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SPACE IN CENTRAL AND EASTERN EUROPE

OPPORTUNITIES AND CHALLENGES FOR THE EUROPEAN SPACE ENDEAVOUR

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Executive Summary

The successive enlargements of the European Union (EU) have created new opportunities and challenges. The **Union's expansion towards Central and Eastern Europe could be particularly beneficial to Europe in the space field**, as some of the new EU members and neighbours have gained tremendous expertise in the domain during the Soviet era. **The present report, "EU4+", investigates and contrasts the two most prominent cases in that region: the four new EU members most active in space, and Ukraine.**

Through their membership, the new EU members can now participate in the decisions that shape space in Europe, including the definition of the European Space Policy, and of the joint programmes of the EU and the European Space Agency (ESA): Galileo and Global Monitoring for Environment and Security (GMES). Four of them – **the Czech Republic, Hungary, Poland and Romania** – have shown a strong interest in maintaining and further developing their space activities. They have signed with ESA a European Cooperating State agreement that has enabled them to participate in its programmes, as a first step towards a full ESA membership. These agreements come to an end for Hungary and the Czech Republic in the next couple of years and negotiations on a possible membership have been officially initiated. It is therefore essential to understand now how these four new member states can further contribute to the European space programme. Europe could certainly benefit from further cooperation with the European Cooperating States (ECS). They have important know-how and experience in space and, despite the still limited weight of their space sector in the European landscape, they have gained significant political weight in Europe. The ECS want to get involved in European programmes as they perceive space as a tool for development and integration. A political will exists in Europe to bring them onboard, yet integration of these countries is slow especially as the "old" Europe still wonders how to involve them. The ECS have not defined their priorities and their space industry is not mature yet; as a result cooperation on industrial projects is developing only slowly.
Despite the similarities that lead Western Europe to consider them as a homogenous group, each of the ECS has its own specificities, reflected in their space activities. A **common approach** coordinated between the European Commission (EC) and ESA towards these four countries would be simpler but also more coherent and effective. On the other hand, the ECS can only **benefit from working together and talking with a common voice**. The **main challenge** to further participation of the ECS in the European space programmes **remains the development of the private sector**. In order to transform vicious circles into virtuous ones **an external, timely impetus**, whether political, legal and/or economic, **is needed**. **Such an impulsion could come from Western Europe, and should be perceived as an opportunity** by its member states.
EU structural funds could be used to develop space-based applications in new member states, but not under the existing mechanisms that would not be sustainable. Seed money could be granted to Small and Medium Enterprises (SMEs) under a new mechanism in order for them to develop space-based applications that could support effectively the countries' development and integration. An ESA membership could also serve as an impetus, but is challenged by political and institutional issues. Additional members would raise concerns among today's members mainly about ESA's industrial policy and decision-making process. It would, however, also be an opportunity for the larger contributors to change ESA rules to their advantage. One way to decrease the strains that additional members might create is to further develop existing activities or start new ones. Besides, it is undeniable that, should the four ECS join ESA in the future, they will certainly be better prepared than their predecessors.

The situation of Ukraine is very different in terms of capabilities and ambitions. Ukraine has gained tremendous expertise in the space field, has inherited a significant share of the Soviet facilities and still has many talented scientists, engineers and technicians. However, the country entered a political and economic crisis after it gained its independence, from which it has not yet managed to recover, mainly because of slow and incomplete structural reforms. The aerospace sector, like many scientific domains, has suffered from the overall crisis and a sudden drop in funding. In addition, the sector was no longer adapted to the reality of the country: Ukraine had decided to abandon military space activities and had a limited internal market for space products. As a result, Ukrainian enterprises had to go international and sell their products on the global market in order to survive. But even if the joint ventures they created with international partners have allowed them to continue, the future of their space activities remains uncertain and very dependent on Russia. Therefore, Ukraine is looking for alternatives to their strong interdependence with Russia. Since the Orange Revolution, Ukraine's leadership has tried to move the country closer to the West and the country is now a priority partner in the European Neighbourhood Policy. Space is an important field for both Ukraine and Europe. The competition between them on some fields should not prevent cooperation, which is today very limited, as it could certainly help in developing a closer relationship.

Large-scale cooperation is, for now, excluded. European companies are not interested in creating joint ventures with Ukraine to commercialise new launchers or even satellites. Ukrainian enterprises could get involved in large scale projects but only either as subcontractors, like for Vega, or if they bring one of the building blocks of a large programme. Otherwise cooperation will take place only on small-scale projects. Today the **main opportunities for cooperation are in space science and applications.** This cooperation would certainly be **facilitated by the development of a political framework**, i.e., ESA-Ukraine agreement, **and by the EU twinning action**, as well as by the adoption of the Fourth National Space Programme by the next Ukrainian parliament. However, **any political framework is likely to remain an empty shell if,** despite the efforts made by the Ukrainian administration in the twinning programmes, **no operational activities are undertaken.** Dedicated actions with Ukraine in the space thematic area in the Framework Programme 7, as well as actions that would follow-up on the mechanisms of the International Association for the Promotion of Cooperation with Scientists from the New Independent States (INTAS), would also support cooperation in the field of science and applications and a further integration of the Ukrainian research teams in the European research community.

Introduction

With its successive enlargements in 2004 and 2007, the European Union (EU) has new members and neighbours in Central and Eastern Europe. **Space could be one of the fields which could greatly benefit from this eastward expansion of the Union.** Some of those countries have gained great expertise in space during the Soviet era, in particular through the Intercosmos programme, and have shown strong interest in further developing their space activities. **This study**, referenced to as "EU4+", **explores the opportunities and challenges for the European space programme created by the enlargement, and contrasts two cases.**

The first part of this report examines the situation of the **new EU Member States** (NMS), and in particular those which have been most active in space. All of them already participate in European programmes, such as Galileo and GMES, through their EU membership, but four of them – the Czech Republic, Hungary, Poland and Romania – have substantial space activities. These four countries have signed a European Cooperating State (ECS) agreement with the European Space Agency (ESA), some of them before they even became EU members. This agreement enables them to increase their participation in European space programmes and is a first step towards a future ESA membership. The ECS agreements of Hungary and the Czech Republic come to an end in the next couple of years and both have expressed their interest in joining ESA. The issue of their memberships will therefore be examined this year. Thus, understanding now how these four countries, and later the other new EU member states, could further contribute to the European space programme is critical.

The second part of the report investigates the major space player of that region, **Ukraine**, which now lies at the EU's eastern border. Ukraine is in a very different situation than the new EU members, even the neighbouring ones. It is especially apparent in the space field, both in terms of activities and relationships with international partners. Unlike other countries of the former Soviet bloc, such as the ECS, Ukraine is a space-faring nation with a well-developed industry that covers almost all space-related domains and that continues to have very high ambitions. Furthermore, Ukraine has remained very dependent on Russia. It has also developed successful joint ventures with American companies but still has very limited cooperation with Europe.

This report analyses the options and the challenges ahead for Europe and the Central and Eastern countries. It investigates and compares the space activities and their economic, institutional, industrial, scientific and political environment in the mentioned countries, and identifies the strengths and weaknesses of the space sector in each of them. Moreover, it analyses the short- and long-term benefits and costs, as well as the challenges, of these countries' further participation in the European space programme from the perspectives of all parties involved, i.e., the Central and Eastern European countries, ESA, EU and their member states. Finally, this report proposes ways on how to associate those countries to the European space programme and strategy.

Part I

The New EU Member States

The Case of the European Cooperating States (Czech Republic, Hungary, Poland and Romania)

Introduction

Space has been a factor of European integration for the past 30 years, as demonstrated by several major common achievements. Until 2004, the European Space Agency (ESA) was essentially the sole forum for space activities in Europe.

A closer cooperation between ESA and the European Union (EU) on space led to the establishment of another forum, the joint Space Council. **The Union's successive enlargements** in 2004 and 2007 **created new challenges for the European space community.** Since 2007, 12 new countries have been able to participate in the decisions that shape space in Europe. Each new EU Member States' (NMS) experience and interest in space greatly varies from one another. Some of them have gained significant expertise during the Cold War through their participation in the former USSR space programmes and four of them, namely the **Czech Republic, Hungary, Poland and Romania**, have showed a strong interest in maintaining and further developing their space activities after the fall of communism, about 17 years ago. As they politically leaned towards the West, they found new partners in Europe to continue their space activities. Cooperation with Western scientists and engineers was actually already taking place in the eighties but increased after the end of the communist era. Eager to be further integrated into Europe and its space community, these countries began cooperating with ESA at the start of the nineties.

A first step was the signature of Cooperation Framework Agreements from 1991 till 1996 and the participation in selected ESA scientific programmes. Subsequently, ESA created a new **European Cooperating State (ECS) status** that was more adapted to the situation of those four countries. Thus the second step was the signature of European Cooperating State (ECS) Agreements from 2004 till 2007. This five-year Agreement enables countries to increase their participation in ESA programmes, as a first step towards a future membership. The question of a membership will be raised for Hungary in the coming year and for the other countries in the years to come. Furthermore, ESA's Director General, J-J Dordain, has expressed the wish that ESA might number 22 Member States in five years' time.[1] It is therefore crucial to understand how those four countries, as the most active NMS in the space field, could further contribute to the European space programme. The present study aims to analyse the options and challenges ahead for the ECS and Europe. First, it investigates and contrasts the space activities and their economic, institutional, industrial, scientific and political environments in those four countries, and identifies the strengths and difficulties of the space sector in each of them. Furthermore, it analyses the short- and long-term benefits and costs, as well as the challenges, of further participation of the ECS countries in the European space programme from the perspectives of all parties involved, i.e., the four countries, ESA, EU and their member states. Finally, the study suggests ways on how to further associate the new Member States to a European space strategy.

[1] "New Members Dive Cautiously into EU Military Space Programs", Space News, October 23, 2006, Vol 17, Issue 41

1. What is really at stake for Europe?

1.1. The European space community could benefit from a further cooperation with the ECS

Some of the new EU Member States have gained **significant experience and expertise**, in particular through their participation in the Soviet Union space programmes, such as Intersputnik and especially Intercosmos from 1967 until the nineties. The latter was designed as a programme of cooperation between the USSR, Bulgaria, Cuba, Czechoslovakia, East Germany, Hungary, Mongolia, Poland, and Romania (Vietnam joined later in 1979).

The programme encompassed five fields (physics, meteorology, biology and medicine, space-based tele-communications and natural resources monitoring). To carry out the joint research programme, 23 satellites, 11 vertical high-altitude research rockets and several hundred meteorological rockets were launched and cosmonauts from each of the participating countries were invited to fly on-board Salyut stations. The Soviet Union defined cooperation rules that shaped the participating countries' space activities. Each participating country had to bear the cost of its contribution, build its own equipment and provide them to the Soviet Union without any exchange of funds.

The contributions were limited to scientific equipment, developed by research institutes. The Soviet Union integrated and launched them. Thus, over 20 years, the participating countries mainly developed expertise in specific scientific fields. For instance, the Czech Republic specialized in ionospheric research instruments. Within Intercosmos, those countries' space communities also gained experience in international cooperation and it is within this programme that their relationships with Western European countries started. Despite the export control restrictions of the Coordinating Committee for Multilateral Export Controls[2] (CoCom), Eastern European countries constituted a bridge between Western and Eastern Europe during the Cold War, as they could access some of the Western technologies of interest to the Soviet Union. Dual technologies were transferred to the Soviet satellite-countries especially during the détente of the seventies, as Western countries decided to strategically loosen their controls on dual-use technologies in order to weaken the Soviet bloc.

Since the end of the communist era, Czechoslovakia (and subsequently the Czech Republic), Hungary, Poland and Romania have tried to maintain and further develop the expertise they gained with Intercosmos and to see it recognised by international partners. **Europe could further benefit from this expertise.**

These four countries today have **lower production costs**, which can help to increase the European space sector competitiveness. They also have **highly-qualified young professionals** who contribute an entrepreneurial and innovative culture and could be a major asset for the development of space activities, in particular applications.

