESA further ensures that, when all mandatory activities and optional programmes are taken into account, 94% of the contribution will be returned, in the form of contracts, to the contributing State. In ESA terms, this principle is called the *industrial return* or *geo-return*. In the context of EU this approach is called *juste retour*. The emphasis on geo-return is an absolutely unique feature of ESA motivating 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 may by less competitive vis-à-vis the rest of Europe.

It should be noted that typically more than 70% of the contributions to ESA's budget is dedicated to optional programmes (in 2009[6] the percentage was 77% amounting to €2211 million out of a total annual income from Member States of €2819 million). 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.

The Czech contribution to ESA is around 0.24% of the total ESA budget amounting to €7.4 million[7] (which covers both mandatory activities and optional programmes). Of this total, around 75% is dedicated to mandatory activities where the contribution, proportional to the GDP, is 0.82%. The GDP based calculation is based on a five year period.

In 2009, ESA committed a total of €3592 million divided through its different programmes as shown in Figure 1.

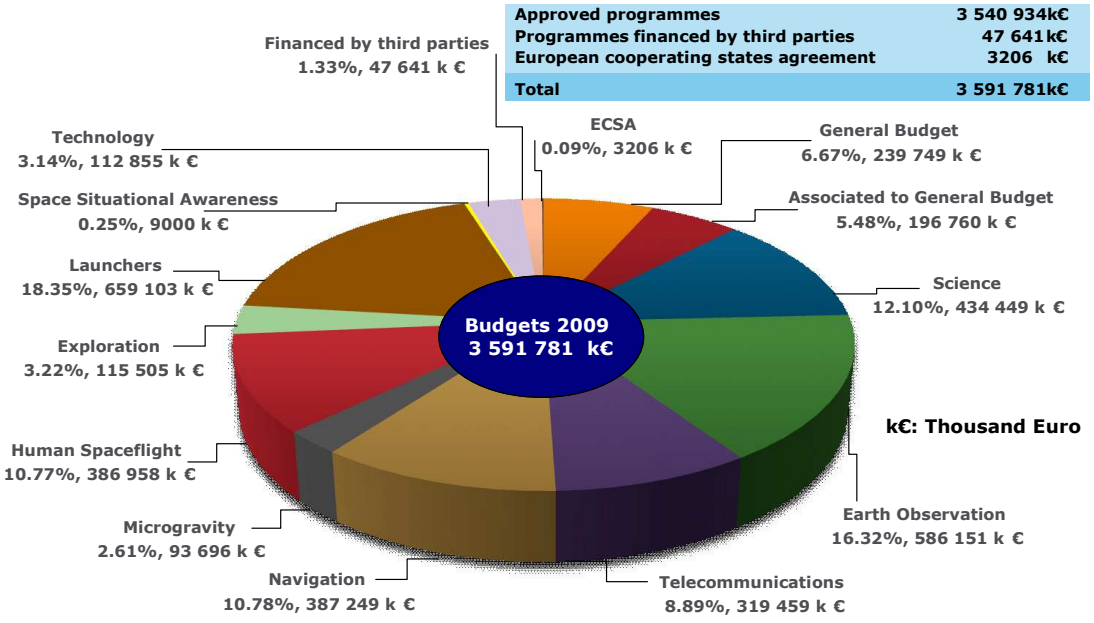


Figure 1 - Amounts approved for commitment in 2009 by area of activity.

[6] European Space Technology Master Plan 2009, ESA.
[7] European Space Technology Master Plan 2009, ESA.

ESA is governed through the ESA Council and its Committees on Industrial Policy (IPC), Science Programme (SPC), Administrative and Finance (AFC) and International Relations (IRC).

Further to these Committees, ad-hoc Programme or Participant's Boards (PB) steer ESA's activities in different ESA optional programmes (JCB-Joint Communication Board, PB-Earth Observation, PB-Launchers, PB-Human spaceflight, Microgravity and Exploration, and PB-Navigation).

The ESA Council is ESA's highest steering body consisting of the representatives of each of the Member States. Every three years the ESA Council meets at ministerial level (last meeting took place in November 2008 in The Hague) and decides the most important issues of ESA, e.g. approves key activities of ESA, namely its mandatory activities and optional programmes. Member States also commit themselves to fund optional programmes up to the chosen amount at this forum. Each Member State is represented on the ESA Council and has one vote, regardless of its size or financial contribution.

ESA is headed by a Director General who is elected by the ESA Council every four years. Each individual research sector has its own Directorate and reports directly to the Director General.

The Czech Republic has been cooperating with ESA since 1996, when it signed a Framework Agreement with ESA[8]. More intense collaboration began in 2000 within the PRODEX program and in the year 2005 within the PECS[9] program. The Czech Republic contributed €9.7 million in the course of about four years (this programme finished with the accession of the Czech Republic to the ESA Convention in Nov. 2008).

2.1.1 Czech-ESA Task Force

In the Agreement between ESA and the Czech Republic[10] concerning the accession to the ESA Convention, 45% of the Czech mandatory contribution (amounting to €2.3 million at the economic conditions of 2009[11]) was allocated to a special transitional ESA programme entitled *Czech Industry Incentive Scheme*.

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

[8] Agreement between the Government of the Czech Republic and the European Space Agency Concerning Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes - Communication of Ministry of Foreign Affairs No. 307/1998 Coll.

[9] European Cooperating State Agreement between the European Space Agency and the Government of the Czech Republic - Communication of Ministry of Foreign Affairs No. 111/2005 Coll. of International Agreements

[10] Agreement between the Czech Republic and the European Space Agency concerning the accession of the Czech Republic to the Convention for the establishment of ESA and related terms and conditions - Communication of Ministry of Foreign Affairs No. 93/2009 Coll. of International Agreements

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

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

2.2 European Union

The Czech Republic has been a member of EU since 2004 and as such, shares its strategic objectives, 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; and
- to secure unrestricted access to new and critical technologies, systems and capabilities in order to ensure independent European space applications.

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. In this area, EU has found common ground with ESA with which it closely coordinates its steps (implementing common projects, setting strategies, coordinating space policy, etc.).

The *Space Council* is a joint and concomitant meeting of the Council of the EU and of the ESA Council at ministerial level based on Article 8 of the Framework Agreement between EU and ESA. The agreement offers a common basis for the coherent and progressive development of an overall European Space Policy. The 6th Space Council was held in May 2009 in Brussels under the Czech Presidency of the Council of the EU. The outcome of the Space Council is resolutions on common priorities of EU and ESA in space matters. At the Space Council the Czech Republic has been so far represented by the Ministry of Education, Youth and Sports (MEYS).

As a member of EU the Czech Republic actively participates in space activities of EU and common activities of EU and ESA (Space Council). It shares its priorities stated by the Space Council Resolutions regarding the implementation of GMES and Galileo, Space and Climate change, Contribution of Space to the Lisbon Strategy, Space and Security and Space Exploration.

[12] Lisbon Treaty amending the Treaty on European Union and the Treaty establishing the European Community - Communication of Ministry of Foreign Affairs No. 111/2009 Coll. of International Agreements

Membership in EU offers the Czech entities the possibility to take part in framework programmes under the priority "Space". It should be noted that within EU juste retour (or geo-return) is not used. This places extra demands on Czech entities to ensure a financial share of the EU programmes such as Framework Programme, Galileo and GMES. Still EU funds in general play an important role in supporting Czech industry and academia.

Within the EU, the European Commission (EC) plays an eminent role in supporting research and development activities in fundamental science. The financing of these efforts materializes via the so-called Framework Programs. 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 Programs (space, traffic, environment, information and communication technology, nanosciences, nanotechnology, and materials).

In the context of the EU the Czech Republic participates in Galileo, the European Geostationary Navigation Overlay Service (EGNOS) and the Global Monitoring for Environment and Security (GMES) which are all discussed in Section 6.2.

With the adoption of the Lisbon Treaty, that confers a space competence to EU (see Article 189 of the Treaty[13]) and which explicitly mentions space and ESA, the relationship between ESA and EU may change. This will very be important especially in the preparation of the next EU multi-annual Financial Framework that will set the overall frame for EU spending in space over the period 2014-2020. In relation EU-ESA it needs to be recalled that not all EU member states are ESA member states and and ESA member states are Switzerland and Norway.

It is important to recall that the industrial policy of these two organisations is substantially different. For EU the industrial policy is primarily focused on *competitiveness and avoiding distortion of the markets* while for ESA is mostly aimed at *developing and safeguarding European industrial capabilities*.

In this changing context and considering the possible scenarios of cooperation between EU and ESA and the approach that will be used, it will be important for the Czech Republic to ensure that a) space in small States like the Czech Republic is protected; b) space, and especially space technology R&D, is a tool for development that contributes to the closing of the structural gaps between EU Member States and c) that space is not a "normal" market due to its strategic role and multi-annual nature. These considerations will be fundamental in the negotiations regarding funding of space activities and procurement of space systems.

European Defence Agency

The European Defence Agency (EDA) is an agency of EU, falling under the direction and authority of the Council of the EU. The decision-making body is composed of Defence Ministers from the 26 participating Member States (all EU Member States, except Denmark) and the EC. The main tasks of EDA are to identify, in association with the competent Council of the EU bodies, the EU's future defence capability requirements, promote and enhance the European armaments cooperation, strengthen the defence technological and industrial base (in particular by developing relevant

[13] CONSOLIDATED VERSION OF THE TREATY ON THE FUNCTIONING OF THE EUROPEAN UNION, Official Journal of the European Union, C 115/49, 9 May 2008, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2008:115:0047:0199:EN:PDF

policies and strategies) and enhance the effectiveness of the European defence research and technology.

The total budget of EDA was around 26 million € in 2008, - the contribution of the Czech Republic was app. 0.255 million € (0.99 % of total budget). Budgetary surpluses are returned to the Member States according to their contribution. EDA was established by a Joint Action of the Council of the EU on the 12th July 2004 (Council Joint Action 2004/551/CFSP). The mission of EDA is to support the Council of the EU and the Member States in their effort to improve the EU's defence capabilities in the field of crisis management and to sustain the European Security and Defence Policy (ESDP) as it stands now and develops in the future.

European Union Satellite Centre

The European Union Satellite Centre (EUSC) is an operational facility whose mission is to support, in coherence with the EU Security Strategy, the decision-making of EU in the field of the Common Foreign and Security Policy and in particular the European Security and Defence Policy, including EU crisis management operations. It achieves this by providing products resulting from the analysis of satellite imagery and collateral data, and related services. Furthermore, EUSC ensures close cooperation with the EU space-related service. EUSC has also contacts with other national and international institutions in the field of space.

The annual budget of EUSC for 2008 was around €12 million.

2.3 EUMETSAT

The European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) is an intergovernmental organisation formed in 1986 to service a current total of 26 Member States. The main purpose of EUMETSAT is to deliver weather and climate-related satellite data, images and products – 24 hours a day, 365 days a year. This information is supplied to the National Meteorological Services. For this purpose EUMETSAT operates a fleet of meteorological satellites.

The EUMETSAT Council is the supreme body of the organisation, composed of representatives from the meteorological services of the Member States. Contributions are based on a scale which is proportional to the Gross National Income (GNI) of the individual Member States. Each Member State has one vote. The Director-General is the legal representative of EUMETSAT. He is responsible for the implementation of decisions of EUMETSAT Council and for the execution of all tasks assigned to EUMETSAT. He heads the Secretariat, which is located at the EUMETSAT headquarters in Darmstadt, Germany.

EUMETSAT derives the vast majority of its funding from the contributions of its Member States. These contributions are calculated as pro-rata to the GNI of the respective State. This helps justify the democratic principles by which EUMETSAT is controlled, on the basis of one vote for each country and weighted majority voting on key financial issues. Preparatory and core activities are covered by a General Budget, which is essentially a programme approved in five-year slices. All major new activities, such as the satellite systems, are covered by new programmatic arrangements.

EUMETSAT, as in ESA's case, has two types of programmes: mandatory and optional however, contrary to ESA, the optional programmes are a small part of the overall budget. EUMETSAT programmes use no geo-return (or juste retour) making

it more demanding for the industry of Member States to make use of the national contribution to EUMETSAT.

The first Meteosat programme, initiated by ESA in 1983, was closely monitored by EUMETSAT from 1987 and was completed as planned, within budget, in 1995. The success story of satellite meteorology in Europe is closely linked to two organisations. One is EUMETSAT itself, which in just two decades has become one of the world's pre-eminent meteorological and environmental satellite organisations, serving the interests of Europe's National Meteorological Services, the citizens of Europe and way beyond. The other is ESA. ESA's research expertise was required for the conception, research and development of the first Meteosat back in the 1970s and ESA was also the driving force behind the original formation of EUMETSAT. Over the past 20 years the relationship between the two organisations has evolved and ESA has now become an established and important cooperation partner for research and development as well as a procurement agency for EUMETSAT.

EUMETSAT also supports Satellite Application Facilities (SAFs) that are specialised development and processing centres within EUMETSAT applications ground segment. Using specialised expertise in Member States, they complement the production of standard meteorological products derived from satellite data at EUMETSAT's central facilities and distribute user software packages. Each SAF is lead by a national meterological service. There are currently eight SAF. These are: Support to Nowcasting and Very Short Range Forecasting, Ocean and Sea Ice, Climate Monitoring, Numerical Weather Prediction, Land Surface Analysis (LSA), Ozone and Atmospheric Chemistry Monitoring (O3M), Global Navigation Satellite System (GNSS) Receiver for Atmospheric Sounding (GRAS) Meteorology, Support to Operational Hydrology and Water Management (H SAF).

SAFs are funded nationally and may offer an opportunity to the Czech Republic to participate in the development of such a facility leading to additional applications and products.

The Czech Republic is expected to become a full Member State of EUMETSAT in 2010 after having being a Cooperating State since March 2005. The Czech Republic takes part in EUMETSAT mandatory programmes and also can 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 2008 was €168 million[14]. In recent years there were no contracts placed by EUMETSAT in the Czech Republic. EUMETSAT´s general budget for 2010 – 2018 years is €1500 million, annually €191 million on average, at 2010 economic conditions.

The Czech Republic's annual contribution for the period 2010 – 2018 will be about €2.5-3.2 million (1 % of general EUMETSAT budget). The Czech Republic will contribute to all mandatory programmes, but not to the optional programme "Jason", as it does not take part in it.

Up to now, all the Czech Republic membership fee payments to EUMETSAT were covered by the Ministry of Environment (ME) which also will make the special payment of €5,076,000 divided into four equal payments between 2010 and 2013.

[14] EUMETSAT Annual Report 2008.

Membership fee for period 2010 – 2018 and the follow-on payments will be guaranteed by the Ministry of Foreign Affairs (MFA).

2.4 National

MEYS has been funding all Czech space activities under the ESA frame. During PECS, it was also the interface with ESA. For this purpose the MEYS uses a private non-profit organisation, the Czech Space Office (CSO). The Ministry of Transport (MT) has been responsible for the national activities related to the joint ESA-EU programme Galileo and has been the interface to this programme. ME has the responsibility for the cooperation with the operational organisation EUMETSAT and is responsible for the Czech involvement in ESA-EU programme GMES.

Ministry of Industry and Trade (MIT) is responsible for industry and will support its involvement in space activities including those under ESA.

Since accession to ESA MEYS is still funding all Czech space activities under the ESA frame however a wider institutional involvement is expected with shared responsibilities with other competent ministries. In 2008 the Government of the Czech Republic assigned the task to MEYS and MT to prepare and submit a proposal on measures indispensable for the implementation of the ESA Convention and accession agreement. Act No. 2/1969 Coll., on establishment of the ministries and other central state administrative bodies of the Czech Republic, as amended, establishes the ministries and other central state administration bodies of the Czech Republic. This act however, does not address specifically the area of space activities, does not explicitly identify the responsible government authority and only implicitly refers to the specific rules, contained in other legislation.

The only pertinent legislation regarding research, development and innovation that can currently be used to support ESA related space activities is the Act No. 130/2002 Coll., on the support of research, experimental development and innovation from public funds and on the amendment to some related acts (Act on the Support of Research and Development - R&D), as amended. According to this Act, MEYS is the governmental authority responsible for research and development, except for the areas of responsibility of the Council for Research, Development and Innovation (RD&I).

The Council for RD&I is an expert and advisory body of the Government of the Czech Republic for research, development and innovation and is responsible in particular for setting priorities and establishing and monitoring the implementation of the National Policy for Research, Development and Innovation.

In accordance with this Act and the National Policy for RD&I, the Technology Agency of the Czech Republic (TACR), the Grant Agency of the Czech Republic (GACR), the ministries (that have retained their competences in R&D) and other public authorities, may provide support for national research and development. MEYS is responsible for international cooperation in R&D. Figure 2 shows the current organizational structure of the RD&I.

Space activities are to be understood in their whole complexity. These are multi-disciplinary activities with enormous potential that can only be fully exploited with the active collaboration of various stakeholders such as governmental bodies, industry, academia and the citizens.

Space activities must take into account political, strategic, economic, and security dimensions at the same time – hence they rarely fall within the competence of a single

ministry as could be considered in current Czech legislation. This may become an obstacle to a healthy and efficient development of the space sector.

Space, as a discipline with great potential added value for the country and the whole of society, offers a great opportunity to improve the competitiveness of Czech industry.

The current legal framework would need to be improved to be able to support the full range of activities necessary to achieve the objectives of the Czech Republic in the field of space. The current approach is not clear from the institutional point of view and does not allow for a balanced participation of the scientific and industrial communities, respecting their roles and missions, that is typical of space related activities.

The possible optimal solution, which would allow for the exploitation of the potential of space activities, would be to setup a structure that would allow the pertinent ministries (MEYS, MT, MIT, ME, Ministry of Defence - MD and others) to jointly exploit this potential and fund the multi-disciplinary, cross-sectional area of space.

Another issue that may require intervention concerns VAT and excise tax. According to the VAT law and excise tax law all international organizations that are based on international agreements that are part of the Czech rule of law are exempted from tax. According to ESA Convention and Czech Accession Agreement, ESA and its activities are exempt from VAT and excise taxes. Currently the implementation of these legal instruments regarding this tax issues needs addressing.

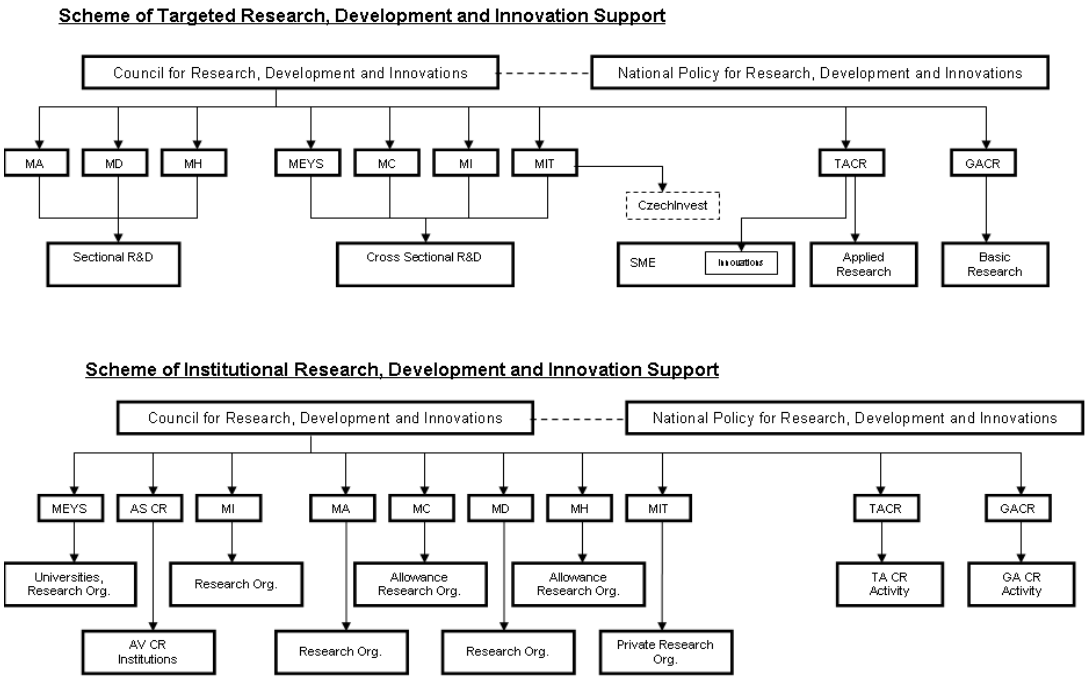


Figure 2 - Structure of RD&I System of the Czech Republic as of Act No. 130/2002 Coll., as amended

2.5 Others

In this Section, institutions relevant (albeit in a more indirect fashion) to space are described.

Other international organisations that may use space-related products or that may have a regulatory role that includes some aspects of space, such as the World Meteorological Organisation, the United Nations Office for Outer Space Affairs, the International Civil Aviation Organisation, the International Maritime Organisation and the International Telecommunication Union, are not included here.

Currently the Czech Republic has no specific bi-lateral agreements regarding space with other national space agencies such as NASA or JAXA.

European Organisation for the Safety of Air Navigation

The European Organisation for the Safety of Air Navigation (EUROCONTROL) is an intergovernmental organisation made up of 38 European Member States and the EU. It is an operational organisation that is the key player in increasing of performance of Air Traffic Management (ATM). Nowadays, together with its partners, EUROCONTROL is committed to building the Single European Sky that will deliver the ATM performance required for the 21st century and beyond.

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 Czech Republic has become a member[15] of EUROCONTROL in January 1996. EUROCONTROL's budget for 2009 was 720 million € (this includes the Maastricht Upper Area Control Centre and CEATS – Central European Air Traffic Services). The Czech Republic contributed approximately 1 million € to that budget (this includes a contribution of around €0.600 million to the CEATS budget). It 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. 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. As an operational organisation, EUROCONTROL does not use the geo-return approach.

A five-year renewable agreement for cooperation between ESA and EUROCONTROL was signed in July 2002. The Agreement establishes a general framework for cooperation and support between these two organisations regarding the use of space technology for civil aviation purposes in areas of common interest such as satellite navigation, telecommunications and the environment.

EUROCONTROL also has an agreement with EC on satellite navigation. The European GNSS (Global Navigation Satellite System) Evolution programme proposed by ESA, responding to aeronautical and other users' needs, is implemented

[15] International Convention on Cooperation for the Safety of Air Navigation EUROCONTROL - Communication of Ministry of Foreign Affairs No.130/2004 Coll. of International Agreements

in the framework of a co-operative effort involving as main partners EU and EUROCONTROL.

EUROCONTROL also cooperates with ESA and other institutions (EU, EDA) on the telecommunications programmes (ARTES 10 Iris, ARTES-9 GNSS-1). EGNOS is a joint programme of ESA, EUROCONTROL and also EC. Their joint activities are enshrined in a Tripartite Agreement that was signed in Luxembourg in June 1998, and later augmented by the signature of the Framework Agreement between ESA and EC in November 2003, effective as from May 2004.

ESA was responsible for the development, validation and initial exploitation, funded under its ARTES-9 programme. EUROCONTROL defined the driving mission requirements for civil aviation users. During this phase, EUROCONTROL defined work plans to support the operational acceptability of EGNOS for civil aviation. EC contributed substantially to the financing of EGNOS development, including the leasing of the payloads for the geostationary satellites. Through its R&D Framework Programmes activities, EU supported user application developments, setting up consortia in charge of specific pilot projects. EC has ensured a smooth continuation of operations after the hand-over of the system by ESA to EC in April 2009 by taking over the ownership, on behalf of the EU, of the EGNOS system, from ESA (by arrangements with ESA and EOIG (EGNOS Operators and Infrastructure Group). Furthermore, EC agreed with ESA that it would take on tasks for the design and procurement of EGNOS equipment and software renewals. EGNOS positioning data have been freely provided since October 2009 through satellite signals to all Europeans via enabled GPS receivers.