Moreover, they offer **potential new markets**, especially for space applications. Their market is all the more promising in that these four countries together represent about 17% of the EU27 population with the size of the market for applications likely being linked to the area and population of the countries rather than to the size of their economy. Finally, they can find niches for their Small and Medium Enterprises (SMEs) or larger companies.

[2] The Coordinating Committee for Multilateral Export Controls (CoCom) was established in 1949 by the Western alliance to control the transfer of advanced technology towards the Soviet Bloc. The Committee had 17 members: Australia, Belgium, Canada, Denmark, France, Germany, Greece, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Turkey, the United Kingdom and the United States. The CoCom system consisted of three lists of restricted transfer items - the international munitions list, the international atomic energy list, and the industrial list (for dual-use items) – and on a collective process to authorise transfers. Each country had one vote and could veto any sale of product or technology to a country of the Soviet bloc by another CoCom member. In response to the evolution of the world situation, in March 1994, the members decided to disband the Committee, which was partially replaced by the Wassenaar Arrangement.

1.2. However, their economic weight remains small in the European landscape and they still suffer from organisational and funding issues

1.2.1. Economic weight of the ECS in Europe

The four new Member States are undergoing a deep restructuring and are perceived as a source of dynamism with a high development potential, including an economic growth stronger than that of the 15 old EU Member States, as detailed in Figure 1.
Nevertheless their economic weight in Europe remains small, as illustrated in Figure 2. Hungary represents 0.7% of the total GDP of the EU27, Romania 0.8%, the Czech Republic 1% and Poland 2.3%. Together they represent less than 5% of the total GDP of the EU27.

Moreover, apart from the Czech Republic whose economic indicators have been qualified as "exceptional", the three other ECS are facing serious economic issues, even though the general economic situation in all these countries is clearly improving. The Hungarian economy suffers particularly from its large public debt, Poland from its unemployment and regional disparities, and Romania from its inflation rate and low competitiveness (see Appendix A for details).

In the space sector, their economic weight is even smaller, as illustrated in Table 1 (see Appendix B for details). Their budgets, taken together, represent less than 0.4% of Europe's civil space budget[3] and about 0.5% of ESA budget.[4]
In addition to a limited economic weight in Europe, the integration of the ECS is unlikely to have a significant impact on competition in the space sector.

1.2.2. Reality of their impact on competition

The fall of communism led to a sudden drop in the funding of all scientific disciplines. New sources of funding and a new organisation of science were then needed, thus a long reorganisation process started in all the ECS. The European Union played a key role in this process, with, for instance, Framework Programmes in which the ECS were eligible to participate, or European networks of scientists that the ECS could enter, even before joining the EU. Fifteen years later, space still tends to suffer from organisational and funding issues.
Moreover, the space industry in the ECS is not yet very developed. First, the participation in Intercosmos was limited to scientific fields which hindered the establishment of a space industry. There has been only limited funding for industry-oriented space activities, so the space industry has hardly developed in areas that

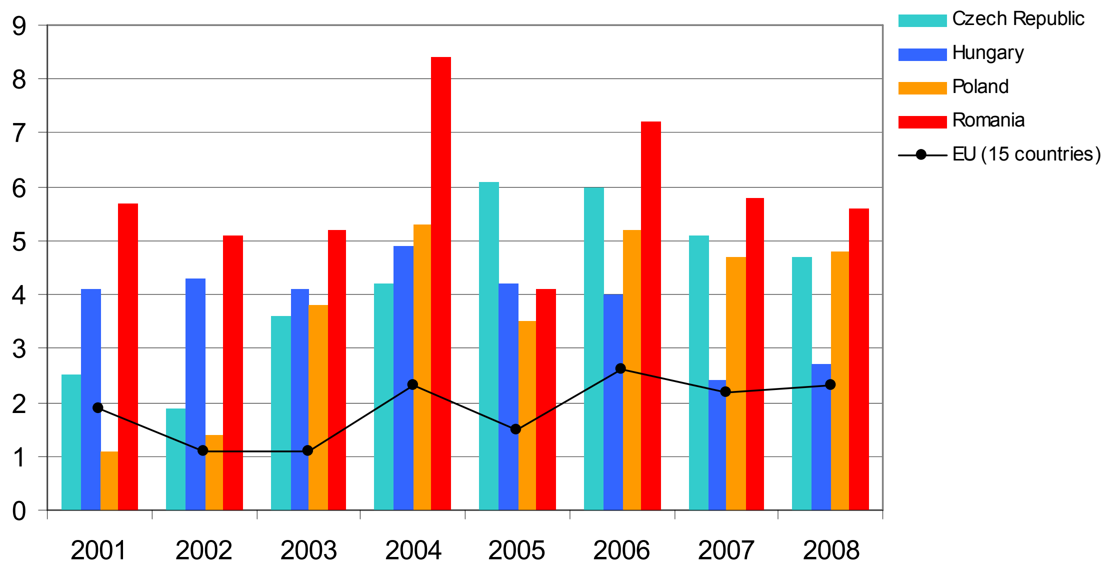


Figure 1: Percentage of GDP real growth rate in the four ECS and in the EU15

[3] Europe 2005 civil space budget, Source European Space Directory

[4] ESA 2005 budget, Source ESA

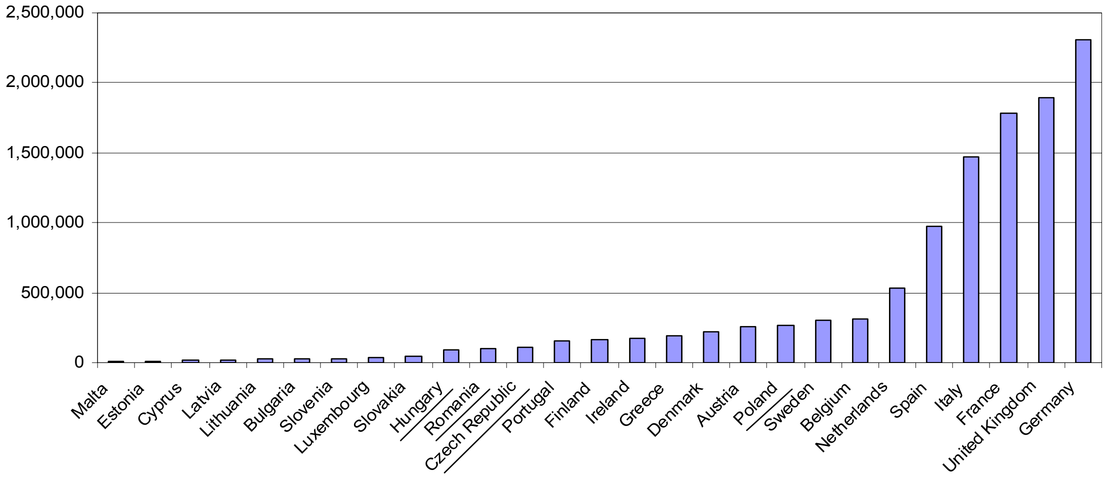


Figure 2: GDP at current prices and exchange rate (in million euros 2006)

require public resources.
Therefore, despite significant know-how, the lack of entrepreneurship has slowed down industrial development. The adaptation to an open market-based economy takes time and many experts in the space field, especially among the older generation, do not know how to start a new business or simply do not dare doing so. In addition, the relations between scientific organisations and the private sector are lacking, which further hinders the development of the space industry. Finally, the few existing space-related companies tend to suffer from lack of visibility and representation.
Therefore the impact of the ECS on competition is likely to be limited, all the more than one can reasonably expect given that their competitive advantage due to lower production costs than their Western counterparts, presented in Figure 3, will not last, as can be concluded from the evolution presented in Figure 4. In fact, Western established players already work with research institutes and SMEs of the ECS and have established branches there (Infoterra Hungary, etc.).

1.2.3. Foreign policy issues

Some of the ECS' foreign policies tend to complicate their relations with Western Europe, and influence cooperation, in the space field. Pro-American stances that some of the ECS' governments have adopted are perceived by several Western European countries as conflicting with European objectives.
A striking example is the American anti-missile shield to be deployed in Central Europe that was condemned by Ukraine and Russia but is also of concern to Western European countries. As part of its US missile defence system, the United States wants to build a missile interceptor site in Poland and a radar station in the Czech Republic, and both countries' governments have agreed to start negotiations, despite the clear public opposition.
More than that, major American aerospace companies have established plants in some of these countries, which might influence cooperation with Europe if those companies, which today develop mainly aeronautical products, expand their activities to the space sector. The most striking example is Poland where companies like Pratt & Whitney or General Electric have established plants.

1.2.4. Internal challenges

The ECS still need to overcome several internal difficulties.
First of all, apart from Romania which has a space agency with an effective coordination role, the ECS suffer from **organisational issues**. They could greatly benefit from a better coordination of space activities, as the role of the space office may be limited, and,

	Space budget	**Contribution to EUMETSAT** (European Organisation for the Exploitation of Meteorological Satellites)
Czech Republic	2.4	0.24
Hungary	2.2	0.2
Poland	4.6 (+1.1 for PECS)	0.6
Romania	4.3	0.5

Table 1: Budget for space activities including the EUMETSAT and the PECS contributions (in million euros)

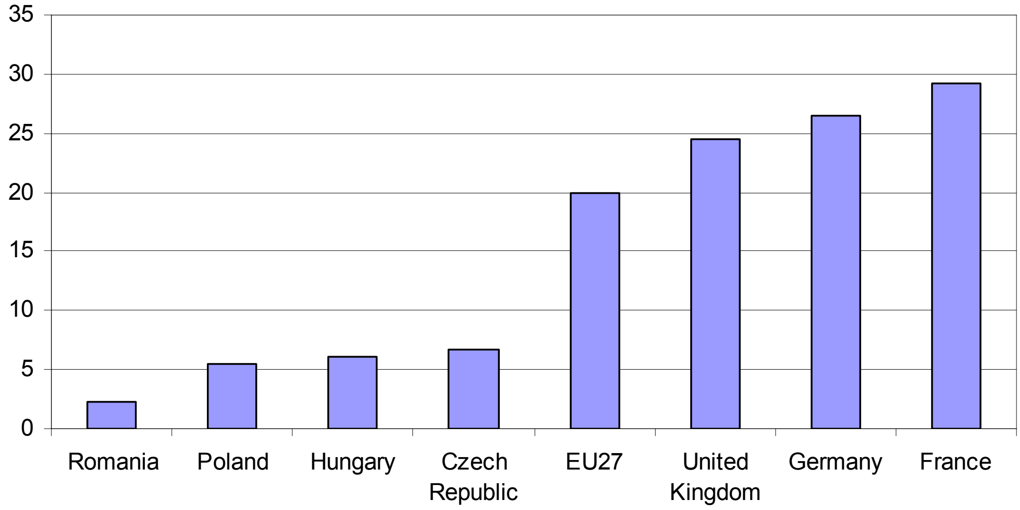


Figure 3: Hourly labour costs (in euros)

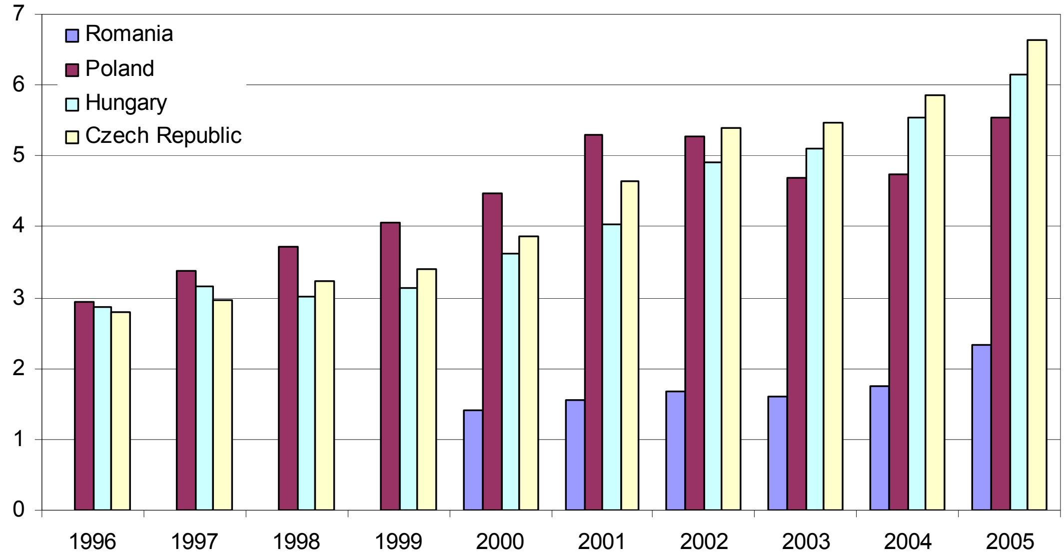


Figure 4: Evolution of the hourly labour costs in the ECS (in euros)

today, space may depend on the cooperation of several ministries. In each of them there is no forum or mechanism to discuss a national space policy at an adequate political level. The space offices lack the critical mass needed for the coordination of the national activities, for representing their country and sustaining relationships with foreign counterparts. The Czech, Hungarian and Polish space offices consist today of, more or less, three people each.

The ECS also need to handle **funding problems**. In all of them most of the space activities are publicly funded. Given the overall economic challenges these countries are currently facing, the funding situation for space, like for all scientific fields, is difficult and remains variable, in terms of level of funding and availability, i.e., when the funding will actually be available. Except for Romania which has a multi-year funding system for R&D, the other ECS have to cope with uneven funding levels. The situation could improve if funding of space activities is seen not simply as financing academic research but also as an investment in innovation with significant economic benefits.

Besides, these difficulties are amplified by recent political changes. For instance, the Hungarian Space Office's location has been changed twice in the past year due to political reorganisations: from an independent office, it was integrated into a ministry and then moved to another one. These changes have had a negative impact on the Office's budget.

Moreover, the funding problems are often combined with a **lack of long-term policy** for space activities, which prevents a focus of the limited resources.

Also, some **adjustments to Western "standards"** of production or management

are still underway. The ECS inherited from their experience with the Soviet Union an "incomplete" scientific expertise. This phenomenon is partly due to the high degree of interdependence between capabilities in all former countries of the Soviet bloc and to the willingness of the Soviet Union to restrict their activities. Two major issues are quality control and assurance and the adaptation to market principles, as further explained below. Finally, the ECS **lack political and public support** for their space activities. Space is perceived as a luxury that these countries cannot afford today and there is a limited public awareness of its usefulness. But what is specific to the public perception of space in the ECS is that first, space tends to be associated with Soviet propaganda and more importantly people "got used" to space, in the sense that they have already participated in major space achievements with the Soviet Union and each of them sent its first cosmonaut more than 20 years ago. The first Czech and Polish cosmonauts flew in 1978, the first Hungarian in 1980, and the first Romanian in 1981 (the first Western European astronaut flew in 1982).
All these reasons lead to a so far limited interest from Western European industry in the new member states. The ECS still have to deal with many important difficulties that hinder the development of their space activities but they demonstrate willingness to address all those issues. It remains undeniable that the ECS' restructuring has been very fast and that they have already achieved a lot in 15 years. Moreover, the ECS, like the other NMS, have gained significant political weight since they joined the European Union.

1.3. But the ECS have gained significant political weight through their EU membership

As EU Member States, the ECS participate in the EU programmes (Framework Programmes etc.) and in the joint EU–ESA programmes (mainly Galileo and GMES), as well as in their decision-making process.
It is noteworthy that the four ECS represent together 16.4% of the population of the EU27, as detailed in Table 2.
As shown in Table 3, it means that they represent together 17.4% of the seats in the European Parliament, as those seats are shared out proportionately to the population of each Member State (with a minimum of 5 and a maximum of 99).

	Population (in millions)	Population (percentage of the EU27 population)
Czech Republic	10.2	2.1%
Hungary	10.1	2.1%
Poland	38.2	7.8%
Romania	21.6	4.4%
TOTAL	80.1	16.4%

Table 2: Population of the ECS[5]

Moreover, they participate in the elaboration of the European Space Policy as they are represented in the High Level Space Policy Group[6] (HLSPG) and sit as fully-fledged members in the Space Council, the joint EU/ESA forum for space.

Member State	Number of seats	As a percentage of the total number of seats
Czech Republic	24	3%
Hungary	24	3%
Poland	54	6.9%
Romania	35	4.5%
TOTAL	137	17.4%

Table 3: Representation of the ECS in the European Parliament (6th Parliamentary Term)

[5] 2006 Average population, Source Eurostat

[6] The Article 8 of the Framework Agreement signed in November 2003 between the EC and ESA established a High-Level Space Policy Group, co-chaired by the EC and ESA and gathering high-level representatives from EU and ESA Member States. Its objective is to reach a common understanding on the implementation of European Space Policy, in particular the preparation of the future European Space Programme.

2. The ECS and Space

2.1. The role of space in the ECS: Space as a tool for development and integration

Space is a key scientific field in the ECS. Given the expertise gained during the Intercosmos programme, the primary rationale for space activities should be maintaining and further developing their knowledge and skills in various space-related fields.
However, investing in space activities is not a priority for the ECS today. Spending more on space could mainly be motivated by two rationales that are strongly connected. First, space activities could support some of the ECS specific policy objectives as well as European common policy objectives. It could help them to tackle major societal challenges, making the public management more efficient and supporting the development of their economy.
The latter includes developing their industry, and in particular SMEs, making the transition from a labour-intensive industry to a higher value-added industry, as well as supporting the development of infrastructures. Thanks to EU programmes, practical benefits of space have started become visible in the ECS. Second, space activities could help these NMS further politically, institutionally, and economically integrate into Europe. The main foreign policy objective that shapes their space activities is their strong willingness to be further integrated into Europe. Space could enable them to access the EU technology market, to participate in European programmes and to be recognised as reliable partners by Western European companies and research institutes.
Space is therefore considered in the ECS **as a potential tool for development and integration**. Yet this tool can be successful only if a number of conditions are met. First, **space can be a successful tool for economic development** if it properly addresses citizens' needs and improves their everyday life, creates growth and value and helps the ECS to achieve their economic goals in line with European objectives.
It would require the adoption of a coherent long-term strategy for their development, which is not yet the case for all of them. Space can also be used to support other policy objectives, like Romania is doing in order to address security issues.
Space can be a successful integration tool if two types of challenges are handled. Internally, the ECS need to improve the organisation and coordination of their space activities, to demonstrate the usefulness of space to their citizens, through lobbying and public relations actions, and to define their role and objectives in the European landscape. Externally, the old Europe's space community needs to have a coordinated and coherent approach and a timely action towards these countries.

2.2. The role of the ECS in the European space activities

The old Europe's space community expects from the ECS the definition of clear priorities in the field, but some of the ECS consider that it is too early to define such priorities.
Today's ECS involvement in European programmes is mostly scientific because of their experience and of the limited development of their industry. The old Europe can only benefit from a less risk-averse attitude towards the ECS and from their involvement in space programmes other than scientific ones. Industry and the private sector might still grow in parallel with the development of partnerships with Western companies but in a slow and incoherent way. Such an evolution would generate a feeling of disillusion among those countries that are today expecting a lot from a closer relationship with Western Europe. This result would be in no one's interest.
It does not make sense for the ECS to focus mainly on developing products that would directly compete with the ones of established players, all the more that their competitive advantage due to their lower production costs might not last. They certainly want to get involved in the development of infrastructure both for economic and strategic reasons and some of them have already invested, especially in ground infrastructure. As EU members they contribute financially to the joint EU-ESA programmes and therefore expect to participate in the development of their infrastructure.

There is a general feeling among the ECS that, because of their limited relations with Western companies they do not get a "fair" return on

such investments at European level. If more public funds are to be devoted to those programmes, a larger industrial return is expected. However, the capacity existing in Western Europe to develop and manufacture space systems is today large enough to address the current market, which is limited and growing only slowly. Thus in the short- to medium-term getting involved in construction and integration phases would not be the best option except for specific technological niches. The Pille radiation dosimeter developed by KFKI AEKI in Hungary is a good example of successful investment in a very special technology.
Moreover, the ECS countries are looking at investment in high value-added sectors in order to evolve from the labour intensive activities in which they are involved because of the foreign investments in sectors like car manufacturing attracted by their lower production costs. Space could be one of these sectors but others may be preferred, like biotechnologies or nanotechnologies, which could offer higher returns.
The domain in which the barriers to entry are the lowest for them are space-based services, whether related to navigation, Earth observation or telecommunications, as well as security and sovereignty. Developing those applications is obviously less capital-intensive than manufacturing space systems. Most of those applications will certainly be developed by SMEs and the innovative and entrepreneurial young professionals of those countries are likely to play a major role in their development. In addition, it is the field in which growth is expected to be the largest in the upcoming decades. Furthermore, the NMS might be more "open" to newer applications than their Western counterparts.
Moreover, a lot remains to be done from both the demand and the supply of space-based services. The development of the "infrastructure" for those applications has already started and it seems unlikely that the NMS will manage to "climb on the bandwagon", at least for now.
However, the ECS will be new users and could also be providers of services based on this infrastructure, especially as they have already gained experience in the Earth observation and/or navigation applications. Finally, space applications could support their development in a visible way, so it is certainly a very strategic choice.

2.3. The vicious circles of the development of the ECS' space activities

As mentioned above, the old Europe's space community expects from the ECS clear priorities as a prerequisite for defining fields of potential cooperation; however some of the ECS prefer not to define them yet, which then hinders cooperation.
Furthermore, even if the ECS define segments on which they want to focus their resources, the space activities in the ECS are unlikely to grow at an adequate pace if nothing is done externally to help them in the "right" direction.
Without any change to the current situation, the development of the private sector might not take place fast enough so that the role of the ECS in Europe might not significantly evolve in the years to come. Those vicious circles, illustrated in Figure 5, could only be transformed into virtuous ones with a coherent impulsion from the West.

2.4. The development of space-based applications in the NMS

The NMS could greatly benefit from the development of space-based applications in Europe. As EU Member States, they can benefit from opportunities in that field and further expand their know-how, however they will not significantly participate in the development of the infrastructure, which is under the responsibility of ESA. For the development of the services funding is available at European

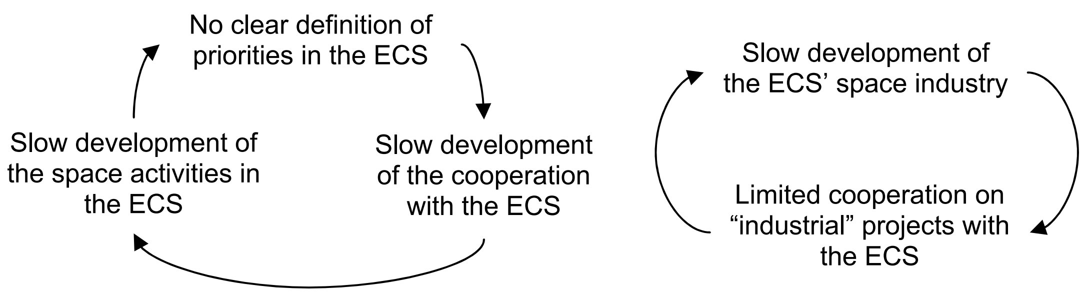


Figure 5: The vicious circles of the development of the ECS' space activities

level mainly in the Framework Programme.
Space-based applications have been, and will be, funded at European level mainly through the Framework Programmes. In the FP6, the budget for the priority thematic area "Aeronautics and Space" was about 1075 million euros for the period 2002-2006, with about 235 million euros distributed between Galileo, GMES and satellite communications activities, as presented in Figure 6.