European Southern Observatory

The European Southern Observatory (ESO) was founded in 1962 and is the foremost intergovernmental astronomy organisation in Europe and the world’s most productive astronomical observatory. ESO has 14 Member States and provides state-of-the-art research facilities to astronomers. Several other countries have expressed an interest in membership. The Czech Republic became a member in 2007.

The ESO does not have space related activities however; its work often either complements space science activities or is instrumental in defining them. It is in this frame that it hosts the Space Telescope — European Coordinating Facility, operated jointly by ESO and ESA.

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).

At La Silla in Chile, ESO operates eighteen optical telescopes, including the most successful low-mass exo-planet hunter. La Silla is equipped with several optical telescopes with mirror diameters of up to 3.6 metres. The 3.58-metre New Technology Telescope broke new ground for telescope engineering and design and was the first in the world to have a computer-controlled main mirror, a technology developed at ESO and now currently applied to most of the world's large telescopes.

The Very Large Telescope (VLT), the world’s most advanced visible-light astronomical observatory, is located on the 2600 m high mountain of Paranal, which also hosts the VLT Interferometer and two survey telescopes, the VST and VISTA.

The third site is the 5000 m high Llano de Chajnantor, near San Pedro de Atacama. Here a sub-millimetre telescope (APEX) is in operation, and a revolutionary telescope – a giant array of 12 m sub-millimetre antennas (ALMA) – is being constructed in collaboration with North America, East Asia and Chile.

ESO is currently planning a 42-metre European Extremely Large optical/near-infrared Telescope, the E-ELT, which will become "the world's biggest eye on the sky".

The annual Member State contributions to ESO are approximately €135 million Euros. The membership fee of the Czech Republic in 2009 was €1,640 million, which was 1.27% of the total ESO budget. Observing time is allocated on the basis of the quality of the project. The success rate of projects by Czech astronomers is around 2%. The Czech Republic has been successfully involved in some ESO programmes.

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.

North Atlantic Treaty Organisation

In the frame of North Atlantic Treaty Organization (NATO)[16], there is a specific Science for Peace and Security (SPS) programme.

The SPS offers grants to scientists in NATO and NATO Partner countries for work on civil science projects. Partner countries include Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Georgia, Kazakhstan, Kyrgyz Republic, Malta, Moldova, Montenegro, Russian Federation, Serbia, Tajikistan, the former Yugoslav Republic of Macedonia1, Turkmenistan, Ukraine and Uzbekistan. Grants are also available to scientists in seven countries known as the Mediterranean Dialogue: Algeria, Egypt, Israel, Jordan, Mauritania, Morocco and Tunisia.

Each SPS project is conducted in a specific NATO priority area by collaboration between working scientists in eligible Partner or Mediterranean Dialogue countries and scientists in NATO countries. Application priority areas include countering threats, environmental sustainability, and communications infrastructure.

Czech researchers have been able to apply for grants in this programme to collaborate on priority research topics, which include NATO Key priorities and additional Partner country priorities. Grants are also offered to assist the academic community in Partner countries to set up computer networking infrastructure and to optimize their use of electronic communication. SPS Key Priorities are currently under revision and the new set is expected to be announced during March 2010.

Applications for support on topics in the priority areas are prepared jointly by working scientists in eligible countries of the Euro Atlantic Partnership Council (EAPC) and countries of the Mediterranean Dialogue. The collaboration must be between scientists in NATO countries on the one hand, and scientists in eligible Partner countries or Mediterranean Dialogue countries on the other. Applications may be submitted at any time, but three deadlines are set each year to meet the three review sessions of the scientific advisory panels.

[16] North Atlantic Treaty - Decree of Ministry of Foreign Affairs No. 66/1999 Coll.

With respect to the development and use of space technologies, Earth observation, satellite telecommunications, navigation and their mutual integrated applications can be envisaged as perspective domains for funding. In the area of environment protection, recent projects have focused e.g. on flood forecasting and environmental risk assessment, climate change, air and water quality, desertification, soil erosion and land-slides, prevention of natural disasters and eco-terrorism. In the information and communications security domain the projects include topics as creating electronic communications networks between scientific and other users, e.g. distance-learning projects. Other projects deal with countermeasures against cyber terrorism including topics as cryptography, identification and authorization, privacy, data protection and security.

United Nations Committee on the Peaceful Uses of Space

The United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) was formally established by United Nations resolution in 1959.

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 United Nations auspices, to encourage continued research and the dissemination of information on outer space matters, and to study legal problems arising from the exploration of outer space."

COPUOS oversees the implementation of five treaties and agreements from which the Czech Republic has ratified four: namely, the

- "Outer Space Treaty"[17] - the Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies.
- "Rescue Agreement"[18] - the Agreement on the rescue of astronauts, the return of astronauts and the return of objects launched into outer space.
- "Liability Convention"[19] - the Convention on international liability for damage caused by space objects.
- "Registration Convention"[20] - the Convention on registration of objects launched into outer space.

However, the Czech Republic still has not yet signed 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, the Scientific and Technical Subcommittee and the Legal Subcommittee. The activities of COPUOS are administratively supported by the Office for Outer Space Activities (OOSA).

[17] 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 Ministry of Foreign Affairs No. 40/1968 Coll.
[18] Agreement on the rescue of astronauts, the return of astronauts and the return of objects launched into outer space - Decree of Ministry of Foreign Affairs No. 114/1970 Coll.
[19] Convention on International Liability for Damage Caused by Space Objects - Decree of Ministry of Foreign Affairs No. 58/1977 Coll.
[20] Convention on Registration of Objects Launched into Outer Space - Decree of Ministry of Foreign Affairs No. 130/1978 Coll.

During the last thirty years several OOSA 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 delegation is supported by the MFA through the Permanent Mission to the UN in Vienna. It actively contributes to the annual meetings of all the Committee bodies presenting reports on national space activities and its position to selected agenda items. The Czech Republic played particularly active role during its Presidency in the Council of the EU when it co-chaired the coordination meetings with other ESA Member States before the COPUOS sessions.

Czech experts also participated in the meetings of ESPI (European Space Policy Institute) and the Permanent Mission of the Czech Republic in Vienna organised the meeting on the achievements of the Czech Presidency of the EU Council in space.

Today, COPUOS has sixty-seven member nations and is one of the largest committees in the United Nations.

International Control Regime

It is necessary to take into the account that peaceful space programs employ many dual-use technologies that could be potentially misused in military programs, including weapons of mass destruction and their delivery system programs, including the ballistic missiles programs. The Czech Republic has elaborated an advanced export control mechanism and is an active member of international export control regimes that are relevant in this field, especially the *Missile Technology Control Regime* (MTCR) and the *Hague Code of Conduct Against Ballistic Missile Proliferation* (HCoC). Specific UN Sanction Regimes may also include items related to ballistic missile technologies. The Czech Republic fulfills its international obligations. It is however necessary to further promote knowledge of space experts about the export control issues and their awareness of the fact that proliferation of technologies, materials and knowledge in sensitive areas can lead to a threat to international security, endangering a good name of the Czech Republic and to have possible negative economic a legal consequences for themselves.

3 Uses of Space

Space technologies, products and services are an important part of everyday life. Weather forecasting, air traffic control, satellite 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 oceans, atmosphere, land surfaces, geology and inner core.

Satellite data has been instrumental in observing climate change and has been essential as well as a basis to predict global warming. Each single ground-based instrument, from different manufacturers, operators and calibration, is differently affected by measurement errors. This makes very difficult any global climatological view of the ensemble of data acquired. Satellite measurements instead ignore all boundaries and supply a unified view of the Earth.

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, 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).

A good example of these uses is the UN-SPIDER SpaceAid framework (system developed under COPUOS/UNOOSA also with financial and technical support from the Czech Republic), that was triggered in January 2010 for the devastating earthquake that struck Haiti. The massive damage to the local infrastructure in Haiti has made satellite images and maps vital to assess damaged areas and plan the relief work. Those images can be used by humanitarian relief workers on the ground to for example identify accessible roads and suitable areas to set up relief facilities. Finally, space-based Earth observation technologies help support security and safety initiatives as well as other national and global policy issues.

Earth observation data is today also crucial to manage our natural resources, from hydrology to forestry, from agriculture to mining, from urban sprawl to soil erosion. Space-based Earth observation technologies support the security and safety of our citizens, as well as other national and global policy issues.

Space technologies not only play an important role in air traffic management, but also in our cars where satellite-based navigators are more and more omni-present. Today, for some of us, is already difficult to imagine driving to an unknown destination without a satellite navigator.

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 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 use 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.

Apart from these areas where space plays an important role in innovation, space and its technologies provide a fundamental tool to understand the Universe and its mysteries building our knowledge. Many satellite missions have been designed to observe the Universe, galaxies and stars with especial attention to our own star, the Sun. Other missions have been observing or visited the solar system's planets while others observe, measure and characterise the space environment that surrounds our planet.

Space is capable of inspiring human activities leading to increased interest in technical and scientific disciplines that form the base of our societies and economies.

Traditionally the space sector is understood to be that part of the economy that is associated with the production of rockets launchers and spacecrafts. The space economy, as defined by the OECD, is much wider and is defined as:

"*All public and private actors involved in developing and providing space-enabled products and services. It comprises a long value-added chain, starting with R&D actors and manufacturers of space hardware (e.g. launch vehicles, satellites, ground stations) and ending with the providers of space-enabled products (e.g. navigation equipment, satellite phones) and services (e.g. satellite-based meteorological services or direct-to-home video services) to final users*".

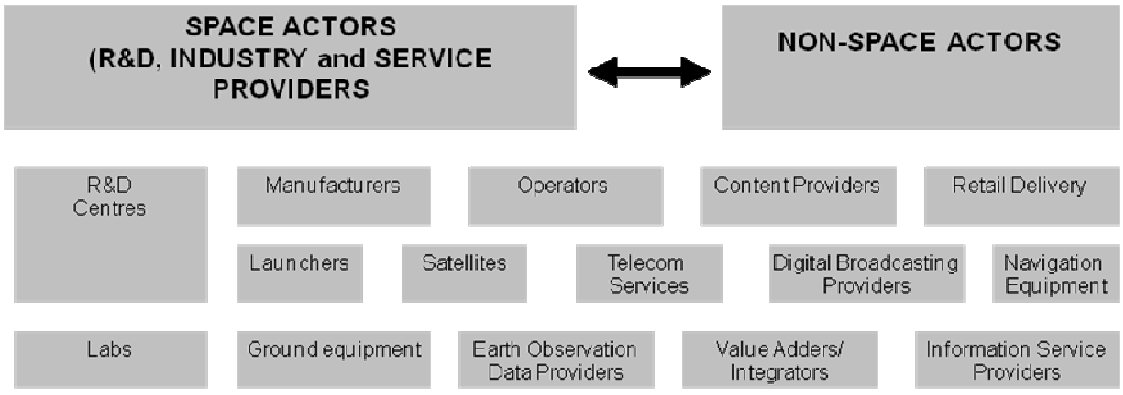


Figure 3 - Simplified overview of the space economy (Source: OECD - Space at a Glance 2007)

A very simplified view of the space economy is shown in Figure 3; a public or private actor may be involved simultaneously in several space activities (e.g. being an operator and service provider, as well as a manufacturer).

Most assessments of the impact of space economy on society have been mostly qualitative and not quantitative. In 2007 the OECD published its first ever overview

of economic inputs into and outputs from space activities. In this overview, only the impact of space activities in Norway was possible to quantify. This quantification was performed through the spin-off factor that is the impact that €1 spent in space would have in the economy as a whole. In practice the spin-off factor is equivalent to the concept of the "return-on-investment".

The estimated "return-on-investment" factor found in Norway was between 3.4 and 4.4 over a period of 9 years with the expectation of climbing further. A similar exercise was more recently performed in Denmark a factor of 4.5 was found. This factor only takes into account the value of obtained contracts due to ESA activities over the turnover from ESA activities.

If other indirect effects are taken into account such as those identified by the OECD namely, increase in efficiency, cost avoidance due to reduced damage to properties and lives, social inclusion by improving accessibility associated to satellite communications, then the factor would be much higher even if difficult to quantify.

In summary, space serves the

- state by providing essential strategic information,
- national economy by providing not only high quality employment but also an instrument of high "return-on-investment",
- citizens by providing services.

4 Capabilities and perspectives

This chapter reviews the current capabilities available in the Czech Republic and discusses, whenever appropriate, their perspective.

The first section refers to academia that is here understood as including universities defined as institutions where teaching and research by professors and PhD students represent the major part of work. In this sense, academia includes both extra-university research institutes (such as the Academy of Sciences of the Czech Republic or the Max-Planck Institute) and the universities themselves. The science community refers to all universities and academic institutions as well as to the external science laboratories.

The second section regards the capabilities in Industry while the third one refers to other organisations that are more difficult to classify since they are either public infrastructures operated publicly or national institutes, publicly owned but operating as private companies. To help in understanding the frame in these players operate (namely their attitude towards property, risk, and profit), let us use a car and its driver as an analogy. For example, one could say that while a taxi driver operating his own taxi is equivalent to industry then the minister's car and its chauffeur represent the equivalent of academia. Finally, a public owned car driven by a private citizen that can keep its profits is the equivalent of the setting of the organisations discussed in Section 4.3

The capabilities regarding human resources are discussed in the last section of this chapter.

4.1 Academia

The Czech Republic has a relatively long tradition in space science activities with the first Czech space experiment flown in 1969. Since then until the nineties, Czech scientists cooperated first with East-European scientists on science projects flown onboard Soviet satellites in the Interkosmos programme and later on, before full ESA membership, with West-European scientists in the frame of ESA cooperation schemes.

During the Interkosmos programme, Czech scientists together with industry, participated in tens of projects for which flight hardware was developed and manufactured. However, at that time, no market considerations, economic sustainability or viability constraints were taken into account.

Czech scientists participated in space projects related to the following scientific areas: solar physics, geophysics, astrophysics, astronomy, geodesy, nuclear physics, material and laser physics, biology, physiology and psychology as well as in radio wave propagation, signal processing, robotic science, thermodynamics, chemistry and computer science. The Czech Republic has reached important achievements in the area of space law.

In many areas, the teams produced very successful results completed in international cooperation with former Interkosmos countries and the United States and recently also within ESA programmes (e.g. two space plasma instruments on board Proba-2 – the TPMU, Thermal Plasma Measurement Unit and the DSLP, Dual Segmented Langmuir Probe).

Without attempting to be exhaustive, the areas of research, pertinent to space in academia include:

- Earth observation
    - Atmospheric composition and meteorology
    - Photosynthesis and carbon cycle
    - Land cover/use modelling
    - Hydrology and geomorphology
- Particle Physics
    - Detection of low and high energy particles
    - Detectors and methods
- Material Science
    - High speed optical detectors
    - IR, UV and X-ray detectors
- Life sciences
    - Psychological aspects of the impact of space environments on humans
    - Human body reactions in space flight
    - Algae grow in microgravity
- Radio Science
    - Radiowave propagation studies and its equipment
    - VHF/UHF propagation and space-hardware
    - Signal processing
- Space Physics
    - Solar research, space weather
    - Magnetospheric and ionospheric research
    - Earth gravitation field models
    - X-Ray, compact object, black holes
    - Optic and IR radiation, stars and galaxies
- Lasers
    - Laser ranging, pico-second timing electronics
    - High-gain lasers

4.2 Industry

Czech industry has a proven capability to develop advanced technologies and manufacture products to the highest world class standards. This has been demonstrated throughout the last century, including during the period when it was not subject to the pressures of a market economy.

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 velvet revolution, there was practically no need for marketing and the relevant skills only started being (re-)developed over the last 20

years. This lack of depth of marketing considerations and expertise is for instance one (if not the only) of the causes of the decline of the Czech aircraft industry.

It must also be noted that the previous space science and technology developments were carried out in isolation from any market forces and commercial considerations. This is a deficit that still needs to be overcome. Nevertheless, industry is beginning to show that it can rise to this challenge. This is clear from the number of new and successful high tech companies.

In the space field, apart from the successes highlighted already in the ESA survey of the Czech Republic in 2007, industry can now boast participation in projects won with international consortia both in Galileo Joint Undertaking (GJU) and competitive ESA tenders, as well as successes in international competitions such as the European Satellite Navigation Competition (ESNC), also known as Galileo Masters.

Before admitting the Czech Republic as a Member State, ESA conducted two surveys to assess our industrial capabilities. First in 2002 and then with a more detailed and focused one in 2007. In both cases the results were very positive. In some cases, the experts were impressed and surprised with the high standards they found. 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 and, after the initial period of familiarisation, enter competition with other Member States.

The surveys provided this confidence and reconfirmed that in the Czech Republic there is industry, not only ready to enter the space market, but some are already in this market.

The first glimpse into the current space industry technology capabilities was given by the successful projects carried out under the ESA PECS (2005-2008), the goal of which was to prepare Czech Republic for full ESA membership (see ANNEX II).

The projects were in the fields of X-ray optics, satellite control systems, satellite navigation, earth observation applications as well as basic payload data processing technologies, and the development of a micro-accelerometer for an important ESA mission (SWARM). Note that ESA projects/contracts, are different from those in EU 7th Framework Programme, in that they cover all costs and are closely monitored by expert ESA staff.

Due to situation both in ESA and in the Czech Republic, PECS projects were predominantly of a scientific nature with some industrial participation. Its selection criteria rarely include considerations of direct use in ESA programmes and activities, except for those related to the ESA Space Science programme, since the Cooperating States are not yet ESA members.

Since becoming a ESA Member State, ESA standard bidding procedures were applied. In the First Call for outline Proposals under the Czech Industry Incentive Scheme (see also ANNEX II), most of the selected proposals were submitted by SME. Apart from the technology areas already established in PECS, the tender resulted in ESA contracts awarded or being prepared in a series of other technologies, including development of mechanical components for satellites, electronics, electronic devices and components, ground and space software, and software applications.

Many other technologies exist in the Czech Republic 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 very restricted profit margins that ESA contracts allow (maximum 8%), as well as the relatively small contribution of the Czech Republic towards ESA. The latter makes such activities mostly interesting for SME.

Space and ESA activities especially, should be seen as an opportunity, in a full-funding frame, to develop technologies, products and services that will be then exploited elsewhere, maximizing the "return-on-investment".

The main Czech hardware competencies with space experience or ambitions are:

- design and manufacture of high-precision mechanical parts and assemblies
- design and manufacture of electronic components, space qualified PCB design and assembly, electric installations in spacecraft
- terminal equipment (aircraft)
- opto-mechanical and opto-acoustic devices
- advanced materials technologies
- precise X-ray optical/mirrors/CCD cameras

In the field of software development, the major skills include design and development of:

- embedded software, satellite control systems and other ground segment, as well as flight software
- satellite positioning technologies and infrastructure (EGNOS, SISNeT, Galileo)
- basic technologies for Earth observation data processing and applications and systems using EO data
- satellite communications (IRIS/ANTARES)
- satellite navigation user applications

A key need for industry to succeed in ESA is a network of industrial partnerships with other ESA Member States. This is essential for participation in ESA tenders, which are typically responded to by international consortia. Also, working with experienced partners, industry will acquire ESA specific know-how much faster and more cost-effectively.

The Czech Space Alliance has worked since 2006 on building up the corresponding awareness supported by ESA and the European-wide space industries association SME4space, presenting Czech companies at ESA industry days and other international events.

Czech space industry has started to have working relationships with small and large companies in most ESA Member States and other space-faring nations, as well as with national industry associations (notably representing Germany, Italy, France, UK, and Japan) and national space agencies. The base for such cooperation already exists, since Czech industry has accumulated well over 300 man-years of design and engineering work for space since 1990.

Industry is also competing with some successes for projects in EU Framework Programme, ESO etc. However, experience shows that the approach needed to do business with ESA (and hence the necessary infrastructure and support) is diametrically different from that with EU, ESO or CERN, not to speak of national R&D programmes, which often are not based on commercial considerations.

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 on innovative SME's as confirmed by the results in PECS and in the first open call by ESA in 2009.

4.3 Others

There are some institutions in the Czech Republic which are difficult to identify as purely academic or purely industrial entities. These are usually public owned and they have know-how and infrastructures that can support space-related R&D in industry.

These institutions may play a very important role supporting Academia and Industry by providing know-how, scientific/engineering and management support as well as the ability to perform tests.

4.4 Human Resources

The prime source of space related expert personnel is obviously located in the Czech universities although no specific space long-term university program exists.

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 has been recently accredited. 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.

Students can obtain electronic and electro-technical education and knowledge related to space (including experience with flight hardware) in special courses in technical universities.

Some technical educational institutions run regular student research projects focusing on satellite telemetry and communication systems. They successfully prepare their graduates to work as experienced personnel in the mechanical and electrical/electronic engineering fields of aerospace. Other departments provide more scientific oriented courses focused on space science, astronomy and ionospheric research.

The number of educational programs 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.

However, a satisfactory level of education capabilities exists to support the development of new satellite applications. Satellite navigation, Earth observation and telecommunications are adequately covered by master study programmes in several universities around the country.

The students, or young engineers and scientists, who are or have been studying space topics at foreign universities, or working in foreign companies on space projects, may also contribute to the enlargement of the Czech space science and technology knowledge-base.

During their stay abroad or after their return, these Czech experts communicate with Czech universities and companies and foster a transfer of information and knowledge acquired abroad.

The number of students managing to obtain a place in foreign universities is limited mostly by lack of financial resources. At the moment it is only the MEYS, through the CSO, that has been supporting this type of initiative through annual or short-term studies of Space Management at the International Space University (ISU) in France (6 students since 2006), space summer schools in Austria and in Germany (5 students from 2007) or participation in programs, seminars and workshops organized by ESA and other partners (since 2007 more than 10 students).

Regarding industry and training, the pertinent programme is the Programme of Support Training Centres training centre under the EU Operational Programme Enterprise and Innovations (EU OPEI) that provides funding for establishment of quality facilities for implementation, organization and management training, personnel actions and other activities related to the development of human resources, lead to enhanced business competitiveness and business operations in designated sectors.

The training of professionals to support Czech space industry is a gap that will need to be addressed. This gap may have an adverse impact on the performance of Czech industry and its growth.

5 Areas of Intervention

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 different areas where intervention is necessary to address this strategy and discusses the markets in which context they fall. Finally, it proposes the fields of activity, under a strategic approach, where intervention may bring benefits to the Czech economic tissue.

5.1 Roles of Academia and Industry

As already mentioned space activities are generally characterised by their high technological content, multi-disciplinarity, 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 and ensure economic sustainability, it is important to discuss and define their roles.

Project Phasing

Typically the life cycle of space projects, independently of its nature, is divided into 7 phases namely[21]:

- 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.
- 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.

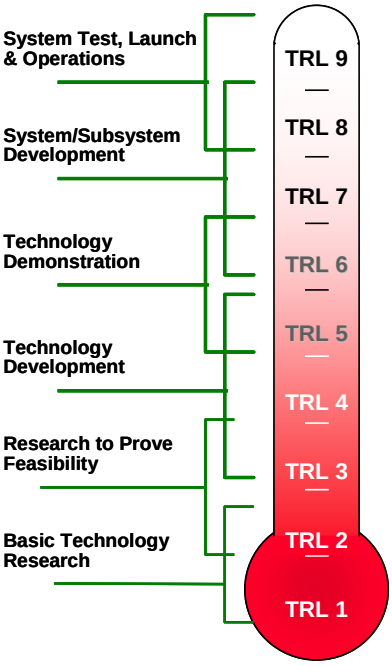
[21] Space Project Management – Project Planning and Implementation, ECSS-M-ST-10C_Rev.1(6March2009), European Cooperation for Space Standardization.

- 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.

It is only 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 validation and verification.