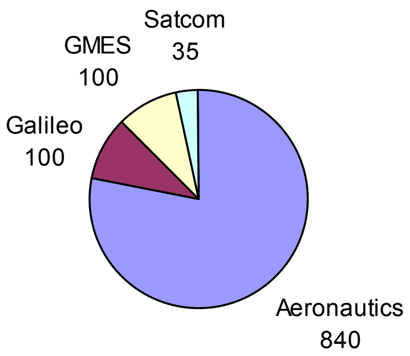


Figure 6: Budget of the FP6 thematic priority "Aeronautics and Space" (in million euros)

In the FP7, the budget dedicated to the theme "Space" in the Cooperation programme should increase five fold and reach about 1.4 billion euros for the period 2007-2013.
The priorities defined in the Work Programme 2007 of the Theme "Space" are:

- Space-based applications at the service of European society
  - Pre-operational validation of GMES services and products
  - Integration of satellite communications and navigation with GMES for prevention and management of emergencies
- Strengthening the foundations of space science and technologies
- Cross-cutting activities
- Activities not subject to a call
  - Coordinated provision of space-based observation data for GMES
  - Development of GMES-dedicated space infrastructure
  - Risk-sharing Finance Facility

Unlike in the FP6, Galileo-related activities will be funded under the theme "Transport" in the FP7. As detailed in Figure 7, GMES should represent about 85% of the total budget.

In the "Space" theme, the NMS could benefit especially from the funding for downstream activities in GMES-related services but in accordance with the rules of the Commission, i.e., based on competitive calls.

Space-based applications might also be funded in other FP7 "Cooperation" themes, especially in the theme "Security" (with a total budget of 1.3 billion euros over the whole FP7 duration) for activities such as "Intelligent surveillance and border security", the theme "Environment" (with a total budget of 1.8 billion euros) for activities such as "Earth Observation and assessment tools for sustainable development", "Sustainable management of Resources" and "Climate change, pollution and risks", and the theme "Information and communications technologies" (with a total budget of 9.1 billion euros).

2.5. The need for an external impetus

This impetus could be political, legal and/or economic.

2.5.1. Political components

First, the funding of space activities in the ECS would benefit from **political support** from the old Europe's space community. Binding

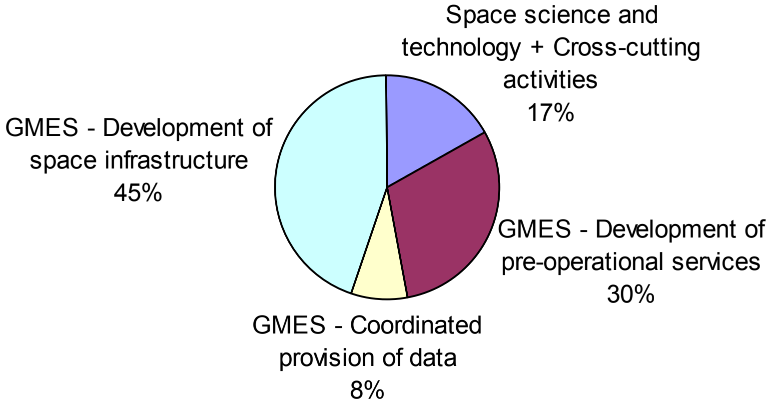


Figure 7: Budget distribution for the FP7 theme "Space"

international agreements, and in particular agreements with European counterparts, are very welcome by their space communities as a way of securing funding.

2.5.2. Economic components

European funds could be used to support the development of space-related activities in the ECS. As mentioned earlier, the funds from the Framework Programme 7 are based on competition between the 27 Member States. Orienting part of the space-related funds towards the NMS could be an economic impetus that would promote the development of applications in those countries.
Structural funds, which are intended to reduce the gaps in development and disparities in well-being in Europe, could also be used for such purposes. Space-based services could directly support the regional policy action, which would be another argument for the development of such services in those countries. Those funds could then support the local development of space-based applications.
The amount of structural funds that the four ECS will receive from 2007 until 2013 is presented in Table 4. Over seven years, the structural funds for the four ECS total more than 122 billion euros. If 1/1000th of those funds could be used to develop space applications in the ECS, it would represent more than 17 million euros a year, to be compared with the annual four million euros of the PECS Programme (one million euros per ECS) or the 16 million euros total space budget of the ECS (detailed in Appendix B).

Czech Republic	23,640
Hungary	22,390
Poland	59,550
Romania	17,270
TOTAL	**122,850**

Table 4: Planned structural funds for the ECS for 2007-2013 (in million euros 2006)[7]

Those calculations led Western European companies to propose using part of the structural funds to support the local development of space applications in the new EU Member States. EADS Astrium proposed a "Verheugen-Marshall Plan" for the NMS with a budgetary line dedicated to the development of the space-based services market in the NMS and of local centres of excellence that would provide those services, with their support.[8]

A closer look at the structure of the regional funds shows that the distribution of those funds, as organised today, prevents a large-scale sustainable policy for the development of space-based applications.
The Regional Policy for 2007-2013 pursues three objectives:

- Convergence

To promote growth-enhancing conditions and factors leading to real convergence for the least-developed Member States and regions

- Regional Competitiveness and Employment

To strengthen competitiveness and attractiveness, as well as employment

- European Territorial Cooperation

To strengthen cross-border cooperation through joint local and regional initiatives, trans-national cooperation aimed at integrated territorial development, and interregional cooperation and exchange of experience
Those objectives are supported by three funds in the manner described in Table 5.

- European Fund for Regional Development (EFRD)
- European Social Fund (ESF)
- Cohesion Fund

Objectives	EFRD	ESF	Cohesion Fund
Convergence	X	X	X
Regional Competitiveness and Employment	X	X	
European Territorial Cooperation	X		

Table 5: The three funds contributing to the Regional Policy objectives

For each country that can benefit from some of the regional funds, a national strategic reference framework is defined with the EC Directorate for Regional Policy which includes strategic objectives for the country. Along those objectives, operational programmes and their priority lines in a variety of fields (for instance, transport, environment, etc.) are proposed by the Member States and approved by the Commission. Some of these programmes include cooperation with other European countries and regions. For each

[7] Source DG-Regional Policy
[8] Security Defence Agenda Roundtable Report, "Is Europe Serious about Space and Security?", 16 October 2006

operational programme, the Member State appoints a managing authority (a national, regional, or local public authority or public/private body), which manages its assigned operational programme(s) and selects the projects, submitted at regional level. Depending on the country, the management of the operational programmes can more or less be centralised, with either few or many different authorities managing the programmes. The duration and budget of the projects selected by the managing authorities can greatly vary from one programme to another and from one managing authority to another.

Thus, to develop a precise space-based application, the demand for funds should stem from regional organisations that would submit a project to the managing authority. The project would then compete with others, which could be of a very different nature in the same operational programme, to be perhaps selected by the managing authority and eventually funded. In such conditions, a coordinated approach to develop even one specific application at country or higher level is very difficult and hardly sustainable. Furthermore, not all European regions that are entitled to regional funds are eligible to the same funds, and for the 2007-2013 period, one programme will be financed by only one fund.

A promising mechanism could take place at the level of regions. As part of the Graz process, an initiative was launched in Toulouse during the workshop "The Role of European Regions in GMES", in March 2006, regarding the setting-up of a network of European regions to promote the use of space applications. It was confirmed in Graz at the conference "A market for GMES in Europe and its Regions", in April 2006, held by the Austrian presidency of the EU Council. This initiative was embraced by the President and Secretary General of the Committee of the Regions (CoR) and endorsed by the EU Competitiveness Council in May 2006. Since then, various coordination and progress meetings have been hosted by the CoR, in which 40 regions from 11 Member States have taken an active role. Such initiatives, if implemented, could be a catalyst for the development of space applications not only in the NMS but also in Western Europe.

2.5.3. Policy components

Another complementary measure to help space-based services taking-off in the NMS is an appropriate remote sensing **data policy** that would enable them to access European data for free or at least at lower costs. Data costs limit the development of research activities and therefore of the applications in the ECS. Besides, the number of clients for remote sensing data is fairly limited in these countries so there is no real market impact to be concerned with today. There are also key "internal" data policy issues. In the ECS, all data are not harmonised yet and are spread in many different organisations or public research institutes that do not share data. Thus a Ministry of Environment needs to buy maps, like any other customers, from a National Institute of Cartography. Given the funding available, such a policy clearly limits research activities. Differentiated price policies for data could be beneficial to the development of space applications. European policy initiatives along those lines already exist, especially the Infrastructure for Spatial Information in the European Community (INSPIRE)[9] that recently complemented other directives like the one on the reuse of public sector information.[10]

2.5.4. The need for a coordinated approach

From a Western European perspective, different approaches are possible, from a bilateral approach to a concerted approach between the old and the new Member States. The bilateral approach is already taking place but evolves at a slow pace as each of the NMS, taken individually, is not a priority for most old Member States. Even though the ECS tend to focus on a bilateral approach with the EC or ESA and tend to neglect their relationships with the other ECS in the space field and even though some of the ECS would prefer being treated differently than the others, a **common approach towards, and from, all the ECS** would certainly be more efficient and coherent. Moreover, the challenges to be addressed require a coordinated approach among all stakeholders: the ECS, the European Union, ESA and their Member States.

2.6. The timing is crucial

Last but not least, space can be a very successful development and integration tool if actions are taken on both sides, **in the years to come**.

The ECS are undergoing profound transformations and they are, in fact, developing at a considerable rate. It is now, and in the coming years, that space could most visibly address their needs, the same time that they will make decisive investment choices.

[9] INSPIRE was established by a the Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 and entered into force in 15 May 2007

[10] Directive 2003/98/EC of the European Parliament and of the Council of 17 November 2003 on the reuse of public sector information

The European space community as a whole could also greatly benefit from the development of space-based services in Eastern Europe. Those services have difficulties taking-off in Europe for a number of reasons, mainly the lack of a private market for those applications. The development of infrastructure and services and their use to the benefit of society could create a momentum in Europe for the use of such services, but it would still require the development of a private market in the ECS.

3. The question of ESA membership

A key element of external impulsion for the ECS would be ESA membership. There is a willingness expressed by both the ECS and ESA to have the former join the latter in the coming years.

3.1. The relationships between ESA and the ECS

3.1.1. Cooperation Agreements and PRODEX

The cooperation between ESA and the ECS started in the early nineties. ESA signed **Cooperation Framework Agreements** with Hungary in 1991, Poland in 1994, the Czech Republic in 1996 and Romania in 1999 (after the signature of a first Cooperation Agreement in 1992).
The second step was the participation in **PRODEX** (Programme de Développement d'Expériences scientifiques), an ESA optional programme created in 1986 that aimed at providing funding for the industrial development of scientific instruments or experiments proposed by research institutes or universities and that was also opened to non-Member States. Hungary and the Czech Republic joined PRODEX in 1998 and 2000 respectively. The Czech Republic was the last country to join PRODEX which was then closed to new non-Member States participants.

3.1.2. The Plan for European Cooperating States (PECS)[11]

A major event in the relationships between ESA and the ECS was the workshop organised by ESA in 1999 in Budapest to review its cooperation with its partners in Central and Eastern Europe, namely the Czech Republic, Hungary, Poland and Romania. The main finding of the workshop was that the step between their existing Cooperation Agreements and the ESA full, or even associate, membership was too large and ESA was asked to propose an intermediate step that would be better adapted to their situations. Thus following this workshop, the ESA Council decided in December 1999 to set up an ad-hoc Council Working Group that would examine the Agency enlargement issue. The main recommendation of the Working Group was that "the Agency establishes a specific framework for facilitating the participation of European non-member States in ESA programmes" which was better adapted than the Associate Membership.
The Associate Membership was a first step towards full membership for Austria, Norway and Finland. In 1999, Portugal was the first country to express the wish to become a full ESA member without first going through the Associate Membership status (defined in Article XIV of the ESA Convention). The ESA Council finally approved the accession of Portugal in November 2000 and, in a similar way, Luxembourg and Greece joined ESA in 2005.
The recommendation of the Working Group led to the creation of the status of **European Cooperating State**, approved by the ESA Council in March 2001, as a first step towards a full membership, as shown in Figure 8.
The new ECS status was conditional to the participation to the Plan for Cooperating States (PECS) which was exclusive of any other ESA programmes. The four countries were declared admissible to the participation in PECS as they had signed a Cooperation Framework Agreement with ESA. The objective of PECS was to associate the ECS countries to the ESA programmes in order to prepare them for a future ESA membership. It includes: giving them the opportunity to indirectly participate in ESA programmes (science and optional programmes, subject to prior favourable recommendation of relevant subordinate bodies of the ESA Council), strengthening their industrial expertise in order to prepare them for a satisfactory geographical return, improving their understanding of ESA organisation, rules and procedures, as well as limiting the duplication of activities in Europe.

[11] C. Baudin, K. Bergquist, "Towards an Enlarged Partnership – ESA's Relations with the Czech Republic, Hungary, Poland and Romania", ESA Bulletin 107, August 2001

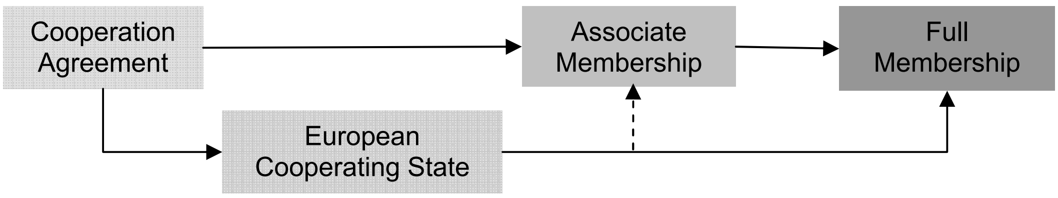


Figure 8: The European Cooperating State status

As summarised in Table 6, Hungary was the first country to sign an ECS Agreement with ESA in 2003, followed by the Czech Republic the same year, Romania in 2006 and Poland in 2007. The minimum contribution over the five years of the agreement is five million euros. Within a year of signing an ECS Agreement, a PECS Charter, describing the PECS projects to be undertaken and their funding, must be signed by both parties. Thus such a Charter has been signed by Hungary in 2003, the Czech Republic in 2004 and Romania in February 2007.
Before the signature of the ECS agreements and the definition of the Charters, ESA ordered assessments of the potential space suppliers in the four ECS, as, unlike in PRODEX, the PECS activities are not limited to science (see Appendix B) and private companies are involved. In fact, this evolution is reflected by the recent transfer of responsibility for the PECS activities inside of ESA from the Science Directorate to the Telecommunication and Navigation Directorate.

3.1.3. The PECS experience and the options for the way forward

The signature of the ECS Agreements has taken a significant amount of time and was only finalised with Poland more than seven years after the Budapest workshop.
But from the perspective of the ECS, and particularly of the Czech Republic and Hungary which have had several years of experience with it, PECS is a great opportunity for them to learn, to give space more visibility in their country and provide them with a long-term vision for space activities. It is important to note that the PECS programme budget does not represent the same share of the space budget in all the ECS. It represents a large share of the space budget of the Czech Republic (37% of the Czech space budget) and Hungary (48% of the Hungarian Space Office budget), but it should represent a smaller share of the Romanian space budget (estimated at 25% of the Romanian space budget) and of the Polish space budget (estimated at less than 20% of the Polish space budget).
The stakeholders in the ECS have begun to acquaint themselves with ESA rules and procedures, but this process takes time. The relationships between the ECS' research institutes and companies and the ones of the ESA Members are still limited and need to be further developed. Apart from a few exceptions, the companies in the ESA Member States know little about the ECS and the opportunities that exist there.
This lack of understanding and communication has generated concerns about these countries and the impact of their entry in the European market. Some of the ECS have actually perceived changes in the attitudes towards them since the beginning of the PECS programme, believing they are seen now as potential competitors. The PECS programme is nevertheless a good opportunity for companies of the ESA Member States, as they could obtain components or subsystems from the ECS and paid for by the ECS themselves as part of their contribution to the PECS programme. The mapping of the ECS' capabilities ordered by ESA seems to have improved the situation; however much remains to be done. There is still a feeling in the ECS that they lack proper recognition of their expertise from the West.
Some elements of the PECS have also generated frustration in the ECS. One source of frustration is the inability of the ECS to

	Cooperation Framework Agreement	PRODEX	PECS	PECS Charter
Czech Republic	1996	2000	2003	2004
Hungary	1991	1998	2003	2003
Poland	1994	-	2007	2007 or 2008?
Romania	1999	-	2006	2007

Table 6: Key dates in the ESA/ECS cooperation

directly bid on ESA's invitation to tender system, EMITS. A second issue stems from the fact that some countries did not manage to have a PECS contribution that increases over the five years of the programme. A final cause of dissatisfaction is the delay in the establishment of the PECS Committee. The Committee was supposed to be created after three countries sign the ECS Agreement, i.e., after Romania joined in February 2006. The PECS committee was finally established and met for the first time on 8 May 2007.
The ECS Agreement is signed for a period of five years. Hungary signed its ECS agreement in 2003, thus the question of its full membership is being raised. In fact, the Hungarian Minister of Informatics sent an official letter to ESA in January 2006 to start the accession negotiations. The request was approved by ESA Council in March 2006. However, the Hungarian administration has been restructured after the June 2006 elections and the Hungarian Space Office relocated so that the negotiations with the new Ministry in charge of space activities have started again only recently. Given those delays, a full membership in 2008 seems no longer reasonable from both sides' perspectives. The Czech Republic also started the same process, in January 2007.
The most likely option for Hungary and the other ECS is an extension of the PECS programme, as it exists, or with a gradually increasing contribution, for another five years or less, or an Associate Membership.

3.2. Benefits and costs of the ESA Membership

The four ECS, ESA and its Member States would benefit in the long-term from a further contribution of the ECS to the European space programmes and strategy.
The first question to address is whether the best option for further involvement is an ESA membership. The ESA membership has a significant cost, in particular for mandatory programmes, and requires an industry that can absorb the geographical return. If the ECS get further involved mainly in applications programmes, then joining ESA might not make sense today as they are already participating through their EU membership. However, ESA would allow them to participate in the European scientific programmes, which is important to the ECS given their expertise, and remains a tool for political integration.

The ESA Membership would have economic and political benefits and costs for all stakeholders.
First, from an **economic point of view**, joining ESA would allow the four ECS to secure a larger and more stable funding for space, to participate in more European programmes and therefore to develop their space activities and to access the European technology market. A closer cooperation with ESA represents an opportunity for the space community of the ECS to demonstrate to their decision-makers the driving role space can play in their economy. For the other Member States, their membership would mean potentially lower costs for some subsystems, more demand for space services, i.e., an additional demand for new and existing products, and a larger budget. If the ECS were to join ESA, they would have to pay, like any other ESA Members States, a yearly contribution that consists of a compulsory contribution to mandatory programmes, as well as a contribution to optional programmes. As stated in the Article XIII of the ESA Convention, the mandatory contribution is based on the countries' average national income for the three latest years for which statistics are available.
To get an order of magnitude of what the minimum level of the ECS annual contribution would be if they were to join today, one can make rough estimates based on the levels of mandatory contribution of the ESA Member States in 2006 and their GDP. Those calculations show that such a minimum contribution of the ECS to the Agency's budget would represent today less than 5% of the total budget for mandatory programmes. As a reminder, the mandatory programmes represent today about 16% of the total ESA budget and covers mainly science projects. The calculations also show that for the Czech Republic, Hungary and Romania, the minimum yearly contribution today would represent about what they have invested in PECS over 5 years, and for the Czech Republic and Hungary would represent about twice their current investment in space. For Poland, this minimum contribution would represent every year more than twice what they are investing in PECS over 5 years. This would then require doubling their current investment in space.
From a **political perspective**, this ESA membership would mean that they are recognised as partners and would be an additional important step towards complete integration. It would also give them a benchmark against which they could assess their own performance.
Besides, the membership would not significantly impact, and could only be

beneficial to, their relationships with other countries like Russia and the United States.

From a **technical and scientific point of view,** the membership would enable them to offer a larger contribution to the European programmes and therefore would allow them to develop new capabilities.

Finally, the ESA membership would make it possible for the four ECS to become more involved in the joint EU-ESA programmes that can **support their development and address some of their societal issues** (development, environmental protection, etc.).

But the membership also entails in the short-term significant **costs for both sides**. First and foremost, ESA membership will greatly cost the ECS. The contrast between the one million euro annual PECS contribution and the minimum contributions mentioned above represents a very large step. In addition, this step must be added to another space-related one: the EUMETSAT membership. All the ECS signed with EUMETSAT a five-year Cooperating State Agreement between 1999 and 2005, as a first step towards a full membership. An extension of this status has been awarded to Hungary and Poland, who signed the Agreement in 1999 and 2000 respectively, but, for instance, the new deadline for Hungary is 2008, at the same time the ESA membership question will be raised. For Hungary and perhaps other ECS, it might influence the ESA membership process.

Therefore, acquiring a good **knowledge of the ESA's complex working process** at all levels is required from the ECS, and this, despite having started, is not completed yet and will still take time. In addition, some of the ECS also need to harmonise their **standards** with those of ESA. One of the main issues is quality assurance and control. During the collaboration with the Soviet Union within Intercosmos, quality assurance and control were rather different than what they are today in ESA and the adaptation is slowed down by the fact that some of them did not have any components testing facilities. They have had to build some facilities or use those located abroad. They have also had to learn in the field of **project management**. Another important issue was the need for them, and in particular for the public research institutes, to **adapt to market principles**. Before the nineties, the research institutes in the ECS did not have to purchase components, as these were provided by the Soviet Union as needed.

Furthermore, they did not have access to information about the market for components similar to the ones they were using. Today finding the right components remains difficult for some of the research institutes. They have not built a network of suppliers yet and still lack information about markets and prices. One can add to this list of major problems the language issue, which tends to amplify the other problems and the time required to solve them. This language issue, as well as other ones, will clearly be less of a problem for the new generation.

The ESA membership also requires a **more effective and transparent organisation of the institutions** in the four ECS and a better coordination of national activities, including more coordination between industry, research institutes and universities. All these elements are taking place and would improve the return in the four ECS but take time. Besides, the old Member States should be aware of the risk overburdening the ECS.

From an ESA perspective, NMS would require significantly more support if they are to become members. This support would bear a cost for the Agency, even though a common approach could be organised, given the similarities in the issues the four ECS would have to deal with. It is important to underline that, contrary to some of the most recent ESA members, the ECS do benefit from strong relationships with the countries that are drivers of European space activities (Germany for the Czech Republic, Hungary and Poland, and France for Romania).

Last but not least, new ESA Member States would also require a re-modelling of the human resources of the Agency in order to have positions available for the representatives of those countries.

3.3. Challenges to the ESA membership

There is a willingness expressed on both sides to have the ECS join ESA in the future, however there are challenges of different natures to overcome. While the membership is mainly a political and economic issue for the ECS, from an ESA perspective, it is political but also institutional since it might affect the basic working rules of the agency.

3.3.1. For the ECS

From an ECS point of view, the main barriers to the ESA membership are the public and political support for space activities, which are decisive for funding, and their technical and industrial capabilities, which define the benefits they can derive from the Membership.

3.3.2. For ESA and its Member States

From an ESA perspective, this enlargement raises issues about ESA's absorption capacity, as ESA needs to remain effective in the achievement of its goals despite additional members.