Technology Readiness Levels[22]	
9	Actual system "flight proven" through successful mission operations
8	Actual system completed and "flight qualified" through test and demonstration (Ground or Flight)
7	System prototype demonstration in a space environment
6	System/subsystem model or prototype demonstration in a relevant environment (Ground or Space)
5	Component and/or breadboard validation in relevant environment
4	Component and/or breadboard validation in laboratory environment
3	Analytical and experimental critical function and/or characteristic proof-of-concept
2	Technology concept and/or application formulated
1	Basic principles observed and reported

Figure 4 - Technological Readiness Levels

[22] ref. Technology Readiness Levels - A White Paper April 6, 1995, John C. Mankins, Advanced Concepts Office, Office of Space Access and Technology, NASA)

Technology Readiness

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 Technological Readiness Levels (TRL) for all the technologies that may be necessary for a space mission.

As can be understood from the Technology Readiness Levels, 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.

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 the investment done to develop the technology.

In these cases, the difficulty is transforming the technology into a product and in retaining the scientists or engineers that performed the R&D in academia. The return-on-investment in this case is very small (close to 1), translating into having the personnel employed during the course of the activity and little else.

In an industrial setting it is easier to achieve a product that can be exploited commercially hence making the return of investment greater then 1, because market considerations will be taken into account that will influence its design, manufacture 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.

This is what innovation is. It is not just invention. In a simple manner invention is the conversion of cash into ideas while 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.

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.

5.2 Awareness

Hand in hand with the need to ensure a high level of awareness and inform the professional community, goes the need for strengthening the synergy, exchange of knowledge and collaboration between all involved entities. Only by fulfilling these requirements can we start viewing the space sector and space activities of the Czech Republic as a systematically arranged and mutually conducted set of relationships which will be beneficial to the entire society and will concurrently conciliate the benefits stemming from considerable added value to the Czech Republic in favourable cost conditions, including new opportunities and challenges.

General public knowledge on space activities is currently limited in the Czech

Republic. The general public's awareness of space activities is the first step towards the foundation of the public's interest and support. The awareness can be built using the same instruments used elsewhere such as reports, interviews and documentation in the media, covering space activities, interesting statistics, results of measurements, media projects, congresses, exhibitions, and the like. In the case of space activities, it is also possible to capitalize on the highly inspirational nature of space activities.

The information for the citizens must be always focused on explaining the importance of space to the general public, pinpointing the most important space applications that people already use in their daily life. Even though the media covers often international satellite or rocket launches, domestic space events and activities need to be more visibly advertised, so that people will become more aware of (and take an interest in) Czech space contributions. In that sense, the website of CSO already attempts to provide appropriate information, together with press reports, press conferences and multimedia tools.

The Czech Space Alliance (CSA) contributed by publicising in the national press and professional publications the new ESA opportunities, and the first successes of Czech industry. Intelligent Transport Systems and Services (Sdružení pro dopravní telematiku - SDT) contributed to outreach above all by organizing the congress of Association of Space Explorers in Prague with over 50 participating astronauts.

The interest in space science and technology must be awakened and supported in order to create a favourable environment (e.g. promote attractive learning activities, create and support new ones, expand on current study branches and programs, and the like). At the same time, it is essential to support qualified professionals in raising their qualifications to keep them "current" in space activities (courses, programs, training, and grants).

To attract and motivate the young generation to start a career in science and engineering is important to involve young students in student satellites projects. These small student satellites would engage them with hands-on experience even during their studies. The low cost of these nano-satellites or more complex international student projects organised and managed by ESA could provide suitable opportunities. This could be done with modest funds and would also raise the awareness due to the high profile that space activities raise.

Many free-time interest groups, leisure companies and organizations provide an appreciable contribution to the awareness on space to the general public.

The CSO has been addressing the entire general public with a spectrum of educational activities aimed mostly at students, young scientists, engineers and technical experts. Another important outreach element is the network of dozens of public astronomical observatories and planetariums, located throughout the Czech Republic in quite surprising large number. They are directly engaged in the promotion and popularization of astronomy and space to the public. Other important organizations include the Czech Astronomical Society and the public association Cosmo Club. Some of these organizations promote the development of scientific, engineering and technical skills among the young generation – an example is the Association of Small Debruars of the Czech Republic or the Association for Youth Science and Technology AMAVET.

All the above organizations support a wide age range of public and professionals interested in space and science.

Dissemination of information among industry about opportunities in space business with focus on ESA activities should also be part of awareness actions using conferences, workshops, web information portals and other media channels.

More attention should be also be paid to raising awareness among decision makers about ongoing issues and needs in the space sector. Space activities need clear long-term planning and commitment. For this reason, systematic information must be available to decision makers, not only in the form of regular briefings or reports, but also in the form of magazines, leaflets and parliamentary bulletins.

5.3 Human resources

Czech space educational activities should motivate the best talents from the incoming young generation to be engaged in the fields of space engineering, technology, science and applications.

There are few human activities that stimulate more the imagination, interest and inventiveness of young people than space activities and programmes. Therefore the approach should be to leverage the Czech membership in ESA to encourage and inspire young people to enter into scientific and engineering disciplines. The CSO has already done a lot of work in this respect and further work should build on their experience.

The main challenge towards primary school children will be to establish and maintain an interest in science and modern technology using an entertaining and spontaneous way to show them how science and technology can be applied in various disciplines with great benefit. Emphasis will be placed on the playful, exciting and funny form of presentation of space and its applications and uses.

In high school, the main objective will be to develop and promote interest in modern science and engineering. Emphasis should be placed on deepening the knowledge and understanding of specifics of space and scientific and technical disciplines related to space. Better cooperation with high school teachers needs to be established.

Regarding undergraduate students, graduate students and young scientists and engineers with an interest in space, they should be supported to help them accomplish their ideas through their studies, professional projects and membership in professional associations.

The quality of human resources currently involved in space activities in the Czech Republic is comparable to those of other developed countries. The involvement of the current scientific and industrial human resources is a good basis for further development. To develop and maintain the reputation of a highly industrialised and technologically advanced country, we must focus on creating conditions to create well qualified young scientists and engineers – not only in space but in other disciplines.

Even with the good basis for further development that currently exists in the Czech Republic, scientists and engineers with existing experience in space is lacking. For this purpose the announcements of ESA for Young Graduate Trainees should be disseminated in the Czech Republic. This scheme allows for young graduates to spend one-year at the main ESA establishments in the Netherlands (ESTEC), Italy (ESRIN), Germany (ESOC) and Spain (ESAC). The Young Graduate Trainee scheme is funded and driven by ESA but will offer a limited number of training opportunities for the Czech Republic, since it is open to all citizens of ESA's Member States.

More targeted schemes are possible to implement with specific cooperation

agreements with ESA like the Spanish, Portuguese and Greek Trainee schemes. These latter schemes allow for more targeted training where the needs of the Member State are addressed first through a consultation with the Member State industry and then through a request to ESA for training vacancies in the areas of interest.

These schemes are funded nationally and a specific cooperation agreement between the national funding organisation and ESA is necessary. A Czech Trainee Scheme would help create engineers and scientists to quickly acquire experience in specific fields necessary to Czech industry.

5.4 Markets

5.4.1 Earth Observation

Earth Observation is one of the fastest developing space sectors with the broadest application and service potential.

Recognising this fact, the EC decided in 1998 to set up a global satellite system observing the Earth, which would focus on Europe, utilise the synergies of both space and in-situ data and bring useful services to European citizens. Named as Global monitoring for environment and security (GMES), the system is a joint activity of the EU and ESA to cover Earth observation needs of Europe. It is now progressing to commence its operational phase while providing first expected monitoring data and information in the following areas, which are also relevant for the Czech Republic:

- Land monitoring services
  - Land use / land cover change
  - Soil sealing
  - Water quality and availability
  - Spatial planning
  - Forest management
- Atmosphere monitoring services:
  - Greenhouse gases
  - Reactive gases, which influence the air we breathe
  - Ozone layer and solar UV radiation
  - Aerosols, which affect temperature, air quality and the transmission of solar radiation.
- Emergency response services
  - Civil protection
  - Humanitarian aid
  - Security crises
- Security services
  - Surveillance Infrastructure: land border surveillance, critical infrastructure (e.g. pipelines)
  - Support to peace-keeping: population monitoring, natural resources (eg. water)
  - Support intelligence and early warning
  - Support crisis management operations

The Czech service providers and users need to be prepared to be able to make use of

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 will support coordination of all EO activities at national level.

For the Czech Republic the GMES opens a wide field of opportunities for national institutions to acquire new types of data for decision making as well as unique opportunity for business to get into projects for GMES, which are currently implemented via the 7th Framework Programme (7th Framework Programme SPACE). For the period 2007 to 2013, €1.200 million is allocated for GMES applications opening opportunities to boost the Czech EU market. However, there is an urgent need to facilitate a higher participation of possible Czech applicants in this field.

Several issues make participation in the 7th Framework Programme difficult for small SMEs. The first is the necessity for co-financing, even if in 7th Framework Programme the situation has improved and SMEs can now request up to 75% for technical work. Even this can be a problem for small companies that typically live from hand to mouth. The other issue is that the evaluation and payment processes take too long, especially final payments. The latter puts additional strain on the SME´s cash flow. In contrast, ESA pays within very reasonable, well defined, time frames and allows for an initial payment on project kick-off. Last but not least, the proposal requirements are often complex for a small SME that cannot afford dedicated resources for bid writing and this, combined with the fact that the proposal costs are not covered, can make bidding in the 7th Framework Programme unattractive for small SMEs.

Recently, a higher participation of Czech users/applicants in GMES has been struggling with problems at two levels - at the institutional level and at the service/users level. At the institutional level a single coordination body to cover the governance of GMES together with GEOSS is going to be established - National Secretariat (NS) for GEOSS/GMES. The aim of this NS for GEOSS/GMES is to coordinate all GEOSS and GMES related activities within the country by MEYS and ME. The NS will be composed of representatives from the ME, Czech Environmental Information Agency (CENIA), Czech Hydrometeorological Institute (ČHMI), and by MEYS. The scope of the NS will be mostly in internal coordination (GMES awareness-raising) and support for proposal writing, and also in closer cooperation with state institutions as possible users of GMES services. However, for the successful utilisation of all GMES services and opportunities, a stronger commitment also from other ministries and institutions is needed (e.g. MT, Ministry of Interior, Ministry of Agriculture or MD).

CENIA operates as a state-subsidised organisation under the ME. The main activities of CENIA are to collect and interpret data and provide assessment, to monitor conditions for aggregated and statistical information about the environment, sectors and socio-economic aspects of sustainable development and to provide the assistance to public administration in the area of Integrated Pollution Prevention and Control (IPPC) and Environmental Impact Assessment (EIA/SEA). The results of CENIA work are presented in the form of maps converted into sustainable development indicators and published in information publications.

On the service/users level, Czech companies need closer cooperation especially with other western European organisations, which have much longer experience with the 7th Framework Programme especially in their participation in relation to GMES.

There is a strong need to have as a part of NS a position dedicated to SMEs to motivate their involvement in GMES and also to advice on proposals writing.

For big national institutions another specialist is needed to analyze services coming from GMES, which can be potentially beneficial for their daily needs.

Apart from the development and utilisation 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 organisations (see Chapter 4). An opportunity for this is now available in the Czech Industry Incentive Scheme and ESA technological programmes, especially TRP, GSTP and EOEP. If proved successful, the Czech products may be used for operational satellites developed by ESA for EUMETSAT, or for GMES Sentinels satellites.

5.4.2 Telecommunications

Telecommunications have a very wide use in everyday activities of the society in the Czech Republic. They had a very fast development in the last 20 years but as elsewhere in Europe, it is a mature market especially for satellite telecommunications.

The Czech Republic does not own and does not operate any satellite network. The Czech Republic, Slovakia, Hungary and Croatia hold however the right from the International Telecommunication Union on the geo-stationary orbital position at 12,8º W for digital broadcasting satellite services (BSS) that is not utilised at present.

In satellite telecommunications most of the market oriented activities are mainly oriented towards software solutions for telecommunication operators and for special applications for control of the telecommunication network and its supervision.

The present market with telecom satellite based services in the Czech Republic can be divided into the following sectors with the associated market shares:

- Broadcasting – 57 %
- Fixed networks – 40 %
- Mobile networks – 3 %

About 12 % of the above indicated infrastructure is used for transport and other related applications.

The present total income from the satellite telecom market in the Czech Republic is estimated at about CZK 300 million per year.

Broadcasting - The telecom satellite market in broadcasting has considerable orientation towards delivery of direct to home (DTH) television broadcasting (90 % market share of the broadcasting sector share) and to the distribution of television and radio program signals by cable and terrestrial networks (10 %).

The Czech Republic is a member of international governmental satellite telecommunications organization – satellite organizations *European International Organization of Space Communications (INTERSPUTNIK),* European Telecommunication Satellite Organisation (EUTELSAT IGO) and the International Telecommunication Satellite Organisation (ITSO). In the area of maritime transport the Czech Republic is also member of International Mobile Satellite Organization (IMSO), that supervize the operations of privatized organization Inmarsat Ltd. that is

offering services for global emergency system (GMDSS) a remote identification and ship survelience system. Satellite networks commonly used in the Czech Republic are those operated by EUTELSAT, ASTRA and INTELSAT.

Fixed networks - Fixed satellite networks are an important part of telecommunications infrastructure for all date transmission services (e.g. IP telephony, Internet, LAN and WAN networks) for public and private network operators and for satellite applications. These use satellite channels in the previously mentioned satellite networks.

Mobile networks - are used mainly for mobile 3G services, news casting and in crisis management, distress, safety and rescue, transport, telemedicine and defence and security systems where Very Small Aperture Terminals (VSAT) are also used. These services use INMARSAT, IRIDIUM and to a lesser degree ORBCOMM and Thuraya satellites.

In the transport sector telecommunications are especially used in data transmission among personal or vehicle navigation devices installed along road or street infrastructures where the integration of subsystems is important.

1) *Mass market*
   a) public transport information (time tables, tables of charges, tariffs
   b) ticket reservations and purchasing (SMS tickets)
   c) real time traffic and travel information (RTTI)
   d) personal navigation
   e) car parking navigation systems

2) *Professional market*
   a) logistics
   b) fleet management
   c) traffic management

3) *Safety related applications*
   a) satellite communications systems for air traffic management (ATM)
   b) emergency systems and transport safety and security systems

It is to be expected that the current profile of the satellite telecommunications market and its structure will be maintained in the Czech Republic. It is possible to expect an increase of requirements of the satellite infrastructure mainly in advanced mobile telecommunications (e.g. broadband internet access), new generation networks and to address the needs of control and supervision systems of intelligent transport systems, e-Health applications, distress, safety and rescue systems etc.

The dominance in the Czech Republic of services and software developments in this area is expected to be maintained. To a lesser degree, the satellite telecommunication market is expected to be oriented towards the development and production of components for applications in the space segments of public and private satellite telecommunication networks. These developments, their use, products, services and applications are expected to find a market not only in the Czech Republic but also in the EU and the rest of the globe.

Satellite communication systems are currently an integral part of the global communication infrastructure and act as a supplement to the terrestrial telecommunication network. The infrastructure of satellite communication is mainly

financed by the private sector, in particular by radio and television broadcast companies and telecommunication branches. The European share of satellite launches and services amounts to 40% of the world market. The goal of the Czech Republic is to acquire a share in this market.

5.4.3 Navigation

Satellite navigation enables users to find out exactly where they are anywhere on the Earth using signals from orbiting satellites. 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, and have received awards for innovative design of applications. Europe's Galileo satellite navigation system will feature 30 satellites to provide the whole planet with a highly accurate, guaranteed global positioning system under civilian control.

The range of potential applications for Galileo is extremely wide. Galileo's advanced technological features and its commercially oriented services will make it a valuable tool for nearly all economic sectors. But the value of Galileo is not limited to the economy and companies. Galileo will also be a key asset for the provision of public services (e.g. guide the blind and people suffering from reduced mobility, monitor children or Alzheimer's sufferers with memory loss, etc.). Integration with other technologies such as mobile communication or traditional navigation aids will further increase its potential. The areas of application for satellite navigation include:

1. **Personal navigation services and emergency calls:** customers will be able to access specific information through the integration of the Galileo system's receivers in a large number of devices such as mobile phones, location-based services and personal mobility (e.g. the nearest hospital, the best way to a restaurant, etc.);
2. **Road transport:** this area covers a wide range of applications, from telematics and navigation devices to electronic fee collection (EFC) for highway or city tolls, safety applications and pay-per-use insurance. Virtually all 240 million vehicles circulating in the EU could benefit from state-of-the-art navigation systems;
3. **Rail transport:** railway infrastructure includes signalling and train location systems, mainly installed at track side. These are gradually being replaced by the European Rail Traffic Management System and the European Train Control System (ERTMS/ETCS). The EGNOS and Galileo systems will enable: 1) Higher level of safety on regional lines, where signalling systems are obsolete or completely missing, 2) Replacement of existing track-side signalling including ETCS balise by means of virtual balise, and 3) safe detection of train integrity.
4. **Maritime, inland waterway and fisheries navigation:** the efficiency, safety and optimization of marine transport are key issues which can benefit from satellite navigation. Directive 2005/44/EC recommends the use of satellite positioning technologies for vessel tracking and tracing in inland waterway transport;

5. **Air transport:** satellite navigation opens up highly interesting prospects in this field. The accuracy and integrity of the Galileo system will enable the use of existing airports to be optimised. It enhances air navigation accuracy in all flight phases and also within movement on landsides. The SESAR joint undertaking, which implements the legal framework laid down in the Single European Sky regulations, will also rely on satellite navigation;
6. **Civil protection, emergency management and humanitarian aid:** helping people after earthquakes, floods, tsunamis and other natural or man-made disasters requires the location of people, assets and resources. Satellite navigation should shorten the response times of rescue services and optimise their deployment;
7. **Dangerous goods:** the legal framework will need to be updated to take account of the many options that Galileo will offer. In the event of problems, satellite navigation can also improve emergency response;
8. **Livestock transport:** every year millions of animals are transported in the EU. Traceability of livestock is of paramount importance to prevent sanitary fraud, ensure food safety and protect animal welfare. Regulation (EC) No 1/2005, which lays down the requirements for the transport of animals, requires the use of satellite navigation systems in all new trucks for long journeys;
9. **Agriculture, parcel measurement, geodesy and cadastral survey:** the location and size of parcels are key data for use in information exchange, whether for commercial purposes or applying for subsidies. Satellite navigation helps farmers to optimise crops, reduce fertiliser and pesticide inputs and ensure effective use of land and water. GNSS systems can also simplify and improve the quality of data collection in geodesy and cadastral surveys;
10. **Energy, oil and gas:** industry makes extensive use of satellite navigation systems for exploration and exploitation. The safety and security of oil and gas transport can also benefit from the positioning functions offered by Galileo. It can also improve the synchronisation of electricity distribution networks;
11. **Search and rescue services:** by allowing near real-time reception of distress messages from anywhere on Earth with precise location information and contact between rescue centres and people in distress, Galileo will facilitate rescue operations and reduce the rate of false alarms. This also has implications for the fight against illegal immigration and the ability to rescue migrants in distress at sea;
12. **Other applications:** these include logistics, environment, science, law enforcement and others (e.g. public transport, public works and civil engineering, immigration and border control, monitoring of prisoners, medical applications and people with disabilities, scientific research, etc.).

It is expected that the Czech entities will benefit from the successful project "Participation of the Czech Republic in the Galileo project" offered for six years to prepare in a systematic manner to contribute to the development of an applied superstructure for transport by using GNSS data.

5.5 Fields of Activity

The setting up of commercial satellites and their associated infrastructures takes a relatively short time, usually in the order of 2 to 3 years. This short period is due to the commercial approach where off-the shelf systems, with some degree of customisation, are used. For this type of missions very little if any R&D is required. This approach is constrained by the market where costs and risks must be known and competitive. By its nature ESA does not undertake this type of missions since its Convention does not cater for the exploitation of space systems. These missions are the purview of satellite operators and organisations such as EUMETSAT, SES-Astra, Eutelsat or the future Galileo operator.

The mandate of ESA covers instead the long process of R&D of space systems from the original idea in the form of a mission concept to the full development of an entire space system. By its nature this is a very long process that may take up to 20 years with its associated costs and risks.

New mission concepts are usually born from advancement in technology that may create opportunities to implement missions that were previously either impossible or difficult to implement. A very good example is SMOS that was born from technologies developed in synthetic aperture radiometry (SAR) that lead to practical space-based ways of measuring the ocean salinity and the soil moisture allowing for the parameterisation of ocean circulation and contributing to determination of the Earth's surface water cycle.

On the other hand, mission requirements stemming from science, applications or markets lead to the identification of technologies that are necessary to fulfil particular mission requirements. Examples of this are the Galileo satellites where an entire set of technologies had to be developed to fulfil the mission requirements.

These two processes with opposite directions, from technology to space mission or from space mission to technology are the purview of ESA and make understandable the strong technology R&D component of all ESA activities that ultimately lead to the development of new families of commercial satellites such as AlphaSat, SGEO or Galileo, and to new scientific satellites or missions such as the ESA Earth Explorers or as Herschel-Planck or Solar Orbiter.

As was discussed in a previous Chapter, ESA manages this two-way process by assessing the state of preparedness of a technology (TRL) so that it can evaluate whether a particular technology is ready for a given type of mission. In many cases, the lack of preparedness of a technology may lead to space mission proposals being rejected. In other cases, the TRL of a technology leads to new space mission proposals, previously unthought-of, being elaborated.

It is for this reason that ESA is by its nature the European space development organization of all EUMETSAT satellites (Meteosat, MSG, MTG, MetOP-EPS), those of the EU (Galileo and the Sentinels in GMES). Since space carries very high risks ESA also carries the demonstration of its developments by producing under its responsibility the first satellite of the series. It is also in this frame that AlphaSat or SGEO are being developed to support European space industry.

In this context, in the Czech Republic, to leverage the development of a space industry, it is necessary to involve Czech actors, as much as possible, in all stages of the value-added chain of space missions taking into account the TRL of each of the

technologies and the time, and success rate necessary to reach the final demonstrated product.

This R&D process is fraught with difficulties, however. As a rule, low TRL activities, where academia and research institutes are essential, have relatively small costs allowing for several directions of science and technology to be exploited. The costs usually increase with the TRL but previous activities have narrowed down the directions of R&D leading to reduced risks. As previously discussed, higher TRL technologies must have increased industrial participation to lead to useful products (innovation). This is also the reason for the phased approach in the implementation of a space system or mission.

To ensure economic benefits to the Czech economy from space activities in a relatively short time the R&D of high TRL technologies must be supported while, to ensure a continuous long-term benefit, low TRL R&D activities must be pursued with systematic evaluation of its readiness and fields of application.

In this frame, for both low and high TRL technologies, the role of Intellectual Property Rights (IPR) and patents 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 the registration of patents and IPR needs to be sustained.

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 then implemented and exploited in the Czech Republic. The collaboration or teaming of academia with Czech industry is a very important factor, especially in the middle-low TRLs, in this process. For this purpose projects that encourage this collaboration, in the respect of their roles, should be encouraged.

At this stage, since the recent accession to ESA, high TRL should have the higher priority to achieve products, applications and services that are used in ESA missions without disregarding low TRL technologies.

It is impossible to be exhaustive at this stage for low TRL technologies. On the other hand for high TRL, taking into account the capabilities in the Czech Republic discussed elsewhere in this document, and their access to high TRL contained in its existing products, opportunities or niches in the areas below should be supported commensurate with the Czech resources available for space.

Flight Hardware

Mechanisms and its related areas are an essential part of any satellite where Czech industry has a high level of preparedness, in fact, it is already supplying high quality mechanical parts to several European space products. Design and development capabilities in this area also exist.

Electronics and its related areas play a fundamental role in any sensor, instrument and satellite and where again there are already Czech suppliers also with capabilities of design and development.