- Impact on ESA industrial policy and activities

An enlargement might have first an impact on the **industrial policy** of the Agency. The four objectives of ESA's industrial policy, defined in the Article VII of its Convention, are the following: meeting the requirements of the European space programmes in a cost-effective manner; improving the worldwide competitiveness of European industry; ensuring that all Member States participate in an equitable manner in European programmes and exploiting the advantages of free competitive bidding.
Those objectives can turn out to be contradictory. Thus, one of ESA's main industrial policy tools, the "geographical return", which aims at supporting the development of technical and industrial capabilities in the Member States, can actually prevent ESA from making the most cost-effective choices and, as a result, become an obstacle to European industry competitiveness. An ESA enlargement would make those objectives even harder to reconcile, especially if the new Members contemplate addressing markets where European industry already suffers from overcapacity. The two main options can then be summarised as: **complementarity** and **new activities**.
The complementarity with existing expertise is clearly mentioned in the PECS agreement and corresponds to a focus of the ECS on technological niches. The other way to reconcile the ESA's industrial policy goals with new Members would be to create new activities in which those new Members could participate. Thus the enlargement might also have an impact on the Agency activities. These new programmes could certainly be scientific or applications-related, for the part ESA might be responsible for. However, it will take time before potential new Members can get involved in such programmes from the very beginning.

- "Geographical return" and the ECS

The ECS benefit today from a geographical return close to 1, as initially defined in the PECS agreement. This Agreement was designed as a way to **prepare industry to absorb the return** and the ECS are likely to be better prepared than the last countries that joined ESA. When Austria and Norway became ESA Members, special measures were taken to help them increase their return. After that experience, a transition period was defined for Finland, Portugal, Luxembourg and Greece to support their industry, before the return rules fully applied.[12] This transition period, that turned out to be necessary, might be avoided with the ECS.

- Impact on ESA governance[13]

Additional Members would also impact the Agency's **decision making-process**.
The voting system at ESA is currently based on the rule "one Member State, one vote", regardless of each country's financial contributions. Obviously the main ESA contributors would like to see that rule evolve and an ESA enlargement to smaller contributors could provide them with an opportunity to have it revised in order to make it more "politically acceptable" to them. It is noteworthy that there are a few cases in which votes are today weighted in relation to the contributions. Some of the decisions regarding optional programmes are made with a two-thirds majority of all participating States, provided that this majority represents at least two-thirds of the contributions to the programme, as defined in the Annex III of the Convention.
Based on the "one Member, one vote" rule, three voting systems are used within ESA. The general voting rule is the simple majority under Article XI.6(d). However unanimity is necessary for international cooperation (Art. XIV), for the coordination of national policies (Art. V.3), for any revision of the ESA Convention (Art. XVI), for the cyclical definition of the financial contributions (Art. XIII) and for the admission of a new Member State.
In some cases, a two-thirds majority is required such as for the adoption of the budget (Art. XI), the nomination of the Director General (Art. XII), and for the definition of industrial policy rules (Art. VII). A potential enlargement might impact the

[12] Poncelet, J.-P., Fonseca-Colomb, A., Grilli, G., "Enlarging ESA? After the Accession of Luxembourg and Greece", ESA Bulletin 120, November 2004

[13] Vaudo, E., Lunares-Calduch, L., Mazurelle, F. , Diekmann, A., "Casting your Vote in ESA – Now and in the Future", ESA Bulletin 112, November 2002

decision-making process differently for each of those voting systems with unanimity becoming even harder to reach. However, the voting efficiency of ESA is likely to be preserved despite an enlargement, as ESA has built a culture of consensus and has created subordinated bodies to "prepare" any decision to be voted by the Council. In any case, the consensus will get more difficult to attain and more Members, especially four or five can change the dynamics and the outcome of the decisions.

Conclusions and Recommendations

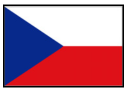
The Czech Republic, Hungary, Poland and Romania have **similarities** because of their common history, which leads Western Europe to consider them as a homogeneous group. However each of those countries has its **own specificities** in terms of expertise, structure of the space activities, funding mechanisms, etc. A **common approach** towards these four countries would be simpler but also more coherent and effective. Nevertheless, given the differences, its implementation would then have to differ from one country to another.
On the other hand, the ECS could only benefit from jointly expressing **common interests,** as they can exert together more weight in their discussions with ESA and the EC that none of them alone are able to. Thus it is crucial for them to work together and develop a common approach despite their willingness to differentiate themselves from the others; the PECS Committee is an opportunity that could help them in that direction and should be fully exploited as such.
The main challenge to further participation in the European space programmes remains clearly the **development of the private sector**; it has to be competitive in the EU programmes and have the capacity to absorb the geographical return of the ESA programmes. The vicious circles that hinder this development can only be transformed into virtuous ones with an **external impetus**. Such an impulsion could come from Western Europe, and should be perceived as an opportunity by its Member States. The risk of not taking that opportunity is two-fold: first, those countries might develop partnerships with other countries outside of Europe, and then, they might also invest in high-tech fields that are not related to space, which is the reason why the timing is crucial. In addition, the approach should be coordinated between the EU and ESA.

EU structural funds could be used to develop **space-based applications** in new member states, but not under the existing mechanisms that would not be sustainable. Seed money could be granted to SMEs under a new mechanism in order for them to develop space-based applications that could support effectively their countries' development and integration.
An **ESA membership** could also be such an impetus, but is challenged by **political and institutional issues**. Additional members would raise concerns among today's members mainly about ESA's industrial policy and decision-making process. It would, however, also be an opportunity for the larger contributors to change ESA rules to their advantage. One way to decrease the strains additional members might create is to further develop existing activities or start new ones. **Science and applications** are the most relevant fields to develop so ESA could offer such opportunities to the ECS.
It must be stressed that, should the four ECS join ESA in the future, they will certainly be **better prepared** than some current Member States were, and that they would likely benefit more from a membership than their predecessors.

Appendix A

Fact Sheets on the Czech Republic, Hungary, Poland and Romania

CZECH REPUBLIC



The Czech Republic[15]

KEY DATES

May 2004	EU membership
March 1999	NATO membership
Jan. 1993	Czechoslovakia split into Czech Republic and Slovakia
Dec. 1989	Election of Vaclav Havel
Nov. 1989	"Velvet revolution"

POPULATION[14]

10,235,828 - 2.1% of the EU population

POLITICS

<u>Government type</u>
Parliamentary democracy

<u>Executive branch</u>
- Chief of state: President Vaclav Klaus (since March 2003)
- Head of government: Prime Minister Mirek Topolánek (since September 2006)

<u>Elections</u>
- President
  - Elected by parliament
  - 5-year term
  - Eligible for a second term
  - Last successful election held in February 2003 (next election to be held January 2008)
- Prime minister appointed by the president

<u>Legislative branch</u>
Bicameral parliament or "Parlament"
- the Senate or "Senat"
  - 81 seats
  - Members are elected by popular vote
  - 6-year terms
  - One-third elected every two years
  - Last elections held in October 2006 (next to be held October 2008)
- the Chamber of Deputies or "Poslanecka Snemovna"
  - 200 seats
  - Members are elected by popular vote
  - 4-year terms
  - Last elections held in June 2006 (next to be held by June 2010)

[14] 2005 average population, Source Eurostat

[15] Map Collection, Perry-Castañeda Library, University of Texas

ECONOMY

GDP (Purchasing Power Standard) [16]	191.21 billion PPS
GDP at current prices[3]	112.61 billion euros
Real GDP growth rate[3]	5.2%
GDP per capita (PPS)[3]	18,700 PPS
Budget[17]	Expenditure: 43.94 billion euros Revenue: 40.33 billion euros
Public debt[18]	30.4% of GDP
Inflation rate[19]	1.6%
GERD[20]	1.42% of GDP
Unemployment rate[21]	7.9%
Economic aid[22]	
Structural funds (2004-06)	2.4 billion euros (2004)
Structural funds (2007-13)	23.64 billion euros (2004)
Military expenditures[23]	1.81% of GDP

[16] 2006 Forecast, Source Eurostat
[17] 2005 Government accounts, Source Eurostat
[18] 2005 General government debt, Source Eurostat
[19] 2005 Inflation rate, Source Eurostat
[20] 2005 Gross Domestic Expenditure on R&D, Source Eurostat
[21] 2005 Annual average, Harmonised unemployment rate, Source Eurostat
[22] Source EC DG Regional Policy
[23] 2005, The World Factbook, CIA

HUNGARY

Hungary[24]

KEY DATES

May 2004	EU membership
March 1999	NATO membership
May 1990	First free multiparty elections
October 1989	Third Hungarian Republic declaration by Mátyás Szűrös

POPULATION[25]

10,087,065 - 2.1% of the EU population

POLITICS

Government type
Parliamentary democracy

Executive branch
- Chief of state: Laszlo Solyom (since August 2005)
- Head of government: Prime Minister Ferenc Gyurcsany (since September 2004)

Elections
- President
  - Elected by the National Assembly
  - 5-year term
  - Eligible for a second term
  - Election last held in June 2005 (next to be held by June 2010)
- Prime minister
  - Elected by the National Assembly on the recommendation of the president
  - Election last held in September 2004

Legislative branch
- Unicameral National Assembly or "Orszaggyules"
  - 386 seats

[24] Map Collection, Perry-Castañeda Library, University of Texas
[25] 2005 Average population, Source Eurostat

- Members are elected by popular vote under a system of proportional and direct representation
- 4-year terms
- Elections last held in April 2006 (next to be held April 2010)

ECONOMY

Main economic issue: Public debt

GDP (Purchasing Power Standard) [26]	156.86 billion PPS
GDP at current prices[3]	89.19 billion euros
Real GDP growth rate[3]	4.0%
GDP per capita (PPS)[3]	15,600 PPS
Budget[27]	Expenditure: 44.31 billion euros Revenue: 38.52 billion euros
Public debt[28]	57.7% of GDP
Inflation rate[29]	3.5%
GERD[30]	0.94% of GDP
Unemployment rate[31]	7.2%
Economic aid[32]	
Structural funds (2004-06)	2.84 billion euros (2004)
Structural funds (2007-13)	22.39 billion euros (2004)
Military expenditures[33]	1.75% of GDP

[26] 2006 Forecast, Source Eurostat

[27] 2005 Government accounts, Source Eurostat

[28] 2005 General government debt, Source Eurostat

[29] 2005 Inflation rate, Source Eurostat

[30] 2005 Gross Domestic Expenditure on R&D, Source Eurostat

[31] 2005 Annual average, Harmonised unemployment rate, Source Eurostat

[32] Source EC DG Regional Policy

[33] 2002, The World Factbook, CIA

POLAND

KEY DATES

May 2004	EU membership
March 1999	NATO membership
December 1990	Election of Lech Walesa as president
June 1989	Solidarność wins the parliamentary elections

POPULATION[34]

38,165,445 - 7.8% of the EU population

Poland[35]

POLITICS

Government type
Parliamentary democracy

Executive branch
- Chief of state: President Lech Kaczynski (since December 2005)
- Head of government: Prime Minister Jaroslaw Kaczynski (since July 2006)

Elections
- President
  - Elected by popular vote
  - 5-year term
  - Eligible for a second term
  - Election last held in October 2005 (next to be held October 2010)
- Prime minister appointed by the president and confirmed by the "Sejm"

Legislative branch
Bicameral legislature
- the Senate or "Senat"
  - 100 seats
  - Members are elected by a majority vote on a provincial basis
  - 4-year terms
  - Last elections held in September 2005 (next to be held by September 2009)
- The lower house or "Sejm"
  - 460 seats
  - Members are elected under a complex system of proportional representation
  - 4-year terms
  - Last elections last held in September 2005 (next to be held by September 2009)

[34] 2005 Average population, Source Eurostat

[35] Map Collection, Perry-Castañeda Library, University of Texas

ECONOMY

Main economic issue: Unemployment rate

GDP (Purchasing Power Standard)[36]	477.81 billion PPS
GDP at current prices[3]	267.37 billion euros
Real GDP growth rate[3]	5.2%
GDP per capita (PPS)[3]	12,500 PPS
Budget[37]	Expenditure: 105.67 billion euros Revenue: 99.68 billion euros
Public debt[38]	42% of GDP
Inflation rate[39]	2.2%
GERD[40]	0.57% of GDP
Unemployment rate[41]	17.7%
Economic aid[42]	
Structural funds (2004-06)	11.20 billion euros (2004)
Structural funds (2007-13)	59.55 billion euros (2004)
Military expenditures[43]	1.71% of GDP (2002)

[36] 2006 Forecast, Source Eurostat
[37] 2005 Government accounts, Source Eurostat
[38] 2005 General government debt, Source Eurostat
[39] 2005 Inflation rate, Source Eurostat
[40] 2005 Gross Domestic Expenditure on R&D, Source Eurostat
[41] 2005 Annual average, Harmonised unemployment rate, Source Eurostat
[42] Source EC DG Regional Policy
[43] 2002, The World Factbook, CIA

ROMANIA

KEY DATES

January 2007	EU membership
March 2004	NATO membership
January 1990	January 1990 "Mineriad" (Miner's riots)
May 1990	Election of Ion Ilescu
December 1989	Romanian revolution and fall of Ceauşescu

Romania[45]

POPULATION[44]

21,634,371 - 4.4% of the EU population

POLITICS

<u>Government type</u>
Semi-presidential democratic republic (Executive functions shared between the president and the prime minister)

<u>Executive branch</u>
- Chief of state: President Traian Basescu (since December 2004)

President Traian Basescu was suspended by the parliament on April 19 2007 but resumed his duties on May 23 2007 after he won an impeachment referendum
- Head of government: Prime Minister Calin Popescu-Tariceanu (since December 2004)

<u>Elections</u>
- President
  - Elected by popular vote
  - 5 five-year term
  - Eligible for a second term
  - Election last held in November 2004, with runoff between the top two candidates held in December 2004
- Prime minister appointed by the president with the consent of the Parliament

<u>Legislative branch</u>
Bicameral parliament or "Parlament"
- the Senate or "Senat"
  - 137 seats
  - Members are elected by direct, popular vote on a proportional representation basis to serve 4-year terms
  - Elections last held in November 2004 (next expected to be held in November 2008)
- the Chamber of Deputies or "Camera Deputatilor"
  - 332 seats
  - Members are elected by direct, popular vote on a proportional representation basis to serve 4-year terms
  - Elections last held in November 2004 (next expected to be held November 2008)

[44] 2005 average population, Source Eurostat
[45] Map Collection, Perry-Castañeda Library, University of Texas

ECONOMY

GDP (Purchasing Power Standard)[46]	189.22 billion PPS
GDP at current prices[3]	96.86 billion euros
Real GDP growth rate[3]	7.2%
GDP per capita (PPS)[3]	8,800 PPS
Budget[47]	Expenditure: 30.32 billion euros Revenue: 29.16 billion euros
Public debt[48]	15.2% of GDP
Inflation rate[49]	9.1%
GERD[50]	0.39% of GDP
Unemployment rate[51]	7.2%
Economic aid[52]	
EU pre-accession assistance (2004-06)	3.08 billion euros (2004)
Structural funds (2007-13)	17.27 billion euros (2004)
Military expenditures[53]	2.47% of GDP

[46] 2006 Forecast, Source Eurostat
[47] 2005 Government accounts, Source Eurostat
[48] 2005 General government debt, Source Eurostat
[49] 2005 Inflation rate, Source Eurostat
[50] 2004 Gross Domestic Expenditure on R&D, Source Eurostat
[51] 2005 Annual average, Harmonised unemployment rate, Source Eurostat
[52] Source EC DG Regional Policy
[53] 2002, The World Factbook, CIA

Appendix B

Space Activities and their Environment in the Czech Republic, Hungary, Poland and Romania

CZECH REPUBLIC

1. The space activities in the Czech Republic

1.1. Organisation of the space activities

- *Ministries responsible for space activities*

The Ministry of Education, Youth and Sports supervises space activities and the cooperation with ESA. It is also responsible of the Czech contribution to the definition of the European Space Policy. The Ministry's advisory body for space activities is the Czech Board for Space Activities (CBSA). The CBSA (formerly the Czech Board for Cooperation with ESA) was created in 1997 after the first agreement with ESA signed in November 1996. The CBSA gathers people from industry, research institutes, universities and all relevant ministries.
The Ministry of Transport is responsible for the implementation of the Galileo programme in the Czech Republic.
The Ministry of Environment represents the Czech Republic in EUMETSAT.

- *The Czech Space Office*

The Czech Space Office (CSO) was created in November 2003 as a private non-profit organisation, independent from the Ministry of Education, Youth and Sports.
The CSO manages and administers space activities in the Czech Republic, provides administrative and technical support on space-related issues to the Ministry of Education, Youth and Sports and its Board and to other ministries and serves as an information and advisory centre for space activities.
On the other hand, it is the contact point for ESA and other national agencies. It coordinates and administers projects in ESA programmes and evaluates results of the cooperation for the Ministry. Finally, it represents the Czech Republic in international institutions such as IAF and HLSPG.
The CSO's office in Prague consists of its managing director, Dr. Jan Kolář, and his assistant. The CSO also has an office in Germany, headed by Ing. Karel Dobes.

- *The Academy of Sciences*

The Academy of Sciences represents the Czech Republic in COSPAR.

1.2. Financial framework

1.2.1. R&D in the Czech Republic

The Czech Republic has a five-annual national R&D policy. The four strategic objectives of the "National R&D policy 2005-2010" are:

- Strengthening research and development as a source of innovation
- Establishing well-functioning public private partnerships
- Guaranteeing human resources for innovation
- Making the performance of the state administration in research, development and innovation more effective

<u>R&D Expenditures</u>
The Council for Research and Development is an advisory body to the government that prepares the state R&D budget proposal. All relevant entities submit their proposal to the Council, which then submits the final budget proposal to the government, as presented in Figure 9. The budget is then reviewed and approved by the parliament. The total state R&D budget for 2005 was about 590 million euros.

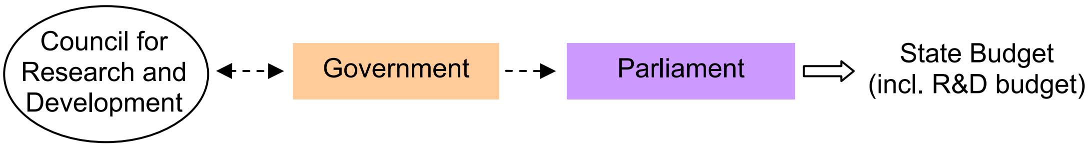


Figure 9: R&D budget approval process[54]

The total R&D expenditure (GERD) in the Czech Republic in 2005 was about 1.4 million euros, which represents about 1.42% of the GDP.[55] As shown on Figure 10, the business sector represents about 53% of the total expenditure on R&D in the Czech Republic. These figures are still far from the Lisbon revised objectives.

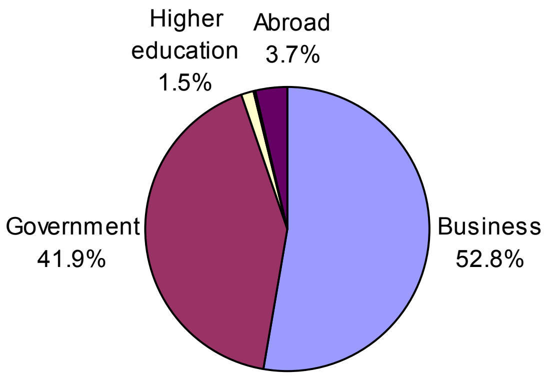


Figure 10: Sources of R&D expenditures[56]

R&D Funding mechanisms

Public support for R&D is provided in two ways, either through targeted financing (grants and programme-based financing through public tenders) or through institutional support.
As presented on Figure 11, the Ministry of Education, Youth and Sports provides more than a third of this funding, the Czech Science Foundation – National Grant Agency and the other ministries less than a third of it each, and finally the Academy of Sciences provides less than 10% of it.

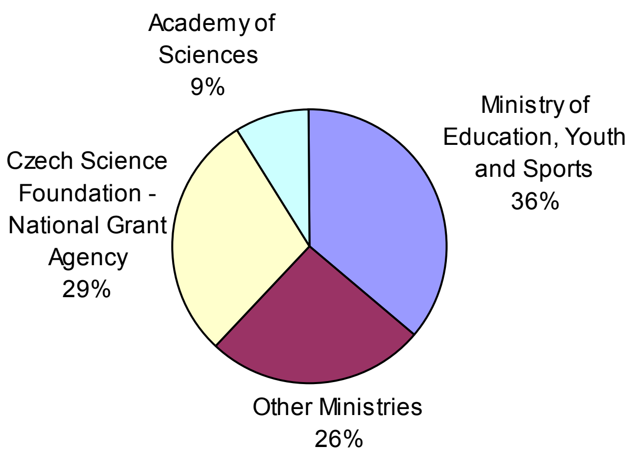


Figure 11: Sources of public R&D funding (2004)[54]

Figure 12 shows that the Ministry of Education, Youth and Sports and the Czech Academy of Sciences provide mainly institutional funding, while the Czech Science Foundation and the other ministries provide mainly grants and programme-based financing.

[54] Source Erawatch

[55] 2005 Gross Domestic Expenditure on R&D, Source Eurostat

[56] 2004 GERD by source of funds, Source Eurostat

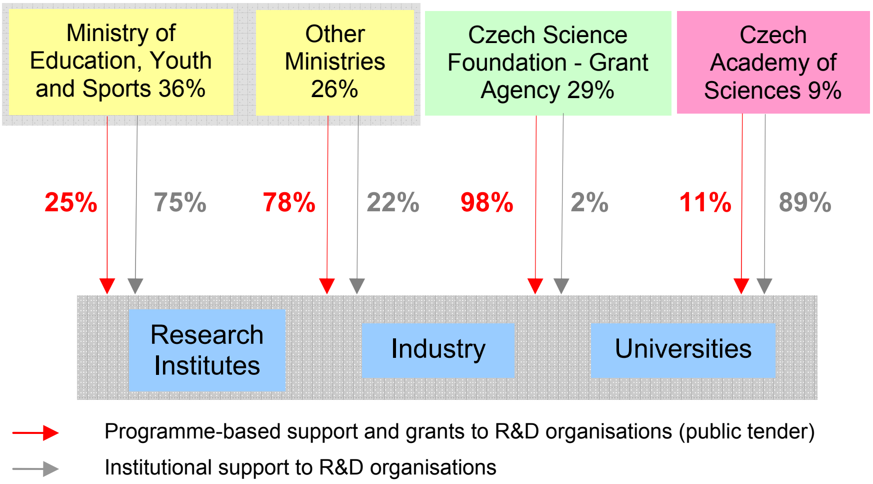


Figure 12: Sources of public R&D funding (2004)[54]

1.2.2. Space activities budget and funding mechanisms

Budget for space activities
The total budget for space activities in 2005 was about 2.4 million euros, including the contribution to EUMETSAT. This budget represents about 0.01% of the national budget and about 0.5% of all public spending on research and technology.
As detailed in Table 7 and represented in Figure 13, most of this budget is provided by the Ministry of Education, Youth and Sports, which funds the ESA PECS projects, and by the Ministry of Transport, which funds Galileo-related activities. In addition, the Ministry of Environment is responsible for the Czech contribution to EUMETSAT. Finally, space research projects, like the other scientific projects, are funded by various grant agencies, the Czech Science Foundation Grant Agency, as well as the grant agencies of the Ministry of Industry and Trade, of the Czech Academy of Science, and by universities.