Devices and components: the Czech Republic already has several device and component manufacturers, with Czech designs or licenses. Where appropriate, the development or qualification for space of these devices or components should be supported.

Payload or satellite sub-systems: in this area there are also high TRL capabilities.

Sensors or scientific instruments: this area should be encouraged fostering the collaboration between academia and industry and leading to the acquisition of knowledge and experience in space project management, development, constraints, quality assurance and others beyond the value or economic benefit of the particular sensor or instrument.

Software (ground or space)

Data processing for satellite data: in this area there are not only very good development capabilities but there are also good opportunities.

Ground segment: antenna/telescope control; telemetry, telecommand and control (TT&C), spacecraft control systems, and other ground segment support systems

On-board: especially that related to payload software

Embedded software: used in many satellite sub-systems

Data and satellite applications: this is an area with proven capabilities that could also lead to fast developments

Services

Support to the development of services for navigation and Earth observation in the form of demonstrations and validation would play an important role in fostering the use of these services and by exposing a wider community to space applications.

There are other areas with middle-high TRL technologies that should be supported in preparation of mid-term opportunities. Of special mention are those associated with launchers where there are capabilities regarding cryogenic sub-systems and propulsive or explosive materials.

As previously mentioned low TRL technologies are essential to maintain a constant flow of innovation however this area is fraught with risk. To ensure that the most promising technologies survive and develop to attain high TRL it would be advisable to use funding competitive processes. For this purpose the ESA's Technology Research Programme, when compatible with the specified technology requirements, as well as the national programmes of TACR and GACR, should be used.

6 Analysis of the programmes and current situation

This chapter discusses the tools and instruments, in the form of programmes available to the Czech Republic to implement its strategy. The programmes are presented for each institution.

6.1 European Space Agency

Current involvement of Czech Republic in ESA is defined by ESA rules regarding the contribution on mandatory activities and subscribed contributions to optional programmes made by the Czech delegation at the ESA Council at ministerial level in 2008.

6.1.1 Mandatory activities

The Czech Republic is bound by the ESA Convention to contribute to ESA's mandatory activities in proportion to its GDP, which is at the level of 5.4 million €. These activities cover the scientific programme and the so called basic activities which include strategic studies and technology programmes, education, common technical facilities and ground infrastructures, and corporate activities. Through the mandatory contribution, the Czech Republic participates in a wide range of ESA scientific missions as well as technology development programmes. The *Czech Industry Incentive Scheme*, as described in section 2.1.1, falls into the mandatory activities domain.

6.1.1.1 Science

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, Gaia, and BepiColombo. Czech scientists interested on these missions have been involved in the past, mostly via PECS projects. At this stage, for missions in the implementation phase, there is little chance for Czech industry to join the already established consortia of companies implementing the missions.

Future ESA missions under the umbrella of the ESA long-term plan Cosmic Vision 2015-2025 are under consideration and the selection of the missions to be implemented out of the current candidate missions will end in 2012. The selection will be based on the scientific merit of the associated scientific objectives, budgetary requirements of the missions (with €450 million cap for both medium-sized missions and €650 million for large-sized missions), 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, Herschel-Plank or Gaia.

Analysis: Czech scientists already participate in Space Science missions with some sub-systems at instrument level (software and hardware). To ensure an active and increased participation in this programme it will be important to support these developments using PRODEX and National resources while ensuring that there is also an industrial component that will retain the experience acquired. When the industrial component is predominant, the Czech Industry Incentive Scheme could also be used if compatible with the resources available.

Regarding the processing and analysis of scientific data this should also be supported through PRODEX or National resources. Czech scientists should also be encouraged to submit scientific proposals for the future science missions with the aim of becoming Principal Investigators of scientific instruments.

6.1.1.2 Technology

To this end ESA manages several technology R&D programmes[23] to guarantee that the necessary technologies are mature enough in due time. From the mandatory contribution the following programmes and initiatives are covered.

The *Technology Research Programme (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 program has a yearly budget of € 43 million with 3-year work plans and yearly procurement plans. Current TRP cycle end in 2010 and next will cover 2011-2013.

The *Innovation Triangle Initiative (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 available budget for both proof-of-concept and demonstration of feasibility/use studies is € 1.5 million per year.

The *Science Core Technology Programme (CTP)* follows-up the Technology Research Programme 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 work is planned in 3 or 4 year cycles and is regularly updated. Current work plan is for years 2008-2011. Yearly budget of the programme amounts to € 10-11 million.

The *General Studies Programme (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.

[23] All ESA programmes except that dedicated to the operations of the European launcher infrastructure in Kourou, French Guyana, are dedicated to development, however, as can be seen in ESA's European Space Technology Master Plan the programmes with a very strong technology R&D component are up to 7% of ESA global budget.

The work is planned in 3 year cycles and is regularly updated. Current work plan is for years 2008-2011. The yearly budget is around € 20 million and is part of the mandatory activities.

The *European Component Initiative (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 ECI type of activities is also addressed under the new optional program GSTP-5 – Element 2 "Building Blocks".

This program runs in its second phase (2008-2010) and has allocated a budget of € 6.5 million.

Analysis: In the mandatory activities of ESA regarding technology, namely TRP, CTP, ITI, GSP and ECI, Czech industry and academia has not been a very active player mainly due to lack of awareness of the web-based procurement tools (EMITS) of ESA and its technology workplans. It is important to address this deficit as soon as possible by further publicising EMITS in the websites of the relevant Governmental authorities and other special actions.

6.1.2 Optional programmes

The Czech Republic participates in range of optional programs. The level of contribution to these programs was decided shortly before the ESA Council at ministerial level in 2008 held in The Hague in November 2008, right after accession of the Czech Republic to ESA.

The limited amount of time available before the ESA Council at ministerial level constrained the negotiations regarding which ESA optional programs the Czech Republic should join.

The period from the date of accession of the Czech Republic to ESA to the date of the ESA Council at ministerial level was very limited. This made the discussions and negotiations among ministries and industry difficult.

For the next ESA Council at ministerial level to be held in 2011 the Czech Republic will need longer and more thorough preparation to decide which ESA optional programmes to subscribe and to what level of resources.

Due to the above mentioned very short period, the decisions of the Czech Republic on which ESA optional programmes to participate in were driven by the following:

- Czech industry and institutions were consulted on their interest and capabilities regarding participation in ESA optional programs and the commitment that they could make use of. The Czech delegation then made the best effort to accommodate the received interests.
- Since the mapping of the Czech industrial capacities at the time was limited and further potential for future participation in collaboration of ESA could exist, and new interests in space projects could arise in the first years of Czech ESA membership, several other programmes were subscribed at the minimal level. This funding essentially serves as a "place-holder" enabling Czech participation even in those programmes for

which no interest was expressed during the limited consultation with industry and institutions.

Analysis: To ensure a wider and deeper consultation of all Czech entities, the review of the status of the participation of the Czech Republic in space activities and the definition of its priorities, social and economic impacts and resources, it will be necessary to start this process at least 1 year before any planned ESA Council at ministerial level.

The Czech Republic currently subscribes to 13 optional programmes. The following list presents all these programmes, from science through technology to application development.

6.1.2.1 Scientific programmes

The *Programme for the Development of Scientific Experiments (PRODEX)* is a programme that provides funding 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).

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. The instrument and experiment proposals are first, at national level, evaluated by the Czech PRODEX committee and are then reviewed and selected by ESA in accordance with its own rules and procedures. No instrument or experiment not selected by ESA shall be funded under this programme. Czech subscription to PRODEX cannot be used to fund development in other Member States. This makes PRODEX a very good platform for national funding of Czech scientific instruments to be flown on-board spacecraft.

Since the beginning of 2010 MEYS established the Czech PRODEX Committee to review project proposals and to follow up on the development of the programme.

The Czech Republic has subscribed €0.25 million per year for the period 2009 – 2010 and €0.5 million per year for the period 2011 – 2015. (e.c. 2008).

Analysis: The subscription in PRODEX of €0.5 million per year seems appropriate to support an active participation of academia and industry. However if Solar Orbiter is selected as one of ESA's space science missions additional funding may be necessary.

The *European Programme for Life and Physical Sciences (ELIPS)* programme in its 3rd period builds on the previous two periods which prepared the European scientific and industrial community in Life and Physical Sciences in space by carrying-out preparatory experiments on non-ISS platforms.

Now the ELIPS Programme Period 3 (ELIPS3) proposes extensive and optimized use of the European Columbus laboratory and of the European resources and capabilities available on ISS, complemented by a unique suite of autonomous European mission platforms for performing gravity- or radiation-related research.

The programme provides focused fundamental and applied research in Life and Physical Sciences in space, technology demonstrations in space, energy and biotechnology, enabling research for Human Exploration (crew health and exobiology research), education and outreach. The ELIPS programme offers to Czech researchers

unique opportunity to perform research on ISS and other platforms such as sounding rockets, parabolic flights and drop towers.

The Czech Republic has subscribed € 2.77 million for the period 2008 – 2012 which is 0.7% of the overall programme budget of € 395 million (all in e.c. 2008).

Analysis: The amount subscribed in ELIPS is high and is constrained by the use of the European Columbus laboratory in ISS. This is also a scientific and technological area with the smallest "return-on-investment". For this economic reason the subscription should be decreased for the next subscription period, possibly to around € 1.5 million, while increasing the subscription to PRODEX and GSTP that allow for a bigger flexibility while allowing for the same type of experiments.

The *Earth Observation Envelope Programme (EOEP)* is the backbone of all EO activities in ESA. The EOEP has two components. The Earth Explorer Component includes scientific missions aimed at the exploration of the Earth – both large missions (Core Missions) and smaller and less expensive missions (Opportunity Missions).

Since 1998 it constantly updates its work plan every five years. Currently the programme is in its third period (EOEP-3). This programme, addressing Earth sciences, contains as well a strong technology component in which technology pre-developments are carried out under two lines – Earth Observation Preparatory Activities (EOPA) and Instrument Pre-development (IPD). It was as well in this programme that all preparatory activities for that lead then to GMES took place.

The Czech Republic has joined the already running EOEP-3 and has subscribed €2.6 million for the period 2008 – 2010 which is 0.17% of the overall programme budget of €1490 million (all in e.c. 2006).

Analysis: The subscription level (€2.6 million) of EOEP should be maintained if not increased for the next subscription period to ensure a Czech participation from the beginning of the definition of future Earth Observation missions to participation in instrument development. This would ensure a participation in the formation of the consortia that carry out the development of the future missions.

6.1.2.2 Technology programmes

The following programmes have a strong technology development component.

The *European Transportation and Human Exploration Preparatory Activities Programme (ETHE)* includes the initial phases of an ATV-based cargo download system (Advanced Re-entry Vehicle – ARV) and the continuation of the cooperation with Russia. This aims at consolidating ISS operations and constitutes a building block of the European vision for human spaceflight and exploration. Studies on the definition of a Moon Lander are pursued, along with technological development for enabling human exploration including life support systems and demonstrators. In addition, studies on the post-ISS infrastructure in LEO shall be decided as soon as the final decision on the extension of the ISS lifetime is taken. The programme also includes a separate component for Early Activities for Transportation.

The Czech Republic has subscribed €0.19 million for the period 2009 – 2012 which is 0.21% of the overall programme budget of €90 million (all in e.c. 2008).

Analysis: At this point in time it is not clear if the subscription to ETHE will lead to any interesting activity with potential future benefits in the Czech Republic. The

successor to this programme could require high levels of subscription. It is proposed to examine the status at the end of the subscription period and to evaluate if it is worthwhile continuing subscribing to the programme or leave this optional programme.

The *Future Launchers Preparatory Programme (FLPP)* has the objective to help determine how Europe maintains and strengthens its independent access to space in the long-term and to achieve a significant step forward in maturation and validation of critical technologies so as to prepare for the Next Generation of Launchers (NGL). The Programme has been investing in the development of technological and industrial capabilities in all main space transportation areas since 2004. It does this to prepare for the decision on Europe's best next-generation launch system, able to meet future institutional needs while also maintaining competitiveness in the commercial launcher market. The programme has 2 elements: Intermediate eXperimental Vehicle for re-entry (IXV) and Systems, Demonstrators and Technology (SDT). Most FLPP procurements takes place through direct negotiation at the level of the prime contractor with competition at the subcontractor level.

The Czech Republic has subscribed €0.5 million for the SDT element for the period 2009 – 2012 which makes 0.42% of the overall element budget of €120 million (all in e.c. 2008). The Czech Republic has not subscribed for IXV element as the consortia of companies built around IXV development has already been established which makes it difficult for Czech companies to participate in the programme.

Analysis: There is some promise that FLPP could exploit Czech existing know-how in cryogenic pumps, turbo-compressors, pyrotechnics, and others. In the case that this promise is fulfilled the next period of FLPP (2013-2016) should be subscribed as well as the follow-up programme concerning the NGL (successor to Ariane 5). In these cases the subscription level for FLPP should be of a similar percentage (0.42%) and the subscription level for the NGL around the same percentage depending on the resources available.

The *General Support Technology Programme (GSTP)* has as objective to perform feasibility, pre-development and qualification of identified critical technologies for future space projects, strategic non-dependence and industrial competitiveness, addressing established and new domains (e.g. civil security and SSA) and including in-orbit demonstration as required.

The fifth period of the General Support Technology Programme (GSTP 5) consists of four elements: Element 1 – classical GSTP activities as described above, Element 2 – development of building blocks and components to high technology readiness level (TRL) and support to their life-cycle, Element 3 – Security technologies, and Element 4 – In-orbit Demonstration (IOD).

Building blocks (Element 2) are to be made available to users in a catalogue of products in line with the newly introduced product policy of ESA, aimed at reducing risks to projects and promoting product reuse. It will also strengthen European non-dependence and will encompass the European Component Initiative, while aiming at breakthrough innovation and promoting technology spin-in.

In this programme 5 year work plans are used with regular updates every year. Support confirmation on single activities by the participating States is necessary to submit bids to the activities.

The Czech Republic has subscribed €3.23 million for the period 2009 – 2013 which is 0.5% of the overall programme envelope of €650 million (all in e.c. 2008).

Analysis: GSTP is of very high interest to industry and academia and due to its confirmation support mechanism for single activities (and guaranteeing a geo-return of 100%) it allows Czech priorities to be addressed. The subscription level should be at least doubled to around € 6-7 million for the next subscription period 2014-2019.

The *European GNSS Evolution Programme (EGEP)* was extended to 2011 to maintain the competences of industry and ESA in navigation technologies for the future evolution of the European global navigation satellite system infrastructure (EGNOS and Galileo). 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. Candidate critical technologies will be put through appropriate laboratory and out-door test-beds, with the aim to provide by 2011 a second generation EGNOS payload on board a suitable host geostationary satellite capable of simultaneously supporting the test and demonstration of new EGNOS services as well as operational services.

The Czech Republic has subscribed €0.48 million for the period 2009 – 2011 which is 0.46% of the overall programme envelope of €105 million (all in e.c. 2006).

Analysis: EGEP is a programme that could ensure the participation of Czech industry in the future generation of Galileo. For this reason the subscription to the next subscription period, that could take the form of a new programme e.g. *European GNSS Supp. Programme Extension*, should be increased to around €1 million.

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.

The slices 1,3-4 – *ARTES 1, 3-4* – support the technology R&D which underpins the competitiveness of the European space industry through the development of innovative satellite communications technology, systems and applications, to enable industry to meet future customer needs, including those of the public sector.

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.

ARTES 3-4 is dedicated to the development, qualification, and demonstration 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.

For the period 2009 – 2013 the Czech Republic has subscribed € 0.12 million for ARTES 1 and €1.7 million for ARTES 3-4 which are respectively 0.2% of €60 million and 0.31% of €550 million of the overall programme-element envelopes (all in e.c. 2008).

Analysis: ARTES 3-4 is geared towards "close-to-market" technological activities that require matching funds from industry. Its effectiveness should be evaluated at the end of the subscription period to assess if these opportunities are being taken up by industry. In the negative case ARTES 5, that allows for 100% (or 75%) funding of telecommunication technology R&D, should be subscribed instead. In any case ARTES 5 should also be subscribed by a similar amount. The possibility to decrease the subscribed amount to subscribe ARTES 5 with at least an equal amount should be investigated as soon as possible.

6.1.2.3 Application development programmes

The following are programmes (or slices of programmes) that are geared towards the development of applications.

Element 10 of the ARTES programme is *ARTES 10 (Iris[24])* with its on-going Phase II.1. Its objective is the development of a modern communication standard enabling aircraft to communicate worldwide scale, using low cost and low complexity user terminals, antennas and communication services. The programme includes the test and validation infrastructure, the ground segment, the end-to-end system integration and interface with the overall Air Traffic Management system, and safety analysis. Operators will be involved in phase II.1 as well as in the future operating entity in phase II.2 that could entail a cost of around €165 million. While all the work for the definition and development of the satellite payload and associated services is incorporated in the programme proposal, there is a checkpoint foreseen in 2011, before the go ahead and funding of the development and exploitation phases.

The Czech Republic has subscribed €4.14 million for the period 2009 – 2011 which is 10.64% of the overall programme-element envelope of €38.9 million (all in e.c. 2008) – by far the largest Czech contribution to an optional programme both in terms of absolute amount of money and share of the subscription. Assuming that the same percentage of the total programme is maintained for the following phase, the subscription could cost in excess of €19 million with an equivalent amount of over €19 million being invested by industry as demanded by the programme declaration.

Analysis: The subscription to ARTES 10 Iris phase II.1 for the period 2009-2011 is the highest of all ESA optional programmes € 4.14 million). Since the subscription to the following phase II.2 would entail a very high amount, with matching funds from industry, it will be necessary to evaluate whether a) industry is prepared to fund to a similar amount phase II.2 while ensuring that the intellectual property rights (IPR),

[24] Iris is an alternative name for ARTES 10. It is not an acronym. In Greek mythology, Iris is the personification of the rainbow and messenger of the gods: Iris links the sky to the Earth

manufacture and exploitation of the products and services developed will remain in the Czech Republic, b) the necessary resources will be available to the Czech State with no detriment to the participation in other programmes. If the benefits will not remain in the Czech (namely IPR, manufacture and exploitation) it is advisable to decrease substantially (at least by a factor of 2-5) the subscription to phase II.2 and keeping the same subscription amount (€ 4 million).

ARTES 20 – the Integrated Applications Promotion (IAP) goal is to foster the use of integrated space technologies, alone or in combination with a variety of terrestrial systems, in a wide range of operational services for society and public policies, thereby exploiting more systematically European investments in space and existing European space capabilities.

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 Czech Republic has subscribed €0.17 million for the period 2009 – 2013 (Phase 1) which is 0.21% of the overall programme-element envelope of €80 million (all in e.c. 2008).

Analysis: The ARTES 20 (IAP) may lead to some integrated systems of interest to the Czech Republic that will be defined in this programme. The next phase (Phase 2) of this programme with application development of integrated systems should be subscribed only if there are applications of clear interest to the Czech Republic. This should be decided at the ESA Council of 2011. It should be noted that the envelope of Phase 2 may be three times higher than the current envelope. In any case the subscription to the following phase should, in principle, be of the same level (0.21%).

The *Global Monitoring for Environment and Security Space Component (GSC)* programme was initiated in 2005 and provides the initial space capacity needed to deliver an effective global monitoring of the environment to meet user-defined requirements.

The current second segment of the GMES Space Component (GSC) programme is a further major step towards full operational capability of the dedicated Sentinel missions. It will also provide a reliable and efficient operational access to Earth observation data from other contributing missions needed by the GMES user community. Segment 2 spans the period 2009-2018, overlapping with the on-going Segment 1 (2006-2013) initiated in the ESA Council at ministerial level in 2005. It includes in particular the development of two units of the Sentinel 4 instrument (to be embarked on MTG), and a Sentinel 5 Precursor satellite, as well as the development activities of the Sentinel-1, -2 and -3 B units up to flight readiness. Segments 1 and 2 are co-funded by the EU and are designed to meet user requirements for a range of operational services, including Emergency Response, Land Monitoring, Marine and

Atmospheric Composition. The detailed content of Segment 2 has been elaborated in close consultation with the EC.

The Czech Republic has subscribed €1.76 million for the period 2009 – 2018 which is 0.2% of the overall programme envelope of €856.6 million (all in e.c. 2008).

Analysis: This programme offers the opportunity for Czech industry to develop products that will then be procured by the EU possibly via ESA, leading to a fallout in the Czech Republic. Due to its long subscription period (2009-2018) it will not be up for subscription soon however, if appropriate and possible at the ESA Council 2011, an increase of the subscription should be considered if it increases the leverage to access EU funding.

The *Meteosat Third Generation (MTG)* programme aims at the development of the technologies and systems which will allow EUMETSAT to ensure continuation of the European meteorological service, and particularly to address the next generation of European geostationary meteorological satellite systems.

MTG comprises two different satellites and will enhance the accuracy of forecasts by providing additional measurement capabilities, higher resolution and more timely provision of data. The programme follows the precedent of the Meteosat Second Generation (MSG) development, i.e. an ESA development programme for the initial two prototype satellites with a fixed contribution from EUMETSAT. ESA will then procure four additional recurrent satellites on behalf of EUMETSAT. The development programme lasts from 2009 until 2020.

For this period the Czech Republic has subscribed €2.24 million which is 0.26% of the overall programme envelope of €860 million (all in e.c. 2008).

Analysis: This programme with a long subscription period (2009-2020) offers the opportunity for Czech industry to develop products for the next generation of operational meteorological satellites that will then be procured by EUMETSAT via ESA and it will lead to benefits in the Czech Republic. If appropriate and possible at the ESA Council 2011, an increase of the subscription could be considered.

6.1.3 Other ESA programmes

There are many other ESA programmes currently not subscribed by the Czech Republic. The following, however, are presented here due to their possible interest.

The *ARTES Element 5: "ESA Telecom – Technology"* has been initiated 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 steps up to and including the step where the subject of the development has been built into a configuration representative of the final product and critical performances have been verified by test. The formal qualification and industrialisation are not part of the programme. 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 open to industry, universities, research organisations, national space agencies and ESA itself. The "Non-competitive Industry Initiated Activities" sub-element 5.2 is funded to a maximum level of 75% by ESA. ESA may fund up to 100% for work carried out by universities and research organisations when such institutions are sub-contractors and if this funding does not exceed 30% of the total cost of the activity. The activities are defined by industry and submitted in response to an Open Call for Proposals. When industry presents a proposal in this sub-element a plan is required for continuing the development to a product ready for commercial exploitation.

Analysis: Subscription to the ARTES 5 Element would ensure an easier participation of Czech entities in the earlier stages of development of telecommunication satellite equipment that would then be supported by ARTES 3-4. It is recommended that this programme element is subscribed as soon as possible. The relative ratio of subscription in ARTES 5 to ARTES 3-4 should be 1 to 1.

The *Space Situational Awareness Preparatory Programme (SSA)* objective 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 are carried out in successive programmatic steps with a view to achieve a full operational capability over a framework of ten years since 2008. ESA is 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.

The high-level users' needs for the European SSA system are especially to support safe and secured operation of space assets and related services, to support risk management (on orbit and during re-entry) and liability assessment, to assess the status and basic characteristics of space objects (both man-made and natural), detect non-compliance with applicable international treaties and recommendations, and to enable the allocation of responsibility for space objects to launching state or organization, and support confidence building measures (identification of owner and/or operator).

The SSA Preparatory Programme comprises four elements: the core element, the space weather activities, the pre-development and bread boarding of critical subsystems of the radar, and the pilot data centres. The core element activities pursue the objective of supporting the definition of the governance, of developing an appropriate data policy and of specifying the data centres that need to be established within the SSA system. It also includes the specification and architectural design of a space surveillance system that will monitor man-made objects in Earth-bound orbits including space debris.

Analysis: The SSA programme started in 2008 without Czech participation. For its strategic it is, however, deemed important to get involved in the programme at the earliest possible occasion. The successful Czech participation in the programme may build on the Czech expertise in related scientific disciplines astronomy and Earth observation.

The *European Participation in the International Space Station Exploitation Programme (ISS Exploitation)* provides for the legal and financial framework as well

the means for fulfilling the obligations and responsibilities accruing to the ESA in the framework of the Space Station Agreements (i.e. IGA and ESA/NASA MOU) during the ISS operations and utilisation phase.

The ISS Exploitation programme is intended to cover the operations/maintenance of the elements developed in the past ISS Development programme and of other European contributions to the space station orbital facility developed in other self-standing programmes. The payloads and experiments to perform the actual utilisation are not covered by this programme.

The ESA ISS Exploitation Programme involves a number of system elements and related functions including all European developed items, which are part of the integrated space station, as well as their maintenance. The flight element includes Automated Transfer Vehicles (ATVs), Columbus laboratory, Node 2 and 3, Cupola, European Robotic Arm and many other facilities of the ISS. Ground elements include Columbus and ATV control centres, cargo integration, ground communication systems, user support and operations centres (USOCs), and crew training and medical facilities.

Analysis: The ISS development is close to completion and the benefits of a Czech participation in the programme are questionable. The prime reason is that in the next ten years the focus of the programme will be on the maintenance, operational activities and procurement of services, ATVs and its subsystems. For virtually all of these procurements significant past expertise is essential which cripples opportunities for the Czech industry. However, the Czech participation in the next period of the programme may be requested by other ESA member states for solidarity reasons. This request should be avoided and only considered if (and only if) the Czech utilization of the ISS considerably increases and becomes significant which is not expected.

6.2 European Union

EU Framework Programme – priority "Space"

EU supports, via the 7th Framework Programme under the priority "Space", a European Space Policy focusing on applications such as GMES (*Global Monitoring for Environment and Security*), with benefits for citizens, but also other space foundation areas for the competitiveness of the European space industry.

Global Monitoring for Environment and Security (GMES) is the European Initiative, which has been established to fulfil the growing need amongst European policy-makers to access accurate and timely information services to better manage the environment, understand and mitigate the effects of climate change and ensure civil security. It is a joint effort of the 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.

Nowadays the whole system is in the pre-operational phase with mixed funding from both EU-ESA sources. The first three Fast Track Services should start operational phase in 2011. The launch of the first satellites is expected during 2012 and the EU operational programme, which should gradually take over funding of the whole system operations and upgrades, will commence in 2014. The initial GMES Fast track and Pilot services are now being finalized or developed through funding from the EU 7th Framework Programme under the priority "Space", while satellite development is

co-funded by ESA – 7th Framework Programme budgets and procured by ESA.

Considering the current programmatic period of the 7th Framework Programme, which was launched in 2007, to space is allocated the amount of €1,400 million of which, €1,200 million is allocated to GMES. The remainder is dedicated to space foundations (space research, transportation, experiments, etc.).

Each year a call is published in this priority area. Up to now three rounds of calls were published. The next call (4th) is envisaged for the second half of 2010.

The Czech Republic, as a member of the EU, has a full opportunity to participate in 7th Framework Programme under the priority "Space" and several institutions and companies participated with their proposals in all previous calls.

Applications from the Czech Republic covered both main topics in 7th Framework Programme under the priority "Space" – GMES and also space foundations. GMES is mostly interesting for state institutions (environmental or emergency agencies) or for GIS, mapping and generally IT companies. In space foundations, universities (technical institutes) and also SMEs are involved, e.g. in planetary robotics or in space transportation issues. However, compared to other countries, the Czech Republic belongs to a group of less successful countries in the 7th Framework Programme under the priority "Space". On one hand, there are not too many projects proposed by Czech applicants and on the other hand the overall rate of successful applications is below average.

The status of the EU regarding space is changing due to the Lisbon Treaty. It will be important for the Czech Republic to ensure that its interests, that are the same as of all EU small Member States, are protected regarding space technology R&D since it plays an important role in the development of its economy.

Nevertheless, participation of the Czech Republic in 7th Framework Programme SPACE is a good additional instrument to support space related activities. The Czech Republic also has tools to support Czech institutions and companies via the national contact person for 7th Framework Programme under the priority "Space"under the Technology Centre of the Academy of Science of the Czech Republic and also in the CSO.

Compared to other instruments (ESA, national funds) the 7th Framework Programme is one of the most difficult to succeed with successful proposals. Also the EU cannot support all fields of space and has to focus its priority "Space" funding instruments as a priority for the EU as whole, which can be limiting in terms of topics offered for participants. In this context a better coordination of activities and especially the definition of roles, for example with the EU delegating the funds for space technology R&D to ESA (even from a small part of the structural funds) will be necessary.

Galileo

The European satellite system Galileo belongs to future generations of the GNSS systems which are intended to present the user with not only basic but also guaranteed services. Galileo is the joint programme of ESA and the EC which represents the European contribution to GNSS.

The definition phase and the development and In-Orbit Validation (IOV) phase of the Galileo programme is being carried out by ESA and co-funded by ESA and the EU. The Full Operational Capability phase of the Galileo programme is fully funded by the European Community and managed by the EC. EC and ESA have signed a

delegation agreement by which ESA acts as a design and procurement agent on behalf of the EC. The EC has delegated to ESA the task of procuring the Galileo infrastructure, in accordance with the GNSS regulation and the EU procurement rules (Delegation Agreement signed in December 2008). The EC furthermore, has provided to ESA by means of a grant agreement, the funds necessary to cover the cost overruns incurred by ESA during the IOV phase.

The Czech engagement in Galileo is through membership of the EU. The reason for this is linked to the fact that the development phase of Galileo took place under an ESA optional programme that is already closed for subscription. In this development phase the consortia for Galileo were established.

Considering that the Czech Republic only became a member of the EU in 2004 and of ESA in 2008, it was not able to participate in the development and production of the European GNSS space segment to a greater extent. For Czech entities, the opportunity to participate as a subcontractor in the finalization of the system nevertheless remains.

The Galileo User Forum (GUF) is worth mentioning since it represents a Czech initiative which gathers end-users of the Global Navigation Satellite Systems (GNSS) applications. Through the GUF Workshops the participants are involved in technical discussions with European institutions responsible for the development of satellite navigation – EC, GSA and ESA. These workshops may produce joint statements of users and recommendations for users and may be considered in the development of satellite navigation systems and their operation implementation. These workshops were carried out to strengthen the Czech Republic's candidature to host the seat of the GSA in Prague.

The Czech Republic is also a candidate to host the seat of the GSA, the agency of the EU which manages public interests related to European GNSS programmes. This candidature is a priority of the Czech government.

European Defence Agency

The EDA is active in the area of Research and Technology (R&T) related to defense.

In this effort, the EDA is working closely with participating Member States, EC and the defence industry. Through its dialogue with these stakeholders, the Directorate aims to strike the right balance between industrial development and competitive market issues.

The EDA and ESA have established informal working contacts since 2008 with a view to identify possible topics for coordination and synergies related to security. Common areas of interest currently range from the definition of requirements for ESA's security-relevant programmes such as 'Space Situational Awareness' and possibly in the European Data Relay Satellite System to assess Unmanned Aerial Systems (UAS) Command and Control over Satellite. Further scope for cooperation exists in the area of R&T development. A more structured relationship with ESA may involve the need for an Administrative Arrangement in the near future.

The EC, the ESA and the EDA have agreed in 2009 to join forces in order to develop critical space technologies in Europe. The aim is to ensure that Europe can rely on a technical and industrial capacity for accessing space, in particular in the area of the manufacturing of satellites and launchers.

6.3 EUMETSAT

EUMETSAT's key partner in developing and manufacturing satellites and supporting technologies is the ESA. Programmes in which the Czech Republic can participate within EUMETSAT activities in the framework of the ESA are Earth Observations Envelope Programmes (EOEP), funding development of scientific satellites, and GMES Space Component Programme (GSC) for developing new generation of satellites called Sentinel. EUMETSAT is also included into the Global Earth Observation System of Systems (GEOSS) initiative. EUMETSAT also cooperates with the EU.

EUMETSAT has been also carrying out its own programmes concerning meteorological Earth observations, which the Czech Republic can participate in. These programmes are designed and developed jointly with the ESA but EUMETSAT remains their main guarantor. In the framework of these programmes EUMETSAT often exploits products and technologies developed in other ESA's programmes, but EUMETSAT Council can refuse by its decision such ESA's claims for products development, application and implementation, which do not correspond with its intentions and objectives. This is an opportunity for the Czech Republic to enter into EUMETSAT's programmes architecture preparation.

EUMETSAT mandatory programmes are:

1. Meteosat First Generation, which will be probably terminated in 2013;
2. Meteosat Second Generation (MSG), at present the highest priority operational programme, which is supposed to deliver data at least till 2018;
3. European Polar System (EPS), in which EUMETSAT has the operational responsibility for polar orbiting MetOp satellites.

Since these programmes are already running, the Czech Republic can participate in them only in specific ways (e.g. software support etc.). New EUMETSAT mandatory programmes launched in 2010 and 2010 are:

1. Meteosat Third Generation (MTG), a joint programme with ESA.
2. Post-EPS, which will provide observations continuity of previous European Polar System (EPS) programme.

Both programmes have been at the preliminary level yet and bring consequently new opportunities for Czech industry and technological development.

EUMETSAT has been also realizing an optional programme Surface Topography Mission (OSTM) focused on sea level measuring. The Czech Republic does not take part in this programme.

6.4 National activities

Geographically small countries do not have sufficient capacity to implement top ranking R&D in all scientific fields. Neither there are enough industrial capacities and service bases for the advancement of competitiveness based on innovation in all economical spheres. Public support should therefore be aimed at existing research, development and technology potential offering capitalization in new products, technologies and services relevant to socio-economical needs of the society.

Currently there is no specific dedicated space programme in the Czech Republic. However the following national resources may play an essential supporting role.

The national R&D system is based on implementation of provisions arising from National RD&I Policy, where the links between RD&I and other areas of state interest are being intensified, primarily as regards the use of their results for innovative products, technologies and services.

The system of public support of RD&I is being reformed on the basis of the Government Resolution no. 287 of 26 March 2008 with a view to simplify the structure of state support. This includes reduction in the number of budgetary chapters, encouraging excellence and high quality research, fostering human resources, promoting international cooperation and creating professional agencies (GACR and TACR).

The GACR supports activities only for basic research with no established priorities.

The TACR will, after approval by the Government of the Czech Republic, announce new programmes for applied research in 2011. In this respect, some of the existing programmes promoting R&D administered from different ministries will cease to be implemented and at the same time a full range of new programmes foreseen by National Policy for RD&I 2009-2015 aiming at stimulating applied R&D, commercialization and utilization of its results in innovations, stimulating the overall R&D environment will be offered mainly by TACR, MEYS, MIT.

Priorities for applied research approved by the National Policy for RD&I 2009-2015 will become a basis for the activities of TACR. The priorities are currently as follows: Biologic and ecologic aspect of sustainable development, Molecular biology and biotechnology, Energy resources, Material research, Competitive engineering, Information society, Security and defence, and Priorities of Czech society development. It would be advantageous to Czech industry and academia to include a transversal priority for space.

Starting from 2012 TACR should announce new calls aimed at a new set of priorities closely related to society needs and knowledge-based economy. The emphasis should be given to relations with basic research and innovative process. New projects should be financed from 2013. MEYS shall stimulate researchers to create knowledge leading to innovation and to cooperate with industry.

The support of RD&I from EU Structural Funds is provided until 2013 especially from three Operational Programmes (OP) namely:

- OP RD&I (under competence of MEYS), which is aimed at strengthening the R&D pro-innovative potential of the CR, mainly through universities, research institutes and their co-operation with private sector. It also focuses on improving, developing and extending activities for commercialisation to increase the number of commercial applications of R&D results.
- OP Enterprise and Innovation (OPEI - under competence of MIT), aiming at the support of development of the entrepreneurial environment and the support of transfer of results of R&D into the business practice. It supports the establishment of new and development of current companies, their innovative potential and utilisation of modern technologies and renewable energy sources. It allows for establishing co-operation between companies and science and technology institutions.

- OP Education for Competitiveness (under competence of MEYS), focusing on the area of development of human resources through education in all various forms, with the emphasis on a complex system of life learning, creating a suitable environment for RD&I activities and stimulation of cooperation of participating subjects.

Until 2011 the MEYS will support R&D under the programmes Basic Research Centres, Information Resources for R&D. The Programme Basic Research Centre aims at supporting the collaboration between research centres to improve their competitiveness within the European Research Area (ERA) and to help train young researchers. Programme Information Resources for R&D seeks to provide researchers with access to information through R&D information resources such as important national and international professional databases, scientific periodicals and specialised electronic and classical documents.

The MIT has for the years 2004 to 2010 approved two active departmental programs TANDEM and IMPULS to support R&D.

The TANDEM Programme aims to support projects of oriented and industrial R&D. The objective of this program is to increase the knowledge transfer of basic research and increased use of its results in industrial applications. It helps to realize the cooperation of the R&D capability, i.e. R&D institutions of higher education, scientific and research institutes of the Academy of Sciences of the Czech Republic, public research institutions, etc., with industrial organizations.

The IMPULS Programme is focused on R&D of new materials, industrial products, manufacturing technology, information and management products and technologies. The objective of this program is to increase the efficiency of manufacturing organizations, especially small and medium sized enterprises, improving the competitiveness of products and upgrading technology. It provides, *inter alia*, support to use the results arising from solving projects in previous levels of the research activity. A prototype, patent, pilot, or verification device, a functional model and a sample of new material, etc. should normally be the result of solving projects supported under this program. The program provides pre-implementation part of the technological innovation.

The MIT ensures a New Notified departmental R&D program TIP for the years 2009 to 2017. Nowadays the third year of announcement of R&D tender for selection of programme projects to TIP Programme. Another tender notice is expected for 2012 to 2014. The program is designed especially for small and medium-sized enterprises (legal and natural persons from the area of industrial production) and academia (research organizations and universities).

The program focuses on projects dealing with R&D of new materials and products, new advanced technologies and new information and management systems. The timeline of the TIP program follows the programs IMPULS and TANDEM ending in 2010. Individual projects can be addressed within 48 months at the utmost. Each completed project must show some kind of outcome according to the current register of information on results, such as patents, utility model, industrial design, pilot plant, verified technology, software. The results of solved TIP projects must be implemented and used first in the Czech Republic.

6.5 Supporting Structure

Since 2003 the Czech Space Office (CSO) has been set up as a private non-profit organization and supports the MEYS. The CSO is used as a professional advisor for some of governmental bodies on issues regarding the space sector. The CSO contributed to governmental efforts to explore and exploit space and at the same time to ensure the Czech's investments in space are made to maximum benefit. CSO is currently funded via projects by the MEYS and the MT.

The main activities of CSO have been as follows:

- providing a comprehensive source of information on all space activities in the Czech Republic;
- Staff under the CSO represents and/or supports the Czech representation in several international governmental space organizations (ESA, EU, High-level Space Policy Group, GMES Advisory Committee, European Space Technology Platform and European Space Policy Institute);
- supporting the Czech long-lasting involvement in space debris issues and the EU initiative formulated in the Code of Conduct document;
- representing the Czech Republic in the International Astronautic Federation as a national member and regularly participates at the International Astronautic Congresses (IAC) taking the opportunity to showcase Czech activities to a wider international audience including other space agencies and leading academics.
- supporting both financially and administratively student and outreach activities

An electronic newsletter "Kosmický Kurýr" is published every month and distributed to continuously increasing number of subscribers. Content on the CSO website (www.czechspace.cz) is permanently updated with news and information on Czech space activities and on respective European programmes and space events.

With the new status of the Czech Republic as a member of ESA a wider representation of all competent governmental authorities in all the activities regarding space is necessary.

The next ESA Council at ministerial level, where new programmes will be open for subscription by Member States, is expected to take place at the end of 2011 (see Figure 5**Chyba! Nenalezen zdroj odkazů.**). For this purpose it will be necessary to start, at the end of 2010, the preparation through a thorough review and assessment of the status of Czech space activities and to identify priorities and resources.

This review and assessment task will have to be performed before any new supporting structure is possible to establish (e.g. a National Space Agency) with an institutional setting different from that of the CSO.

The preparation for the 2011 ESA Council at ministerial level needs to be lead by a Steering Committee with a clear mandate to act on behalf of the Czech government and representing all institutional competent authorities. The Steering Committee will lead this preparation process and be assisted by the experience and human resources

of the CSO that will act as its secretariat carrying out its decisions. For this purpose the Steering Committee should as soon as possible steer the activities of the CSO.

For purposes of consultation a Council of Stakeholders (e.g. industry, academia, funding agencies) could be established to provide a forum for the Steering Committee to expose results and proposals in preparation of the next ESA Council at ministerial level in a wider setting.

The Steering Committee should also logically act as the Preparatory Committee for the establishment of a National Space Agency. The National Space Agency can be established either as a governmental cross-sectional body or as a non-profit organisation reporting and answering to the Steering Committee. The formation of a National Space Agency covering all aspects of space activities should be formalized as soon as possible.

The Steering Committee could be in a first iteration, be composed of representatives of the MEYS, MT, MIT, ME, MFA and possibly MD and others.

6.6 Others

Czech Trade Promotion Agency

The Czech Trade Promotion Agency (CzechTrade) was established by the MIT in May 1997.

The CzechTrade´s main objective is to promote international trade and cooperation between Czech and foreign companies. The CzechTrade´s professional information, assistance and consulting services accompany Czech exporters to foreign markets, and the CzechTrade is a contact partner for foreign companies entering the Czech market, seeking interesting and reliable business partners and suppliers. These supporting services to industry are charged per hour, however the hourly rate is subsidized by the Czech government. Furthermore SME's can benefit from different national and EU supporting programmes.

The CzechTrade's Head Office is located in Prague. At the present time, CzechTrade has a network of 33 offices acting in 36 countries on four continents (some offices are entitled to act in more than 1 country). The network of the CzechTrade´s foreign offices provides on-the-spot practical assistance to Czech exporters abroad, and represents a unique contribution to the promotion of Czech exports. The Agency's services are available in 13 regional offices in the Czech Republic created in cooperation with the network of Czech Chamber of Commerce.

CzechTrade brings up-to-date news reports on export opportunities from the whole world to the Czech entities involved in export of goods and services. CzechTrade provides information on export opportunities in projects of international organizations (CERN, World Bank, ESO, ESA) for Czech companies and miscellaneous networking events (workshops B2B meetings, etc.) in the Czech Republic and abroad.

CzechTrade also provides basic information and links on the website on ESO and the ESA. Since January 2008, Czech Trade has been acting as the Industrial Liaison Office. CzechTrade makes (by assignment of the ESO headquarters Garching) announcement of call for expression of interest in public contracts for supplying goods and services for ESO. These activities comprise identifying potential suppliers and addressing these requirements directly to relevant Czech companies. Then CzechTrade passes Czech Suppliers´ contacts to the ESO.

Czech Investment Promotion Agency

The CzechInvest is an investment and business development agency established by the MIT in 1992. The CzechInvest´s main objective is to attract foreign investors and develop domestic companies.

CzechInvest acts as intermediary between the EU's structural funds and SMEs and submits the proposal for investment incentives to respective bodies. CzechInvest furthermore within the frame of technology workshops presents the Czech space industry abroad and promotes Czech Republic as an ideal place for investments.

Industrial Associations

In the Czech Republic, some industrial associations play a big part in creating suitable conditions for space activities both for their members, Czech industry in general and also the general public (e.g. they heighten awareness of space activities).

They often represent a mediator between industrial companies and state administration. Their role of sharing knowledge and experience, conveying needs of their members and protecting their interests is very important.

Czech space industry that has an interest in space and its applications is organized in three main associations: Intelligent Transport Systems and Services (Sdružení pro dopravní telematiku - SDT), Association of the Aviation Manufacturers (Asociace leteckých výrobců - ALV) and Czech Space Alliance (CSA).

SDT integrates information and telecommunication technologies with transport engineering under the support of other related industry, in order to provide for the existing traffic infrastructure an advanced system of control of traffic and transport processes. SDT was founded in 2000. The association comprises more than 70 members. The main goal of SDT is to achieve fast development of transport telematics in the field of roads, railway, waterway and air transport by providing technical, economic and ecologic benefits to a society and also to association members. SDT provides mainly a communication infrastructure to its members, therefore most of the association projects are in fact joint projects of a subset of the association member's companies.

ALV covers whole range of activities in aviation in the Czech Republic and acts as a representative of aircraft industry in the Czech Republic, Europe and the whole world. ALV was founded in 1994 and has more than 40 members, from major prime contractors and systems suppliers, through aircraft aggregates and components manufacturers to small specialist companies. They cover the whole spectrum of skills from design, development and production of the aeronautical systems to maintenance and operation including marketing and sales. The main objectives of ALV are to analyse and defend the ALV member interests, promote the Czech aerospace industry and its products and coordinate industrial and business activities. In this association, the only organisation currently involved in space activities is VZLU.

CSA is an industrial association of the Czech space industry, with proven skills and track record in aerospace business and with broad international client base. CSA was established in 2006 under the auspices of Czech Trade. CSA comprises 18 companies from a spectrum of technology disciplines and some 300 man years of experience in space projects. The main goals are to represent and promote the interests of the space industry to the national decision makers, the media and other relevant associations or entities, cooperate with the ministries and all other official entities supporting space

activities in the formulation of space policy, present the skills of its members at international events and establish dialogue with similar associations and space agencies. Companies represented in CSA have more than 75% of the ESA contracts in the Czech Republic.

Bi-lateral Space Agreements

As mentioned in Chapter 2.5, there are currently no bi-lateral agreements with other national space agencies, however following the interests of the Czech Republic and the strategic guidelines specified in this document, such agreements could be established.

7 Recommendations

In this Chapter the recommendations stemming from all information, discussion and considerations from the National Space Plan 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 (2016)

To ensure that Czech Republic is on the way to accomplish the Vision above it will necessary to achieve the following mid-term objectives 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.

7.3 Evaluation Criteria (2016)

To evaluate whether the mid-term objectives were achieved in 2016 it is necessary to define quantifiable evaluation criteria. The following are proposed:

- 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.
- Has a formalised structure supporting space activities

7.4 Evaluation and Review of Objectives

The mid-term objectives of Section 7.2 should be evaluated under the light of the evaluation criteria of Section 7.3 in 2016. At this date a new or revised National Space Plan should be formulated.

7.5 Programmes and 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 especially, should be seen as an opportunity, in a full-funding frame, to develop technologies, products and services that will be then exploited elsewhere, maximizing the “return-on-investment”.

Institutions referred to in chapter 4.3 may play a very important role supporting Academia and Industry by providing know-how, scientific/engineering and management support as well as the ability to perform tests to maximize the "return of investment".

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 with knowledge transfer should be supported using national schemes.

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

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 Intellectual Property Rights and Innovation

All R&D activities funded with public funds should aim towards developing 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 is also not excluded that where ESA requires the ownership of the IPR for operational or continuity reasons, activities are funded ensuring a competitive advantage for academia or industry on the maintenance, upgrade or development of the systems developed.

All activities under this space plan should consider the ownership of the IPR and the exploitation of these rights.

At this point it is necessary to speak of Technology Readiness Level (TRL). This is a concept 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.

In this frame, for both low and high Technology Readiness Level technologies, the role of IPR and patents 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 the registration of patents and protection of the IPR 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 then implemented and 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.

7.5.1.3 SME

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 on innovative SME. Specific measures to support SME and their innovative behaviour should be devised possibly through TIP programme of the MIT. Innovative SME can also ask for support within the OPEI programme which falls to the competence of MIT. These measures should also contemplate IPR and patent registration support.

7.5.1.4 General Approach

At this stage, since the recent accession to ESA, high TRL should have the higher priority to achieve products, applications and services that are used in ESA missions without disregarding low TRL technologies.

It is impossible to be exhaustive at this stage for low TRL technologies. On the other hand for high TRL, taking into account the capabilities in the Czech Republic discussed elsewhere in this document, and their access to high TRL contained in its existing products, opportunities or niches in the areas below should be supported commensurate with the Czech resources available for space.

Flight Hardware

Mechanisms and its related areas are an essential part of any satellite where Czech industry has a high level of preparedness; in fact, it is already supplying high quality mechanical parts to several European space products. Design and development capabilities in this area also exist.

Electronics and its related areas play a fundamental role in any sensor, instrument and satellite and where again there are already Czech suppliers also with capabilities of design and development.

Devices and components: the Czech Republic already has several device and component manufacturers, with Czech designs or licenses. Where appropriate, the development or qualification for space of these devices or components should be supported.

Payload or satellite sub-systems: in this area there are also high TRL capabilities.

Sensors or scientific instruments: this area should be encouraged fostering the collaboration between academia and industry and leading to the acquisition of knowledge and experience in space project management, development, constraints, quality assurance and others beyond the value or economic benefit of the particular sensor or instrument.

Software (ground or space)

Data processing for satellite data: in this area there are not only very good development capabilities but there are also good opportunities.

Ground segment: antenna/telescope control; telemetry, telecommand and control (TT&C), spacecraft control systems, and other ground segment support systems.

On-board: especially that related to payload software.

Embedded software: used in many satellite sub-systems.

Data and satellite applications: this is an area with proven capabilities that could also lead to fast developments.

In the area of Earth observation it could lead to extend the portfolio and quality of offered services about the state of Earth’s environment and to effective data collection, data management and maintenance.

Ground segment Services

Support to the development of services for navigation and Earth observation in the form of demonstrations and validation would play an important role in fostering the use of these services and by exposing a wider community to space applications.

There are other areas with middle-high TRL technologies that should be supported in preparation of mid-term opportunities. Of special mention are those associated with launchers where there are capabilities regarding cryogenic sub-systems and propulsive or explosive materials.

As previously mentioned low TRL technologies are essential to maintain a constant flow of innovation however this area is fraught with risk. To ensure that the most promising technologies survive and develop to attain high TRL it would be advisable to use funding competitive processes. For this purpose the ESA's Technology Research Programme, when compatible with the specified technology requirements, as well as the national programmes of TACR and GACR, should be used.

7.5.1.5 Czech Space Support Programme

The main tool for the Czech Republic to influence, develop and participate in space must be through its membership of the ESA where all European-wide space-related research and developments are carried out leading to systems that are then commercialised and exploited by other European organisations.

For the Czech Republic the *geo-return* used in ESA programmes is especially important as it guarantees the return on Czech contributions made to ESA back to the Czech Republic, however, the Czech industry must have the technical capabilities to be able to absorb the investment put forward. On the other hand to complement the participation in ESA activities a Czech Space Support Programme with a clear strategy is necessary.

The Czech Space Support Programme should also fund student satellites projects to attract and motivate the young generation to start a career in science and engineering involving young students in these student satellites projects. These small student satellites would engage them with hands-on experience even during their studies. The low cost of these nano-satellites or more complex international student projects organised and managed by ESA could provide suitable opportunities. This could be done with modest funds and would also raise the awareness due to the high profile of these space activities.

An amount around €1 million per year is proposed as the budget for a Czech Space Support Programme that should include the costs of the supporting structure, the educational and training activities (including student satellites) and specific technology or scientific space activities.

7.5.1.6 Legal Framework

The current legal framework may need to be improved to support the full range of activities necessary to achieve the objectives of the Czech Republic in the field of space. The current approach is not clear from the institutional point of view and does not allow for a balanced participation of the scientific and industrial communities, respecting their roles and missions, typical of space related activities.

The possible optimal solution, that would allow for the exploitation of the potential of space activities, would be to setup a structure that would allow the pertinent ministries (MEYS, MT, MIT, ME and possibly MD and others) to jointly exploit this potential and fund the multi-disciplinary, cross-sectional area of space.

Another issue that may require intervention concerns VAT and excise tax. According to the VAT law and excise tax law all international organizations that are based on international agreements that are part of the Czech rule of law are exempted from tax. According to ESA Convention and Czech Accession Agreement, ESA (as an international organization) and its activities are exempt from VAT and excise taxes. These issues also need to be address.

7.5.2 European Space Agency

To ensure a wider and deeper consultation of all Czech entities, the review of the status of the participation of the Czech Republic in ESA space activities and the definition of its priorities, social and economic impacts and resources, it will be necessary to start this process at least 1 year before any planned ESA Council at ministerial level. Schema shows the current plan for ESA Councils at ministerial level that take place, in general, every three years.

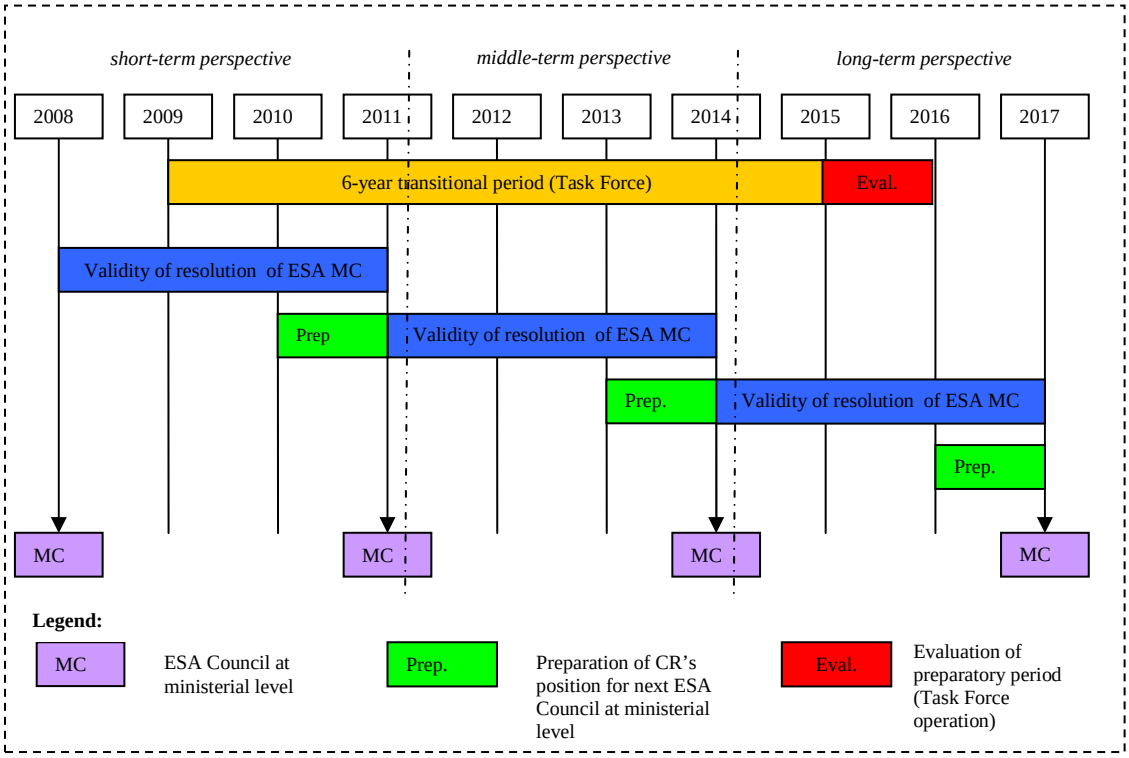


Figure 5 – Milestones for ESA programmes from 2008 to 2017

7.5.2.1 Scientific Programmes

Space Science

The Space Science Programme is part of the mandatory activities of ESA where Czech scientists already participate in some missions with some sub-systems at instrument level (software and hardware).

It should be noted that ESA's Space 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, Herschel/Plank or Gaia.

To ensure an active and increased participation in this programme it will be important to support these developments using PRODEX and National resources while ensuring that there is also an industrial component that will retain the experience acquired. When the industrial component is predominant, the Czech Industry Incentive Scheme could also be used if compatible with the resources available.

Regarding the processing and analysis of scientific data this should also be supported through PRODEX or National resources. Czech scientists should also be encouraged

to submit scientific proposals for the future science missions with the aim of becoming Principal Investigators of scientific instruments.

Programme for the Development of Scientific Experiments (PRODEX)

The Czech Republic has subscribed €0.25 million per year for the period 2009 – 2010 and €0.5 million per year for the period 2011 – 2015. (e.c. 2008).

The subscription in PRODEX of €0.5 million per year seems appropriate to support an active participation of academia and industry. However if Solar Orbiter is selected as one of ESA's space science missions additional funding may be necessary.

European Programme for Life and Physical Sciences (ELIPS)

The Czech Republic has subscribed €2.77 million in this optional programme for the period 2008 – 2012 which is 0.7% of the overall programme budget of €395 million (all in e.c. 2008).

The amount subscribed in ELIPS is high and is constrained by the use of the European Columbus laboratory in ISS, parabolic flights, drop towers and ground based facilities related to ELIPS program. This is also a scientific and technological area with the smallest "return-on-investment". For this reason the subscription should be decreased, possibly to around € 1.5 million, while increasing the subscription to PRODEX and GSTP that allow for a bigger flexibility while allowing for the same type of experiments.

7.5.2.2 Technology R&D

ESA manages several technology R&D programmes to guarantee that the necessary technologies are mature enough in due time. These programmes may fall under the mandatory activities of ESA or are optional programmes.

Mandatory Programmes

In the mandatory activities of ESA regarding technology, namely the Technology Research Programme (TRP), Science Core Technology Programme (CTP), Innovation Triangular Initiative (ITI), General Studies Programme (GSP) and European Component Initiative, Czech industry and academia has not been a very active player mainly due to lack of awareness of the web-based procurement tools (EMITS) of ESA and its technology work-plans. It is important to address this deficit as soon as possible by further publicising EMITS in the websites of the relevant Governmental authorities and other special actions.

General Support Technology Programme (GSTP)

The Czech Republic has subscribed €3.23 million for the period 2009 – 2013 which is 0.5% of the overall optional programme envelope of €650 million (all in e.c. 2008).

GSTP is of very high interest to industry and academia and due to its confirmation support mechanism for single activities (and guaranteeing a geo-return of 100%) it allows Czech priorities to be addressed. The subscription level should be at least doubled to around € 6-7 million for the next subscription period 2014-2019.

7.5.2.3 Earth Observation Technology R&D Programmes

Earth Observation Envelope Programme (EOEP)

The Czech Republic has joined the already running EOEP-3 optional programme and has subscribed €2.6 million for the period 2008 – 2010 which is 0.17% of the overall programme budget of €1490 million (all in e.c. 2006).

The subscription level (€2.6 million) of EOEP should be maintained if not increased for the next subscription period to ensure a Czech participation from the beginning of the definition of future Earth Observation missions to participation in instrument development. This would ensure a participation in the formation of the consortia that carry out the development of the future missions.

7.5.2.4 Earth Observation Application Development Programmes

Meteosat Third Generation (MTG)

For the period 2009-2020 the Czech Republic has subscribed €2.24 million which is 0.26% of the overall programme envelope of €860 million (all in e.c. 2008).

This programme with a long subscription period (2009-2020) offers the opportunity for Czech industry to develop products for the third generation of operational meteorological satellites that will then be procured by EUMETSAT via ESA. EUMETSAT financially participates in development of the next generation of meteorological satellites, that later will be procured by EUMETSAT via ESA, which will lead to benefits in the Czech Republic. If appropriate and possible at the ESA Council 2011, an increase of the subscription could be considered.

Global Monitoring for Environment and Security Space Component (GSC)

The Czech Republic has subscribed €1.76 million for the period 2009 – 2018 which is 0.2% of the overall optional programme envelope of €856.6 million (all in e.c. 2008).

This programme offers the opportunity for Czech industry to develop products that will then be procured by the EU possibly via ESA, leading to a fallout in the Czech Republic. Due to its long subscription period (2009-2018) it will not be up for subscription soon however, if appropriate and possible at the ESA Council 2011, an increase of the subscription should be considered if it increases the leverage to access EU funding.

Both MTG and GMES Space Component are opportunities for the Czech industry to establish itself as supplier to large space integrators. The MTG programme is especially attractive due to higher numbers of satellites to be built (this includes MTG satellites ordered by EUMETSAT). For this reason it may be beneficial and is recommended to raise the Czech contribution to MTG programme if funds are available and, of course, other participating states agree. This could make the Czech Republic an indispensible partner of the programme thus securing key procurements. The GMES programme still offers the chance to join the consortia developing Sentinels 4 and 5 while it is already too late for Sentinels 1 – 3.

7.5.2.5 Navigation Technology R&D Programme

European GNSS Evolution Programme (EGEP)

The Czech Republic has subscribed €0.48 million for the period 2009 – 2011 which is 0.46% of the overall optional programme envelope of €105 million (all in e.c. 2006).

EGEP is a programme that could ensure the participation of Czech industry in the future generation of Galileo. For this reason the subscription to the next subscription period, that could take the form of a new programme e.g. *European GNSS Supp. Programme Extension*, should be increased to around €1 million.

7.5.2.6 Telecommunication Technology R&D Programmes

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

ARTES 3-4

For the period 2009 – 2013 the Czech Republic has subscribed €1.7 million for the Element 3-4 of ARTES which is 0.31% of €550 million of the overall optional programme-element envelope (all in e.c. 2008).

ARTES 3-4 is geared towards "close-to-market" technological activities that require matching funds from industry. Its effectiveness should be evaluated at the end of the subscription period to assess if these opportunities are being taken up by industry. In the negative case ARTES 5, that allows for 100% (or 75%) funding of telecommunication technology R&D, should be subscribed instead. In any case ARTES 5 should also be subscribed by a similar amount. The possibility to decrease the subscribed amount by 50% and to subscribe ARTES 5 with at least an equal amount should be investigated as soon as possible.

ARTES 5

The *ARTES Element 5: "ESA Telecom – Technology"* has been initiated 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 steps up to and including the step where the subject of the development has been built into a configuration representative of the final product (see also discussion on product in the part of section 6.2.1 devoted to ARTES 3-4) and critical performances have been verified by test. The formal qualification and industrialisation are not part of the programme. 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 are awarded in open competition and are 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 open to industry, universities, research organisations, national space agencies and ESA itself. The "Non-competitive Industry Initiated Activities" sub-element 5.2 is funded to a maximum level of 75% by ESA. ESA may fund up to 100% for work carried out by universities and research organisations when such institutions are sub-contractors and if this funding does not exceed 30% of the total cost of the activity. The activities are defined by industry and submitted in response to an Open Call for Proposals. When industry presents a proposal in this sub-element a plan is required for continuing the development to a product ready for commercial exploitation.

The Czech Republic should subscribe to ARTES 5 programme around 0,57% of the overall programme envelope of €150 million (all in e.c. 2008) as this amount to about half the current contribution to ARTES 3-4.

Subscription to the ARTES 5 Element would ensure an easier participation of Czech entities in the earlier stages of development of telecommunication satellite equipment that would then be supported by ARTES 3-4. It is recommended that this programme element is subscribed as soon as possible. The relative ratio of subscription in ARTES 5 to ARTES 3-4 should be 1 to 1.

7.5.2.7 Telecommunications Application Development Programmes

ARTES 10 Iris

The Czech Republic has subscribed €4.14 million for the period 2009 – 2011 which is 10.64% of the overall optional programme-element envelope of €38.9 million (all in e.c. 2008) – by far the largest Czech contribution to an optional programme both in terms of absolute amount of money and share of the subscription. Assuming that the same percentage of the total programme is maintained for the following phase, the subscription could cost in excess of €19 million with an equivalent amount of over €19 million being invested by industry as demanded by the programme declaration.

The subscription to ARTES 10 Iris phase II.1 for the period 2009-2011 is the highest of all ESA optional programmes € 4.14 million). Since the subscription to the following phase II.2 would entail a very high amount, with matching funds from industry, it will be necessary to evaluate whether a) industry is prepared to fund to a similar amount phase II.2 while ensuring that the intellectual property rights (IPR), manufacture and exploitation of the products and services developed will remain in the Czech Republic, b) the necessary resources will be available to the Czech State with no detriment to the participation in other programmes. If the benefits will not remain in the Czech (namely IPR, manufacture and exploitation) it is advisable to decrease substantially (at least by a factor of 2-5) the subscription to phase II.2 and keeping the same subscription amount (€ 4 million).

ARTES 20

The Czech Republic has subscribed €0.17 million for the period 2009 – 2013 (Phase 1) which is 0.21% of the overall optional programme-element envelope of €80 million (all in e.c. 2008).

The ARTES 20 (IAP) may lead to some integrated systems of interest to the Czech Republic that will be defined in this programme. The next phase (Phase 2) of this programme with application development of integrated systems should be subscribed only if there are applications of clear interest to the Czech Republic. This should be decided at the ESA Council of 2011. It should be noted that the envelope of Phase 2 may be three times higher than the current envelope. In any case the subscription to the following phase should, in principle, be of the same level (0.21%).

7.5.2.8 Launcher and Human Exploration Technology R&D Programmes

Future Launchers Preparatory Programme (FLPP)

The Czech Republic has subscribed €0.5 million for the SDT element (Systems, Demonstrators and Technology) for the period 2009 – 2012 which makes 0.42% of the overall element budget of €120 million (all in e.c. 2008). The Czech Republic has not subscribed for IXV element (Intermediate eXperimental Vehicle for re-entry)

since the consortia of companies built around IXV development has already been established which makes it difficult for Czech companies to participate in the programme.

There is some promise that FLPP could exploit Czech existing know-how in cryogenic pumps, turbo-compressors and others. In the case that this promise is fulfilled the next period of FLPP (2013-2016) should be subscribed as well as the follow-up programme concerning the NGL (successor to Ariane 5). In these cases the subscription level for FLPP should be of a similar percentage (0.42%) and the subscription level for the NGL at 0.21% to 0.4% depending on the resources available.

European Transportation and Human Exploration Preparatory Activities Programme (ETHE)

The Czech Republic has subscribed €0.19 million for the period 2009 – 2012 which is 0.21% of the overall optional programme budget of €90 million (all in e.c. 2008).

At this point in time it is not clear if the subscription to ETHE will lead to any interesting activity with potential future benefits in the Czech Republic. The successor to this programme could require high levels of subscription. It is proposed to examine the status at the end of the subscription period and to evaluate if it is worthwhile continuing subscribing to the programme or leave this optional programme.

7.5.2.9 Security of the Earth

The *Space Situational Awareness Preparatory Programme (SSA)* objective 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 are carried out in successive programmatic steps with a view to achieve a full operational capability over a framework of ten years since 2008. ESA is 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.

The high-level users' needs for the European SSA system are especially to support safe and secured operation of space assets and related services, to support risk management (on orbit and during re-entry) and liability assessment, to assess the status and basic characteristics of space objects (both man-made and natural), detect non-compliance with applicable international treaties and recommendations, and to enable the allocation of responsibility for space objects to launching state or organization, and support confidence building measures (identification of owner and/or operator).

The SSA Preparatory Programme comprises four elements: the core element, the space weather activities, the pre-development and bread boarding of critical subsystems of the radar, and the pilot data centres. The core element activities pursue the objective of supporting the definition of the governance, of developing an appropriate data policy and of specifying the data centres that need to be established within the SSA system. It also includes the specification and architectural design of a space surveillance system that will monitor man-made objects in Earth-bound orbits including space debris.

The SSA programme started in 2008 without Czech participation. For its strategic it is, however, deemed important to get involved in the programme at the earliest possible occasion. The successful Czech participation in the programme may build on the Czech expertise in related scientific disciplines astronomy and Earth observation.

7.5.2.10 International Space Station Exploitation Programme

The *European Participation in the International Space Station Exploitation Programme (ISS Exploitation)* provides for the legal and financial framework as well the means for fulfilling the obligations and responsibilities accruing to the ESA in the framework of the Space Station Agreements (i.e. IGA and ESA/NASA MOU) during the ISS operations and utilisation phase.

The ISS Exploitation programme is intended to cover the operations/maintenance of the elements developed in the past ISS Development programme and of other European contributions to the space station orbital facility developed in other self-standing programmes. The payloads and experiments to perform the actual utilisation are not covered by this programme.

The ESA ISS Exploitation Programme involves a number of system elements and related functions including all European developed items, which are part of the integrated space station, as well as their maintenance. The flight element includes Automated Transfer Vehicles (ATVs), Columbus laboratory, Node 2 and 3, Cupola, European Robotic Arm and many other facilities of the ISS. Ground elements include Columbus and ATV control centres, cargo integration, ground communication systems, user support and operations centres (USOCs), and crew training and medical facilities.

The ISS development is close to completion and the benefits of a Czech participation in the programme are questionable. The prime reason is that in the next ten years the focus of the programme will be on the maintenance, operational activities and procurement of services, ATVs and its subsystems. For virtually all of these procurements significant past expertise is essential which cripples opportunities for the Czech industry. However, the Czech participation in the next period of the programme may be requested by other ESA member states for solidarity reasons. This request should be avoided and only considered if (and only if) the Czech utilization of the ISS considerably increases and becomes significant which is not expected.

7.5.3 European Union

In the context of Article 189 of the Lisbon Treaty[25] and considering the possible scenarios of cooperation between the EU and ESA and the approach that will be used, it will be important for the Czech Republic to ensure that a) space in small States like the Czech Republic is protected; b) space, and especially space technology R&D, is a tool for development that contributes to the closing of the structural gaps between EU Member States and c) that space is not a “normal” market due to its strategic role and multi-annual nature. These considerations will be fundamental in the negotiations regarding funding of space activities and procurement of space systems.

It is important to recall that the industrial policy of these two organisations is substantially different. For the EU the industrial policy is primarily focused on

[25] CONSOLIDATED VERSION OF THE TREATY ON THE FUNCTIONING OF THE EUROPEAN UNION, Official Journal of the European Union, C 115/49, 9 May 2008, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2008:115:0047:0199:EN:PDF

competitiveness and avoiding distortion of the markets while for ESA is mostly aimed at *developing and safeguarding European industrial capabilities*.

It will be important for the Czech Republic to ensure that its interests, that are the same as of all EU small Member States, are protected regarding space technology R&D since it plays an important role in the development of its economy.

In this connection, the European Commission will submit a proposal of a regulation concerning the European Space Program during this year. The Czech Republic will take an active part in the preparatory discussions.

During 2010 the European Commission will propose the main directions and aims of the future 8th Framework Program for 2014-2020. The Czech Republic will actively participate in the negotiations in the Council of EU.

7.5.3.1 Framework Programme

The Czech Republic belongs to a group of less successful countries in the 7th Framework Programme under the priority "Space". On one hand, there are not too many projects proposed by Czech applicants and on the other hand the overall rate of successful applications is below average.

Compared to other instruments (ESA, national funds) the 7th Framework Programme is one of the most difficult to succeed with successful proposals. Also the EU cannot support all fields of space and has to focus its priority "Space" funding instruments as a priority for the EU as whole, which can be limiting in terms of topics offered for participants. In this context a better coordination of activities and especially the definition of roles, for example with the EU delegating the funds for space technology R&D to ESA (even from a small part of the structural funds) will be necessary.

7.5.4 EUMETSAT

EUMETSAT supports Satellite Application Facilities (SAFs) that are specialised development and processing centres within the EUMETSAT applications ground segment. Using specialised expertise in Member States, they complement the production of standard meteorological products derived from satellite data at EUMETSAT's central facilities and distribute user software packages. Each SAF is lead by a national meterological service. There are currently eight SAF.

SAFs are funded nationally and may offer an opportunity to the Czech Republic to participate in the development of such a facility leading to additional applications and products. The possibility to develop in the Czech Republic a SAF covering applications not yet contemplated in the existing SAF should be investigated since it may bring national benefits.

7.5.5 National

7.5.5.1 Supporting Structure

With the new status of the Czech Republic as a member of ESA a representation, wider than that provided by the CSO, of all competent governmental authorities in all the activities regarding space is necessary.

The next ESA Council at ministerial level, where new programmes will be open for subscription by Member States, is expected to take place at the end of 2011 (see Figure 5**Chyba! Nenalezen zdroj odkazů.**). For this purpose it will be necessary to

start, at the end of 2010, the preparation through a thorough review and assessment of the status of Czech space activities and to identify priorities and resources.

This review and assessment task will have to be performed before any new supporting structure is possible to establish (e.g. a National Space Agency) with an institutional setting different from that of the CSO.

The preparation for the 2011 ESA Council at ministerial level needs to be lead by a Steering Committee with a clear mandate to act on behalf of the Czech government and representing all institutional competent authorities. The Steering Committee will lead this preparation process and be assisted by the experience and human resources of the CSO that will act as its secretariat carrying out its decisions. For this purpose the Steering Committee should as soon as possible steer the activities of the CSO.

For purposes of consultation a Council of Stakeholders (e.g. industry, academia, funding agencies) could be established to provide a forum for the Steering Committee to expose results and proposals in preparation of the next ESA Council at ministerial level in a wider setting.

The Steering Committee should also logically act as the Preparatory Committee for the establishment of a National Space Agency. The National Space Agency can be established either as a governmental cross-sectional body or as a non-profit organisation reporting and answering to the Steering Committee. The formation of a National Space Agency covering all aspects of space activities should be formalized as soon as possible.

The Steering Committee could be in a first iteration, be composed of representatives of the MEYS, MT, MIT, ME, MFA and possibly MD and others.

The supporting structure should act as executive and secretariat of the Steering Committee and by (most tasks are already covered by the CSO) performing the following tasks *inter alia*:

- acquire, collect and process all information relevant for space activities and provide a comprehensive source of information on all space activities in the Czech Republic;
- operate as liaison with industry and academia regarding their field of expertise and maintain a detailed database for this purpose;
- support the representation or represent the Czech Republic in ESA, EU (regarding space), EUMETSAT, European Space Policy Institute, ESO, UN-COPUOS and other international organisations or initiatives relevant to space activities;
- represent or support the representation of the Czech Republic in the International Astronautic Federation and regularly participate in the International Astronautic Congresses (IAC) taking the opportunity to showcase Czech activities to a wider international audience including other space agencies and leading academics;
- maintain updated information on policy and international agreements regarding space;
- carry out or support awareness activities in academia, industry, the general public and policy/decision makers;

- manage its own allocated budget;
- manage or support the management of the budget of the Czech Supporting National Programme;
- support educational and training activities by:
    - Building and maintaining the network of contact points in academia, relevant to space, including updated information on courses and their content;
    - Organize or support the organisation of the competitions for specialisation or training courses;
    - Identify, in direct contact with industry and Industrial Associations training actions in specific technologies of interest to industry and support them;
    - Maintain a list of objective indicators regarding education and training to allow a regular assessment of the education and training programme;

The supporting structure should have a specific budget to support its activities.

7.5.5.2 Human resources, Training and Education

There is an important gap in the training of professionals to support Czech space industry that will need to be addressed. This gap may have an adverse impact on the performance of Czech industry and its growth. It is essential to support qualified professionals in raising their qualifications to keep them "current" in space activities (courses, programs, training, and grants).

The MEYS should as soon as possible stimulate the careers of university graduates in areas of applied research, innovation and in knowledge-demanding fields. It should as well announce from 2013 all new calls promoting short and long term fellowships of researchers at European and international institutions.

More targeted schemes are possible to implement with specific cooperation agreements with ESA like the Spanish, Portuguese and Greek Trainee schemes. These latter schemes allow for more targeted training where the needs of the Czech Republic are addressed first through a consultation with its industry and then through a request to ESA for training vacancies in the areas of interest.

This scheme must be funded nationally and a specific cooperation agreement between the national funding organisation and ESA is necessary. A Czech Trainee Scheme would help create engineers and scientists to quickly acquire experience in specific fields necessary to Czech industry.

7.5.5.3 Awareness

The interest in space science and technology must be awakened and supported in order to create a favourable environment (e.g. promote attractive learning activities, create and support new ones, expand on current study branches and programs, and the like).

Dissemination of information among industry about opportunities in space business with focus on ESA activities should also be part of awareness actions using conferences, workshops, web information portals and other media channels.

More attention should be also be paid to raising awareness among decision makers about ongoing issues and needs in the space sector. Space activities need clear long-term planning and commitment. For this reason, systematic information must be available to decision makers, not only in the form of regular briefings or reports, but also in the form of magazines, leaflets and parliamentary bulletins.

The Council for RD&I should improve the popularization of RD&I by setting up an internet portal with up-to-date information.

MEYS should continue to support activities demonstrating the utilization of research and its application for the benefits of the society and in cooperation with CzechTrade its presentation abroad. On top of whole range of existing activities it should focus on the unsatisfactory interest of young people to engage in RD&I.

7.5.5.4 Other Supporting Measures

Priorities for applied research approved by the National Policy for RD&I 2009-2015 will become a basis for the activities of TACR. The priorities are currently as follows: Biologic and ecologic aspect of sustainable development, Molecular biology and biotechnology, Energy resources, Material research, Competitive engineering, Information society, Security and defence, and Priorities of Czech society development. If still possible, it would be advantageous to Czech industry and academia to include a transversal priority for space.

There is a strong need to support the National Secretariat for GMES with a position dedicated to SMEs to motivate their involvement in GMES and also to advice on proposals writing. For big national institutions another specialist is needed to analyze services coming from GMES, which can be potentially beneficial for their daily needs.

Regarding Galileo, the Czech Republic should support the participation of Czech entities in the development of applications and services for EGNOS and Galileo, primarily its use in traffic navigation, safety, energy, geodesy, agriculture, environment and preservation and defence. In particular the following activities concerning satellite navigation and communication systems are of interest of the Czech administration:

- strategy of the use of GNSS systems in individual sectors of the national industry;
- determination of demand for certain applications such as safety, dependability, accuracy, resistance against interference, privacy protection, cost and progress in certification and support of the standardized process;
- corresponding mapping (cartographic) foundations for GNSS systems;
- pilot verification of technical standard proposals in laboratories an; in trial operations,
- use of the GNSS system as a key component in telematic solutions for transport in all relevant types of traffic for the increase of the economics, ecologic and safety of transport.

7.6 Financial implications

As previously discussed space activities require a multi-year budget approach not only because on 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 since it joined ESA at the end of 2008 and any discontinuity can have adverse effects on its industrial capabilities in the transition period where its industry is familiarising itself with space requirements. For the same reason the involvement in any human spaceflight that have a low return on investment is considered only with minimal subscriptions.

Current Commitments

Tables I - IV below show the current commitments of the Czech Republic in on-going ESA programmes in the time scale from 2010 to 2019.

ESA Long Term Plan

To prepare future commitments of its Member States and the EU under the light of its strategic objectives and priorities as considered within the European Space Policy, ESA has drafted a ten-year Long-Term Plan (LTP). [26]

The LTP describes the set of on-going and planned programmes with the correlated financial profiles at the economic conditions of 2020, for the next ten years in accordance with applicable ESA Council's instructions. For this purpose ESA has elaborated 3 scenarios to encapsulate the different economic and political conditions that may develop in this time-frame.

The first ESA scenario (ESA Scenario 1) is a pessimistic scenario and it assumes that there will be no increase of the support of ESA Member States with respect to their commitments taken at the 2008 ESA Council at ministerial level and that the EU will pursue the primary objectives of the European Space Policy, without further fostering the European role in the space international arena (e.g., security and exploration).

The second ESA scenario (ESA Scenario 2) is a middle-of-the-road scenario and assumes that additional funding is assumed to come from the European Union new Financial Perspectives starting as of 2014 and that Member States are assumed to increase their contribution to ESA from 2014. In this scenario, in addition to the activities identified in the ESA Scenario 1, further important undertakings related to environment, development and climate change would be possible, in particular in human exploration, launchers, security and applications.

The third ESA scenario (ESA Scenario 3) is an optimistic scenario and assumes that there could be a major step forward in the European space programme with a breakthrough in Human Exploration and Launchers. This major step forward would stem in particular from the strong political support given at the 5th Space Council in September 2008 to a primary role that Europe should be playing in particular in the future human exploration global endeavour, and in which the overall transportation scenario, including unmanned future launchers, should benefit of synergies on re-entry activities. The materialisation of this scenario would have to rely not only on the political support, but above all on increases larger than in the ESA Scenario 2 of both Member States' contributions and European Union financial support to European programmes.

[26] Draft ESA Long-Term Plan 2010-2019, ESA Council, ESA/C(2009)127, Paris, 3 December 2009.

Czech Long Term Plan

To provide a guideline to decision makers Czech scenarios were elaborated based on the actions, approach and priorities previously discussed in this document and on the ESA LTP. It should be noted that the costs to support SME and the IPR are here assumed as external since this issues are of interest to Czech entities as a whole.

As discussed in 7.5.2, every 3 years the ESA Council at ministerial level takes place and where new optional programmes may be agreed. The lower part of the Tables below show "Future Optional Programmes" that could be decided in the next ESA Councils at ministerial level and where there could be a Czech interest in subscribing. Assumed subscription percentages are also shown reflecting this interest. However the precise participation will have to be decided after review and consultation in preparation for each of the ESA Councils, as discussed previously.

In the future optional programmes shown in the Tables the following programmes were not described elsewhere. It should be noted that:

- "Security on Earth Initiative" – would include, with substantial support from the EU, the progressive development of a "Security on Earth Element" (e.g. Sentinels S of GMES) approximately around 2020 and aiming at providing in-orbit demonstrations of innovative technologies such as high resolution hyper-spectral and thermal infrared and/or optical sensors and new generation SAR. These could be building blocks towards the development of an innovative constellation for Earth observation, monitoring and crisis management to be operational after 2020
- Post-EPS Development – is the development programme for the successor to the operational EUMETSAT MetOP/EPS system
- Climate Change Continuation – is the programme that continues the initiative that started in 2008 (Climate Change Initiative) to generate, preserve and give access to long-term data sets of the essential climate variables and make them freely available to climate research and modelling communities worldwide. It builds on the availability of Europe's global data sets and on data delivered by a network of other space agencies. It will also guarantee the provision of space-based information for the future, in a form readily usable by scientific communities and government bodies.

The Czech scenario A1 assumes that the current level of commitments is maintained at approximately the same percentage of subscription with small variations that implement the recommendations previously discussed in this Chapter and uses the ESA LTP Scenario 1 for the future commitments. Table I shows the result of this scenario. Table II shows scenario A2 that makes the same assumptions however takes into account a reduction in ARTES 10 Iris for its Phase II.2 to its current level (in absolute numbers) of 4 million Euro making it about 3% of the overall programme envelope to reflect the considerations in 7.5.2.7.

The Czech scenario B1 uses as a basis the ESA LTP Scenario 2 and the perceived growing Czech capabilities. Table III reflects these assumptions. Scenario B2 (Table IV) uses the same ESA LTP Scenario but takes into account the possible decrease in the subscription to ARTES 10 Iris. In all Tables the amounts are in million Euro (€). The percentage of subscription to the overall ESA programme and comments are also shown. Tables I to IV show as well the assumed costs of a Czech Space Support Programme based on 10% of the total ESA subscription.

In all these scenarios, the placeholder “Other Strategy, Applications & Technology in ARTES”, is targeted at future new slices of ARTES as well as margin in the case of very successful performance of Czech industry especially in ARTES 20.

Table I: Scenario A1														
Programme		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	ESA total	Sum 10-19	CZ CM 08
Mandatory	Mandatory activities	5.46	5.95	6.12	6.31	6.29	6.29	6.29	6.29	6.29	6.29	7084.10	61.5	0.82
Current	EOEP (including Period 1,2,3)	0.54	0.60	0.67	0.44	0.29	0.06					1283.80	2.60	N/A
Optional	GMES Space Component (ESA+EC)	0.26	0.29	0.33	0.43	0.14	0.12	0.12	0.07			1911.60	1.76	0.21
	MTG 1	0.06	0.16	0.19	0.30	0.46	0.36	0.32	0.20	0.12	0.06	981.60	2.24	0.26
	ELIPS 3	0.58	0.64	0.54	0.56	0.45						248.80	2.77	0.70
	Transportation and Human Exploration	0.07	0.06	0.06								39.80	0.19	0.21
	ARTES 1 Phase V	0.01	0.03	0.04	0.04							27.30	0.12	0.20
	ARTES 3/4 Phase 1	0.09	0.11	0.17	0.18	0.18	0.12					412.40	0.85	N/A
	ARTES 10 Phase II.1	1.77	1.92	0.43								36.20	4.13	11.83
	ARTES 20 Phase I	0.03	0.04	0.05	0.04	0.01						53.70	0.17	0.21
	European GNSS Evolution Programme	0.19	0.20	0.09								69.50	0.48	0.64
	FLPP Period 2 Step 2 SDT activities	0.04	0.27	0.11	0.08							103.50	0.50	0.42
	GSTP Phase 5	0.61	0.51	0.69	0.73	0.42	0.27					272.20	3.23	1.01
	Prodex	0.25	0.50	0.50	0.50	0.50	0.50					135.70	2.75	N/A
Additional	ARTES 5 Period 2 Phase IV	0.08	0.04									28.40	0.12	0.43
Optional	ARTES 5 Sub-element 5.1	0.04	0.11	0.15	0.12	0.08						116.80	0.50	0.43
	ARTES 5 Sub-element 5.2	0.03	0.03	0.04	0.05	0.04	0.01					48.90	0.21	0.43
Future	Other Str. Apps & Tech. in ARTES				0.01	0.05	0.20	0.45	0.59	0.66	0.77	1337.30	2.74	0.21
Optional	ARTES 10, Iris Phase II.2			2.26	2.92	4.11	5.18	3.29	1.77			165.30	19.53	11.82
	ARTES 20 IAP Phase 2			0.04	0.04	0.09	0.09	0.07				153.30	0.32	0.21
	GSTP continuation					0.18	0.90	1.32	1.60	1.55	1.55	354.90	7.10	2.00
	Prodex continuation							0.50	0.50	0.50	0.50	210.00	2.00	N/A
	European GNSS Supp. Pr. Ext.			0.08	0.11	0.20	0.20	0.19	0.18	0.18	0.17	206.70	1.32	0.64
	EOEP continuation				0.11	0.39	0.58	0.61	0.67	0.73	0.76	1605.30	3.85	0.24
	Post-EPS Development (ESA+Eumetsat)			0.05	0.10	0.16	0.29	0.45	0.63	0.71	0.63	1165.50	3.03	0.26
	Climate Change Continuation					0.05	0.05	0.05	0.05	0.06	0.10	180.00	0.37	0.21
	ELIPS Period 4				0.17	0.17	0.24					240.00	0.58	0.24
	Human Expl. Prep. Studies				0.02	0.04	0.09	0.10	0.11	0.14	0.19	336.80	0.69	0.21
	SSA Programme				0.02	0.02	0.03	0.06	0.10	0.11	0.13	226.30	0.46	0.21
	Security on Earth Initiative (ESA+EU)				0.02	0.02	0.03	0.06	0.10	0.11	0.13	226.30	0.46	0.21
	FLPP Period-3				0.10	0.22	0.35	0.52	0.72	0.77	0.77	722.80	3.47	0.48
	Total for scenario 1 (less funds)	10.11	11.46	12.62	13.46	14.65	16.04	14.44	13.63	11.96	12.06	20148.00	130.44	N/A
	Czech Space Support Programme	1.01	1.15	1.26	1.35	1.47	1.60	1.44	1.36	1.20	1.21	N/A	13.04	N/A
	Grand total (ESA+national)	11.13	12.60	13.88	14.81	16.12	17.65	15.88	14.99	13.15	13.27	N/A	143.48	N/A

Table II: Scenario A2														
Programme		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	ESA total	Sum 10-19	CZ CM 08
Mandatory	Mandatory activities	5.46	5.95	6.12	6.31	6.29	6.29	6.29	6.29	6.29	6.29	7084.10	61.5	0.82
Current	EOEP (including Period 1,2,3)	0.54	0.60	0.67	0.44	0.29	0.06					1283.80	2.60	N/A
Optional	GMES Space Component (ESA+EC)	0.26	0.29	0.33	0.43	0.14	0.12	0.12	0.07			1911.60	1.76	0.21
	MTG 1	0.06	0.16	0.19	0.30	0.46	0.36	0.32	0.20	0.12	0.06	981.60	2.24	0.26
	ELIPS 3	0.58	0.64	0.54	0.56	0.45						248.80	2.77	0.70
	Transportation and Human Exploration	0.07	0.06	0.06								39.80	0.19	0.21
	ARTES 1 Phase V	0.01	0.03	0.04	0.04							27.30	0.12	0.20
	ARTES 3/4 Phase 1	0.09	0.11	0.17	0.18	0.18	0.12					412.40	0.85	N/A
	ARTES 10 Phase II.1	1.77	1.92	0.43								36.20	4.13	11.83
	ARTES 20 Phase I	0.03	0.04	0.05	0.04	0.01						53.70	0.17	0.21
	European GNSS Evolution Programme	0.19	0.20	0.09								69.50	0.48	0.64
	FLPP Period 2 Step 2 SDT activities	0.04	0.27	0.11	0.08							103.50	0.50	0.42
	GSTP Phase 5	0.61	0.51	0.69	0.73	0.42	0.27					272.20	3.23	1.01
	Prodex	0.25	0.50	0.50	0.50	0.50	0.50					135.70	2.75	N/A
Additional	ARTES 5 Period 2 Phase IV	0.08	0.04									28.40	0.12	0.43
Optional	ARTES 5 Sub-element 5.1	0.04	0.11	0.15	0.12	0.08						116.80	0.50	0.43
	ARTES 5 Sub-element 5.2	0.03	0.03	0.04	0.05	0.04	0.01					48.90	0.21	0.43
Future	Other Str. Apps & Tech. in ARTES				0.01	0.05	0.20	0.45	0.59	0.66	0.77	1337.30	2.74	0.21
Optional	ARTES 10, Iris Phase II.2			0.56	0.73	1.03	1.29	0.82	0.44			165.30	4.88	2.96
	ARTES 20 IAP Phase 2			0.04	0.04	0.09	0.09	0.07				153.30	0.32	0.21
	GSTP continuation					0.35	1.80	2.64	3.20	3.10	3.10	354.90	14.20	4.00
	Prodex continuation							0.50	0.50	0.50	0.50	210.00	2.00	N/A
	European GNSS Supp. Pr. Ext.			0.08	0.11	0.20	0.20	0.19	0.18	0.18	0.17	206.70	1.32	0.64
	EOEP continuation				0.15	0.52	0.77	0.81	0.89	0.98	1.01	1605.30	5.14	0.32
	Post-EPS Development			0.13	0.26	0.40	0.72	1.10	1.55	1.74	1.56	1165.50	7.46	0.64
	Climate Change Continuation					0.05	0.05	0.05	0.05	0.06	0.10	180.00	0.37	0.21
	ELIPS Period 4				0.17	0.17	0.24					240.00	0.58	0.24
	Human Expl. Prep. Studies				0.02	0.04	0.09	0.10	0.11	0.14	0.19	336.80	0.69	0.21
	SSA Programme				0.27	0.30	0.34	0.37	0.40	0.40	0.40	389.50	2.49	0.64
	Security on Earth Initiative (ESA+EU)				0.02	0.02	0.03	0.06	0.10	0.11	0.13	226.30	0.46	0.21
	FLPP Period-3				0.10	0.22	0.35	0.52	0.72	0.77	0.77	722.80	3.47	0.48
	Total for scenario 1 (less funds)	10.11	11.46	11.00	11.65	12.32	13.91	14.40	15.32	15.06	15.07	20148.00	130.30	N/A
	Czech Space Support Programme	1.01	1.15	1.10	1.16	1.23	1.39	1.44	1.53	1.51	1.51	N/A	13.03	N/A
	Grand total (ESA+national)	11.13	12.60	12.10	12.81	13.55	15.31	15.84	16.85	16.57	16.58	N/A	143.33	N/A

Table III: Scenario B1														
Programme		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	ESA total	Sum 10-19	% CZ*
Mandatory	Mandatory activities	5.46	5.95	6.12	6.31	6.29	6.29	6.29	6.29	6.29	6.29	7084.10	61.5	0.82
Current	EOEP (including Period 1,2,3)	0.54	0.60	0.67	0.44	0.29	0.06					1283.80	2.60	N/A
Optional	GMES Space Component (ESA+EC)	0.26	0.29	0.33	0.43	0.14	0.12	0.12	0.07			1911.60	1.76	0.21
	MTG 1	0.06	0.16	0.19	0.30	0.46	0.36	0.32	0.20	0.12	0.06	981.60	2.24	0.26
	ELIPS 3	0.58	0.64	0.54	0.56	0.45						248.80	2.77	0.70
	Transportation and Human Exploration	0.07	0.06	0.06								39.80	0.19	0.21
	ARTES 1 Phase V	0.01	0.03	0.04	0.04							27.30	0.12	0.20
	ARTES 3/4 Phase 1	0.09	0.11	0.17	0.18	0.18	0.12					412.40	0.85	0.21
	ARTES 10 Phase II.1	1.77	1.92	0.43								36.20	4.13	11.83
	ARTES 20 Phase I	0.03	0.04	0.05	0.04	0.01						53.70	0.17	0.21
	European GNSS Evolution Programme	0.19	0.20	0.09								69.50	0.48	0.64
	FLPP Period 2 Step 2 SDT activities	0.04	0.27	0.11	0.08							103.50	0.50	0.42
	GSTP Phase 5	0.61	0.51	0.69	0.73	0.42	0.27					272.20	3.23	1.01
	Prodex	0.25	0.50	0.50	0.50	0.50	0.50					135.70	2.75	N/A
Additional	ARTES 5 Period 2 Phase IV	0.08	0.04									28.40	0.12	0.43
Optional	ARTES 5 Sub-element 5.1	0.04	0.11	0.15	0.12	0.08						116.80	0.50	0.43
	ARTES 5 Sub-element 5.2	0.03	0.03	0.04	0.05	0.04	0.01					48.90	0.21	0.43
Future	Other Str. Apps & Tech. in ARTES				0.05	0.21	0.82	1.79	2.38	2.66	3.06	1337.30	10.97	0.82
Optional	ARTES 10, Iris Phase II.2			2.26	2.92	4.11	5.18	3.29	1.77			165.30	19.53	11.82
	ARTES 20 IAP Phase 2			0.04	0.04	0.09	0.09	0.07				153.30	0.32	0.21
	GSTP continuation					0.18	0.90	1.32	1.60	1.55	1.55	354.90	7.10	2.00
	Prodex continuation							1.00	1.00	1.00	1.00	210.00	4.00	N/A
	European GNSS Supp. Pr. Ext.			0.08	0.11	0.20	0.20	0.19	0.18	0.18	0.17	206.70	1.32	0.64
	EOEP continuation				0.11	0.39	0.58	0.61	0.67	0.73	0.76	1605.30	3.85	0.24
	Post-EPS Development (ESA+Eumetsat)			0.05	0.10	0.16	0.29	0.45	0.63	0.71	0.63	1165.50	3.03	0.26
	Climate Change Continuation					0.21	0.21	0.21	0.21	0.25	0.41	180.00	1.48	0.82
	ELIPS Period 4				0.17	0.24	0.24	0.24	0.24	0.24	0.24	670.00	1.61	0.24
	Human Expl. Prep. Studies								0.11	0.27	0.40	368.40	0.77	0.21
	Human Exploration Mission preparation				0.02	0.04	0.04	0.04	0.18	0.27	0.27	410.50	0.86	0.21
	SSA Programme				0.09	0.10	0.11	0.12	0.13	0.13	0.13	389.50	0.82	0.64
	Security on Earth Initiative (ESA+EU)				0.02	0.13	0.25	0.47	0.66	0.84	1.02	1615.80	3.39	0.21
	FLPP Period-3				0.10	0.53	0.57	0.72	0.77	0.77	0.77	884.20	4.24	0.48
	NGL Future Developments									1.54	1.54	640.00	3.07	0.48
	Total for scenario 1 (less funds)	10.11	11.46	12.62	13.51	15.46	17.21	17.24	17.10	17.53	18.30	23211.00	150.54	N/A
	Czech Space Support Programme	1.01	1.15	1.26	1.35	1.55	1.72	1.72	1.71	1.75	1.83	N/A	15.05	N/A
	Grand total (ESA+national)	11.13	12.60	13.88	14.86	17.00	18.93	18.96	18.82	19.29	20.13	N/A	165.59	N/A

Table IV: Scenario B2														
Programme		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	ESA total	Sum 10-19	% CZ*
Mandatory	Mandatory activities	5.46	5.95	6.12	6.31	6.29	6.29	6.29	6.29	6.29	6.29	7084.10	61.5	0.82
Current	EOEP (including Period 1,2,3)	0.54	0.60	0.67	0.44	0.29	0.06					1283.80	2.60	N/A
Optional	GMES Space Component (ESA+EC)	0.26	0.29	0.33	0.43	0.14	0.12	0.12	0.07			1911.60	1.76	0.21
	MTG 1	0.06	0.16	0.19	0.30	0.46	0.36	0.32	0.20	0.12	0.06	981.60	2.24	0.26
	ELIPS 3	0.58	0.64	0.54	0.56	0.45						248.80	2.77	0.70
	Transportation and Human Exploration	0.07	0.06	0.06								39.80	0.19	0.21
	ARTES 1 Phase V	0.01	0.03	0.04	0.04							27.30	0.12	0.20
	ARTES 3/4 Phase 1	0.09	0.11	0.17	0.18	0.18	0.12					412.40	0.85	0.21
	ARTES 10 Phase II.1	1.77	1.92	0.43								36.20	4.13	11.83
	ARTES 20 Phase I	0.03	0.04	0.05	0.04	0.01						53.70	0.17	0.21
	European GNSS Evolution Programme	0.19	0.20	0.09								69.50	0.48	0.64
	FLPP Period 2 Step 2 SDT activities	0.04	0.27	0.11	0.08							103.50	0.50	0.42
	GSTP Phase 5	0.61	0.51	0.69	0.73	0.42	0.27					272.20	3.23	1.01
	Prodex	0.25	0.50	0.50	0.50	0.50	0.50					135.70	2.75	N/A
Additional	ARTES 5 Period 2 Phase IV	0.08	0.04									28.40	0.12	0.43
Optional	ARTES 5 Sub-element 5.1	0.04	0.11	0.15	0.12	0.08						116.80	0.50	0.43
	ARTES 5 Sub-element 5.2	0.03	0.03	0.04	0.05	0.04	0.01					48.90	0.21	0.43
Future	Other Str. Apps & Tech. in ARTES	0.00	0.00	0.00	0.05	0.21	0.82	1.79	2.38	2.66	3.06	1337.30	10.97	0.82
Optional	ARTES 10, Iris Phase II.2	0.00	0.00	0.56	0.73	1.03	1.29	0.82	0.44			165.30	4.88	2.96
	ARTES 20 IAP Phase 2	0.00	0.00	0.04	0.04	0.09	0.09	0.07				153.30	0.32	0.21
	GSTP continuation					0.18	0.90	1.32	1.60	1.55	1.55	354.90	7.10	2.00
	Prodex continuation					0.00	0.00	1.00	1.00	1.00	1.00	210.00	4.00	N/A
	European GNSS Supp. Pr. Ext.			0.08	0.11	0.20	0.20	0.19	0.18	0.18	0.17	206.70	1.32	0.64
	EOEP continuation				0.15	0.52	0.77	0.81	0.89	0.98	1.01	1605.30	5.14	0.32
	Post-EPS Development (ESA+Eumetsat)			0.13	0.26	0.40	0.72	1.10	1.55	1.74	1.56	1165.50	7.46	0.64
	Climate Change Continuation					0.21	0.21	0.21	0.21	0.25	0.41	180.00	1.48	0.82
	ELIPS Period 4				0.17	0.24	0.24	0.24	0.24	0.24	0.24	670.00	1.61	0.24
	Human Expl. Prep. Studies								0.11	0.27	0.40	368.40	0.77	0.21
	Human Exploration Mission preparation				0.02	0.04	0.04	0.04	0.18	0.27	0.27	410.50	0.86	0.21
	SSA Programme				0.27	0.30	0.34	0.37	0.40	0.40	0.40	389.50	2.49	0.64
	Security on Earth Initiative (ESA+EU)				0.02	0.13	0.25	0.47	0.66	0.84	1.02	1615.80	3.39	0.21
	FLPP Period-3				0.10	0.53	0.57	0.72	0.77	0.77	0.77	884.20	4.24	0.48
	NGL Future Developments									1.54	1.54	640.00	3.07	0.48
	Total for scenario 1 (less funds)	10.11	11.46	11.00	11.69	13.12	15.08	17.19	18.79	20.63	21.31	23211.00	150.38	N/A
	Czech Space Support Programme	1.01	1.15	1.10	1.17	1.31	1.51	1.72	1.88	2.06	2.13	N/A	15.04	N/A
	Grand total (ESA+national)	11.13	12.60	12.10	12.86	14.43	16.58	18.91	20.67	22.70	23.44	N/A	165.42	N/A

Involvement

Most if not all ESA activities concern R&D however these activities have an impact on different areas of society that are the beneficiaries or users of the results transcending academia or industry. For this reason it would be necessary to ensure that several different governmental institutions are involved in the discussions, and possibly funding, of the different ESA programmes. The table below, while not exhaustive, proposes in first iteration, the Czech ministries that should have an interest. The numbers reflect a priority.

ESA Programme Theme	ME	MEYS	MD	MT	MIT
Space Science and Science		1			2
Technology R&D		1	3	3	2
Earth Observation R&D	1	1		2	
Navigation R&D		3	3	1	2
Telecommunication R&D		3	3	2	1
Launcher R&D		1	2	2	1
Earth Observation Application Development	1	2	3	2	2
Navigation Application Development	3	3	3	1	2
Telecommunication Application Development			3	2	1
Launcher Development		2	3	2	1
Human Space Flight		1		2	1

LIST OF ACRONYMS

ALV – Association of the Aviation Manufacturers

ARTES – Advanced Research in Telecommunications Systems (ESA optional programme)

ARTES 3-4 – Element 3-4 of the ARTES programme (ESA optional programme)

ARTES 5 – Element 5 of the ARTES programme (ESA optional programme)

ARTES 10 Iris – Element 10 of the ARTES programme (ESA optional programme)

ARTES 20 IAP – Element 20 of the ARTES programme – Integrated Applications Promotion (ESA optional programme)

AS CR – Academy of Sciences of the Czech Republic (AV ČR in Czech)

ATM – Air Traffic Management

ATV – Automated Transfer Vehicle (ESA)

CEATS – Central European Air Traffic Services

CENIA – Czech Environmental Information Agency

CERN – European Organization for Nuclear Research

CIIS – Czech Industry Incentive Scheme (ESA transitional and mandatory programme)

COPUOS – Committee on the Peaceful Uses of Outer Space

CSA – Czech Space Alliance

CSO – Czech Space Office (ČKK in Czech)

CTP – Science Core Technology Programme (ESA mandatory activity)

DSLP – Dual Segmented Langmuir Probe

e.c. XXXX – economic conditions of year XXXX. This parameter is used in ESA to take into account inflation across its multi-year programmes. For this purpose it uses the consumer price inflation in the euro area that is measured by the Harmonised Index of Consumer Prices (HICP). The HICP is compiled by Eurostat and the national statistical institutes in accordance with harmonised statistical methods. This same index is also used by the European Central Bank.

EC – European Commission

ECI – European Component Initiative (ESA optional programme)

EDA – European Defence Agency (Agency of the EU)

EGEP – European GNSS Evolution Programme (ESA optional programme)

EGNOS – European Geostationary Navigation Overlay Service

ELIPS – European Programme for Life and Physical Sciences (ESA optional programme)

EO – Earth Observation

EOEP – Earth Observation Envelope Programme (ESA optional programme)

ESA – European Space Agency

ESAC – European Space Astronomy Centre (ESA establishment)

ESO – European Southern Observatory

ESOC – European Space Operations Centre (ESA establishment)

ESPI – European Space Policy Institute

ESRIN – Centre for Earth Observation (ESA establishment)

ESTEC – European Space Research and Technology Centre (ESA establishment)

ETHE – European Transportation and Human Exploration Preparatory Activities Programme (ESA optional programme)

EU – European Union

EUMETSAT – European Organisation for the Exploitation of Meteorological Satellites

EUROCONTROL – European Organisation for the Safety of Air Navigation

EUSC – European Union Satellite Centre

EUTELSAT – European Telecommunication Satellite Organisation

FLPP – Future Launchers Preparatory Programme (ESA optional programme)

GACR – Grant Agency of the Czech Republic

GDP – Gross Domestic Product

GEOSS – Global Earth Observation System of Systems

GMES – Global Monitoring for Environment and Security (ESA optional programme in cooperation with the EU)

GNSS – Global Navigation Satellite System

GSA – European GNSS Supervisory Authority

GSC – GMES Space Component Programme (ESA optional programme)

GSP – General Studies Programme (ESA mandatory activity)

GSTP – General Support Technology Programme (ESA optional programme)

IAP – Integrated Applications Promotion (ESA programme)

IPR – Intellectual Property Rights

ISS – International Space Station

ITAR – International Traffic in Arms Regulation

ITI – Innovation Triangle Initiative (ESA mandatory activity)

ITSO – International Telecommunication Satellite Organisation

JWST – James Webb Space Telescope (ESA)

LTP – Long-Term Plan

MA – Ministry of Agriculture (MZe in Czech)

MC – Ministry of Culture (MK in Czech)

MD – Ministry of Defence (MO in Czech)

ME – Ministry of Environment (MŽP in Czech)

METoP – EUMETSAT Polar System (EPS)

MEYS – Ministry of Education, Youth and Sports (MŠMT in Czech)

MFA – Ministry of Foreign

MH – Ministry of Health (MZ in Czech)

MI – Ministry of Interior (MV in Czech)

MSG – Meteosat Second Generation (EUMETSAT satellite class and was an ESA optional programme)

MT – Ministry of Transport (MD in Czech)

MTG – Meteosat Third Generation (ESA optional programme that will become an EUMETSAT satellite class)

MIT – Ministry of Industry and Trade (MPO in Czech)

NATO – North Atlantic Treaty Organization

NGL – Next Generation Launcher (possible future ESA optional programme for the successor of Ariane 5)

OECD – Organisation for Economic Co-operation and Development

OOSA – Office for Outer Space Activities

PB – Programme Board (ESA)

PECS – Programme for European Cooperating States (ESA optional programme for ESA non-Member States)

PRODEX – Programme for the Development of Scientific Experiments (ESA optional programme)

R&D – Research and Development

R&T – Research and Technology

RD&I – Research, Development and Innovation

SAF – Satellite Application Facility of EUMETSAT

SDT – System, Demonstrators and Technology (component of ESA's FLPP programme)

SDT – Sdružení pro dopravní telematiku (Czech professional association)

SISNeT – Signal in Space through the Internet

SGEO – Small Geostationary Telecommunication Satellite (ESA optional programme, ARTES 8)

SME – Small or Medium Enterprises

SMOS – Soil Moisture and Ocean Salinity (ESA mission in EOEP programme)

SPS – Science for Peace and Security

SSA – Space Situational Awareness programme (ESA optional programme)

TACR – Technology Agency of the Czech Republic

TIP – Technologie, Informační systémy, Produkty (Programme of the Czech Ministry of Industry and Trade)

TPMU – Thermal Plasma Measurement Unit

TRL – Technology Readiness Level

TRP – Basic Technology and Research Programme (ESA mandatory activity)

UN – United Nations

VLT – Very Large Telescope (ESO)

VTUPV – Military Technical Institute of Land Forces in Vyškov

VZLU – Aeronautical Research and Test Institute

ANNEX I – ESA optional programmes with Czech Republic participation

(Part 1)

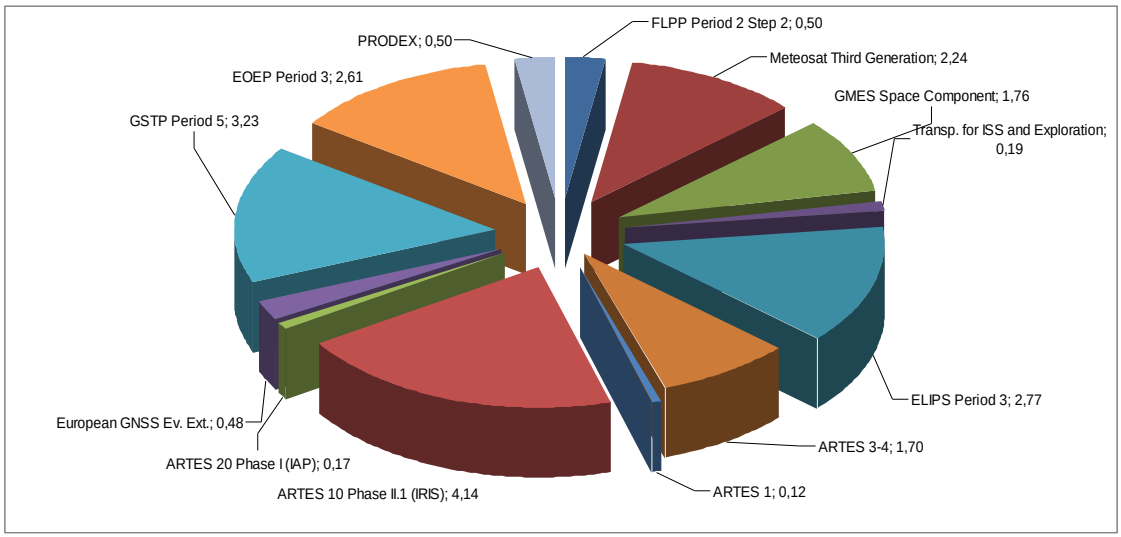
Name	***Goal***	***Duration***	***Contribution*** *(million €)*
MTG (*Meteosat Third Generation*)	Development of a new generation of geostationary meteorological satellites	2009-2020	2,24
FLPP Period 2 Step 2 (*Future Launchers Preparatory Programme*)	To propose concepts for new generation launchers, experiments with sample return vehicle, solid and liquid propulsion experiments	2009-2012	0,5
ELIPS Period 3 (*European Programme for Life and Physical Sciences and Applications in Space*)	Utilization of microgravity environment for life and physical sciences and applied research and development	2008-2012	2,77
ISS Development (European Transportation and Human Exploration) (*European Transportation and Human Exploration Preparatory Activities Programme*)	Development of transportation means for human spaceflights; in the first stage namely for the International Space Stations (ISS)	2009-2012	0,19
ARTES 1 Phase V: Preliminary Studies and Investigation (*Advanced Research in Telecommunication Systems*)	To define strategic directions for satellite telecommunication involving marketing surveys and technology analyses, feasibility studies, standardization, and alike	2009-2013	0,12
ARTES 3-4 Phase I: **ESA Telecom – Products** (*Advanced Research in Telecommunication Systems*)	To prepare products established on the basis of satellite telecommunication for commercial purposes	2009-2013	1,7
ARTES 10 Phase II-1 – Iris: **Satelite Communication for Air Traffic Management** (*Advanced Research in Telecommunication Systems*)	To develop a unified European safety and air traffic management system	2009-2011	4,14

ANNEX I – ESA optional programmes with Czech Republic participation

(Part 2)

Name	***Goal***	***Duration***	***Contribution*** *(million €)*
ARTES 20 – IAP Phase I: Integrated Applications Promotion (*Advanced Research in Telecommunication Systems*)	Development of innovative solutions (applications) combining several technologies such as navigation, telecommunication and Earth observations	2009-2013	0,17
European GNSS Evolution (*European Global Navigation Satellite System Evolution Programme*)	To maintain and further improve the technology so far acquired through the EGNOS and Galileo projects	2009-2011	0,48
GMES Space Component Segment 2 (*Global Monitoring and Environment and Security Space Components Programme*)	To launch the satellite series for Earth's observation Sentinel-1B, 2B, 3B, the preparatory phase of the Sentinel-4, Sentinel -5 satellites and the construction of the Sentinel-5 Precursor satellite.	2009-2018	1,76
GSTP Phase 5 (*General Support Technology Programme*)	To mature various needed technologies, test their feasibility, turn it into products or readily available technology, or verification under conditions of a spaceflight	2009-2013	3,23
EOEP Period 3 *(Earth Observation Envelope Programme)*	Prepare future Earth observation missions	2009-2013	2,61
PRODEX (*Scientific Experiment Developement Programme)*	Support of design and development of scientific experiment	2009-2010	0,5
		TOTAL	**20,34**

ANNEX I – ESA optional programmes with Czech Republic participation (Part 3 - Figure)



Czech Republic's current financial participation in the optional programs of the ESA in millions of Euro

ANNEX II - List of all activities related to space

(Part 1)

PECS Projects			
Project Title	**Principal Investigator**	**Duration**	**Cost**
AMI4FOR	Wirelessinfo association	2005 – 2008	203 000 €
Bepi Colombo I	Faculty of Mathematics and Physics CU	2006 – 2010	211 000 €
Bepi Colombo II	Astronomical Institute AS CR	2007 – 2012	496 400 €
Cluster II	Institute of Atmospheric Physics AS CR	2005 – 2010	260 000 €
DOBIES	Nuclear Physics Institute AS CR	2007 – 2008	53 950 €
DTL/DML	ANF Data	2007 – 2010	250 000 €
EGNOS EduTools	Iguassu Software Systems	2008 – 2009	481 820 €
FLOREO	SPRINX Systems	2008 – 2010	383 250 €
Gaia	Astronomical Institute AS CR	2007 – 2011	471 900 €
GOCE	Astronomical Institute AS CR	2007 – 2010	225 200 €
GRID	Iguassu Software Systems	2005 – 2007	187 450 €
GSE Land	Gisat	2007 – 2009	359 221 €
IIM-TS	Iguassu Software Systems	2007 – 2008	76 200 €
IIM-TS2	Iguassu Software Systems	2008 – 2009	74 650 €
Integral	Astronomical Institute AS CR	2005 – 2009	280 000 €
Proba-2 DSLP	Institute of Atmospheric Physics AS CR	2005 – 2009	175 098€
Proba-2 TPMU	Institute of Atmospheric Physics AS CR	2005 – 2009	93 600 €
RESPOND CZ	Gisat	2007 – 2009	291 330 €
SatCom	Faculty of Electrical Engineering CTU	2009 – 2010	97 400 €
SCOS-2000 Monitoring	ANF Data	2005 – 2007	448 113 €
Sentinel 2: SPECTRA	Institute of Systems Biology and Ecology AS CR	2005 – 2010	210 000 €
SISNeT	Iguassu Software Systems	2005 – 2007	330 642€
SOHO	Astronomical Institute AS CR	2005 – 2010	250 000 €
SOSI CZ	ANF Data	2008 – 2010	388 885€
SWARM	Aeronautical Research and Test Institute	2008 – 2010	870 000 €
WAVES	Institute of Atmospheric Physics AS CR	2005 – 2010	365 900 €
X-ray Observation XMM	Astronomical Institute AS CR	2007 – 2011	290 000 €
X-Ray Optics	Rigaku	2007 – 2010	354 000 €

ANNEX II - **List of all activities related to space**

(Part 2)

Czech Industry Incentive Scheme **First Call for Outline Proposals (AO 6052)**			
Project Title	**Principal Investigator**	**Duration**	**Cost**
Control and tracking system for ground station antennae	Projectsoft HK	2010	197 950€
Hermetically Sealed Low ESR Tantalum Capacitor	AVX Czech Republic	2010 – 2012	454 240 €
Highly Miniaturized and Sensitive Thermal Neutron Sensor	Institute of Experimental and Applied Physics CTU	2010 – 2012	178 151 €
Laboratory Wide Dynamic Range Gamma-Ray Calibration Facility	Institute of Experimental and Applied Physics CTU	2010 – 2011	147 900 €
Langmuir probe experiment	Astronomical Institute AS CR	2010	30 158 €
Neutron Facilities in the Czech Republic for Calibration and Testing of ESA-Compliant Neutron-Sensitive Devices	Institute of Experimental and Applied Physics CTU	2010 – 2012	88 449 €
New acousto-optic device based on Calomel for hyper-spectral imaging in space applications NAOMI	BBT-Materials processing	2010 – 2012	199 368 €
PalDMC	Iguassu Software Systems	2010 – 2011	199 956 €
Preparatory Activities for MTG Participation	CSRC	2010	100 000 €
Preparatory study of digital plasma wave analyzer technology for Cosmic Vision spacecraft	Institute of Atmospheric Physics AS CR	2010 – 2012	83 019 €
Real-time Extrapolation Methods for Thermal Testing	L.K. Engineering	2010 – 2011	150 517 €
Real-time Performance Monitoring Tool	Iguassu Software Systems	2010 – 2011	199 466 €
Redukcni regulator tlaku 3 – RRT 3	Frentech Aerospace	2010 - 2011	100 000 €
Reusable Payload On Board SW Framework	Evolving Systems Consulting	2010 – 2011	100 000€
Study of SCOS-2000 deployment over WAN for a concept of CMCP	ANF Data	2010	173 094 €
UrbanAtlas+	Gisat	2010 – 2012	183 390 €

***ANNEX II* - List of all activities related to space**

(Part 3)

6th Framework Programme			
GEMS	CZECH HYDROMETEOROLOGICAL INSTITUTE	2005-2009	670 999 €
HUMBOLDT	HELP SERVICE REMOTE SENSING	2006-2010	520 173 €
HUMBOLDT	INTERGRAPH CR SPOL. S R.O.	2006-2010	520 173 €
HUMBOLDT	USTAV PRO HOSPODARSKOU UPRAVU LESU BRANDYS NAD LABEM (FOREST MANAGEMENT INSTITUTE)	2006-2010	520 173 €
CASCADOSS	GISAT S.R.O.	2007-2009	23 316 €
SISTER	TELEMATIX SERVICES, A.S.	2006-2009	404 497 €
HEALTHWARE	MASARYKOVA UNIVERZITA V BRNE	2005-2008	211 169 €
TANGO	UNIVERZITA KARLOVA V PRAZE	2006-2009	341 667 €

7th Framework Programme			
MACC	CESKY HYDROMETEOROLOGICKY USTAV	2009-2011	608 053 €
geoland2	GISAT S.R.O.	2008-2015	1 250 214 €
AEROFAST	KYBERTEC S.R.O.	2009-2011	113 907 €
SAFER	GISAT S.R.O.	2009-2011	1 538 931 €
COSMOS	TECHNOLOGICKE CENTRUM AKADEMIE VED CESKE REPUBLIKY	2008-2011	80 039 €
PRoVisG	CESKE VYSOKE UCENI TECHNICKE V PRAZE	2008-2011	173 160 €
G-MOSAIC	GISAT S.R.O.	2009-2011	588 360 €
ISP-1	CESKE VYSOKE UCENI TECHNICKE V PRAZE	2009-2012	251 704 €
SP4ESP	Univerzita Karlova v Praze	2009-2010	17 565 €
ProViScout	České vysoké učení technické v Praze	Approved proposal	Approved proposal