Sources of funding	M€ 2005
Ministry of Education, Youth and Research - ESA PECS	0.905
Ministry of Environment - EUMETSAT	0.240
Ministry of Industry and Trade, Academy of Science, Universities	0.700
Ministry of Transport - Galileo	0.600
TOTAL	2.445

Table 7: Funding of space activities[57]

[57] Source CSO

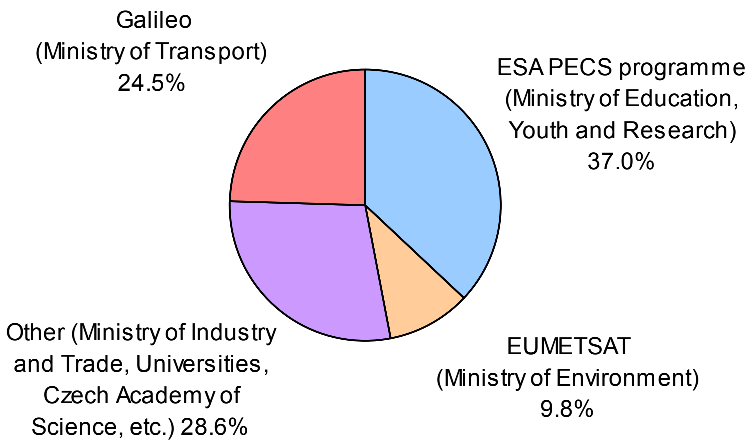


Figure 13: Sources of funding for space activities in 2005[57]

As shown on Figure 14, this budget covers the main fields.

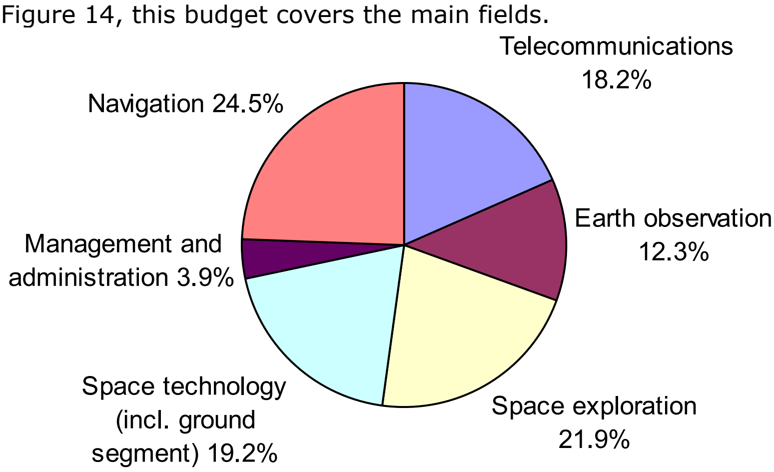


Figure 14: Funding of space activities per field in 2005[57]

Funding mechanisms for space activities

As presented on Figure 15, the Ministry of Education funds the ESA PECS Programme. The proposals for ESA submitted by Czech research institutes, universities and companies are gathered by the CSO and assessed and selected by the CBSA. The final list of proposals is then sent to ESA by the CSO. ESA Programme Boards review these proposals and finalise the list of PECS projects for the Czech Republic.

The Ministry of Environment is responsible for the Czech contribution to EUMETSAT.

The other source of funding specific for space activities are the Galileo projects of the Ministry of Industry and Trade.

For the grants from other sources (Czech Science Foundation, Ministry of Industry and Trade, etc.), space-related proposals are in competition with proposals from other scientific fields.

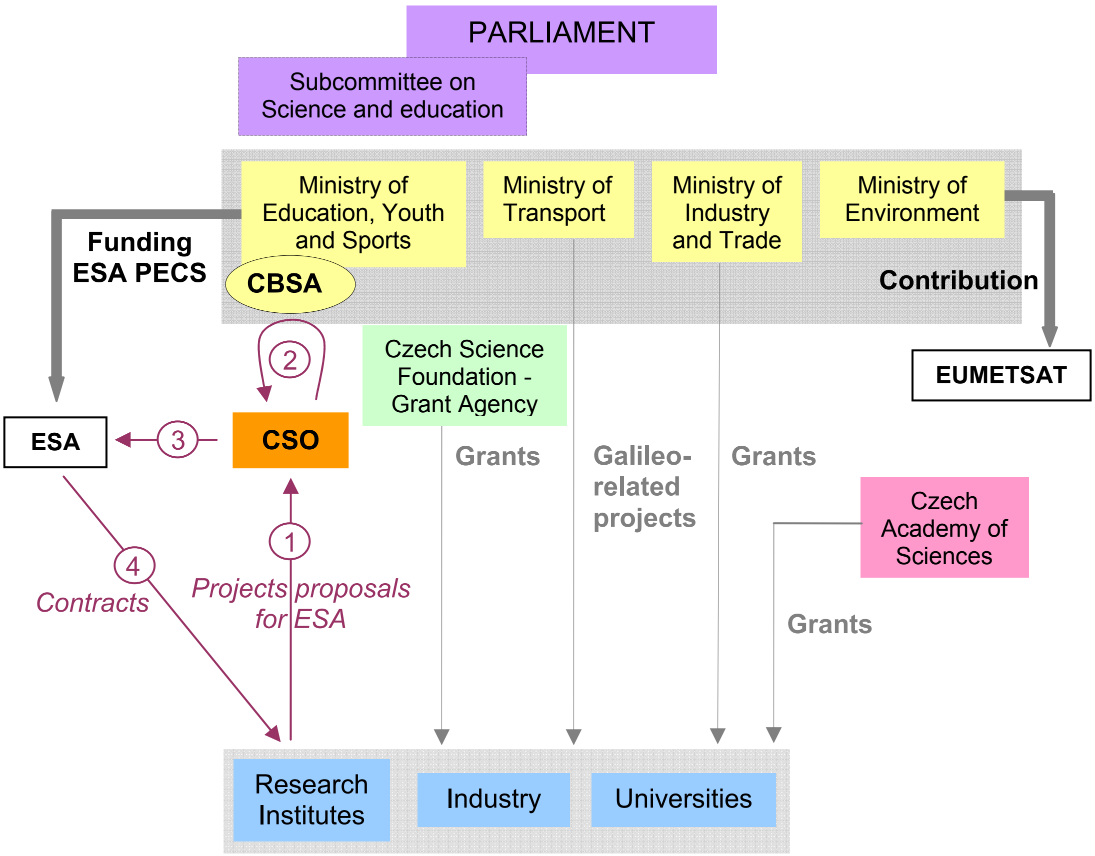


Figure 15: Funding mechanisms for space activities

1.3. Scientific and technical capabilities

1.3.1. Main achievements

The numerous achievements in space of Czechoslovakia and of the Czech Republic from 1993 are the following:

1969 First instrument in space
- Solar photometer onboard Intercosmos 1

1973 First instrument on interplanetary probe
- Micrometeorite detectors onboard Mars 4

1977 First animals in space
- Japanese quails onboard Cosmos 936

1978 First cosmonaut
- Vladimír Remek onboard Soyuz 28

1978 First satellite
- Magion 1

1984 Equipment on VEGA 1 (Halley Comet Probe)
1988 Instruments for Fobos 1 (Mars exploration)

Twenty-three out of the 25 Intercosmos satellites (1969-1991) were equipped with Czechoslovakian instruments. Five Czech Magion satellites were launched in 1978, 1989, 1992, 1995, and 1996. Four space furnaces, “CSK”, were used onboard MIR space station in 1984, 1994, and two in 1995. Three MACEK micro-accelerometers flew onboard Resurs F 15 in1992, Atlantis-STS 79 in 1996, and Mimosa in 2003. Finally, the Czech microsatellite Mimosa was launched in 2003 by Rockot.

1.3.2. Main activities and capabilities

The key sectors of the Czech space activities are the following:

- Astronomy
- Magnetospheric, ionospheric and atmospheric research
- Microgravity research experiments
    - Materials processing – Space furnaces
- Components
    - Optics
    - Electronics
    - Micro-accelerometers
    - Composite parts
- Scientific instruments and micro-satellites construction
    - Magion and MIMOSA satellites
- Hardware test facilities
- Software
    - Ground segment
    - Satellite operations
- Remote sensing applications
    - Data processing
- Navigation applications

1.3.3. Scientific institutes

The main scientific institutes with space-related activities are under the auspices of:

- The Academy of Sciences
    - Astronomical Institute
    - Institute of Atmospheric Physics
    - Institute of Plasma Physics

- Charles University
    - Faculty of Mathematics and Physics

- The Technical University of Prague
- The Technical University of Brno

The Czech Hydrometeorological Institute, the Czech Geological Survey and the Czech Environmental Information Agency (CENIA) can be added to these institutes.

Moreover, the Czech Republic has a ground station in Panska Ves and has four astronomical observatories:

- Hradec Králové Observatory
- Klet Observatory
- Ondřejov Observatory
- Štefánik Observatory

1.3.4. Industry

The Czech space industry consists mainly of a dozen SMEs. The main companies with space-related activities are listed in Table 8.

Company	Space-related activities
BBT Materials Processing	Hardware and software for material science experiments in microgravity
Space Devices	Scientific instruments for space research
Czech Space Research Centre (CSRC)	Electronics
LA Composite	Composite parts
Meopta	Optics and precise mechanics
Reflex	X-ray satellite optics
VZLU	Hardware testing facilities, micro-accelerometers and composite parts
Frencken Brno s.r.o.	Satcom components
ANF Data	Software for ground segment and satellite operation
Iguassu Software Systems	Ground segment software
GISAT	Remote sensing data processing
Lesprojekt	Remote sensing data processing
Arcdata	Remote sensing data processing

Table 8: Main Czech companies with space-related activities

A space industry association, the Czech Space Alliance, was established in 2006 by three companies – BBT Materials Processing, CSRC and Iguassu Software Systems – under the auspices of CzechTrade, the National Trade Promotion Agency of the Ministry of Industry and Trade of the Czech Republic, in order to increase their visibility.
It is noteworthy that the aviation industry is well-developed in the Czech Republic and despite a limited interest in space today, this expertise could be applied to space systems.

1.4. Legal framework

1.4.1. National space legislation

The Czech Republic does not have specific national space-related laws.

1.4.2. International treaties and arrangements

The Czech Republic ratified the main international treaties governing space activities, as detailed in Table 9.

Outer Space Treaty	R
Rescue Agreement	R
Liability Convention	R
Registration Convention	R
Moon Agreement	-
Nuclear Tests Ban	R
ITU	R

R: Ratified -: Not ratified

Table 9: Ratification of the United Nations Treaties by the Czech Republic

Furthermore, the Czech Republic is a partner of the Missile Technology Control Regime (MTCR) since 1998 and is a participating state of the Wassenaar Agreement.

1.4.3. Export control

The main authority of the national export control system is the Licensing Office of the Ministry of Industry and Trade.

2. National Policies

2.1. Rationales for space activities

The main rationales for space activities in the Czech Republic are:

- The development of the economy
- The development of high-tech industry and especially of SMEs
- The maintenance and development of the knowledge and skills already gained in various space-related fields both in research and in industry
- The development of international cooperation and the demonstration of their expertise to their international partners

2.2. National priorities in the space field

There is no Czech space policy as such. The participation in European space programmes is their main objective, which requires the development of European cooperation for Czech institutes and industry in space research and applications, and the strengthening of their relationship with ESA in order to become a Member State.
As a result, the Czech Republic closely follows ESA policy.

2.3. Foreign policy objectives

The main foreign policy objective that influences space activities is their strong willingness to be further integrated into Europe. Space-based technology is perceived as an enabler of the new EU Member States' integration.

2.4. Existing international cooperation

The Czech Republic is a member of the main space-related international organisations, as detailed in Table 10, and joined the European Southern Laboratory in January 2007.

ITSO / Intelsat	X
Intersputnik	X
Intercosmos	X
IMSO / Inmarsat	X
Eutelsat	X
Eumetsat	Cooperating state

Table 10: Membership of the Czech Republic in space-related international organisations

The Czech Republic does not have any space-related bilateral agreements.

3. Relationship with Europe and contribution to European space activities

3.1. European Union

Participation in EU projects

The Framework Programmes represent for the Czech Republic the main sources of R&D funding from the EU. The total contribution of the Czech Republic to FP5 and EURATOM programme budgets was 68 million euros and the aggregate contribution to the Czech teams that participated in 701 projects is 65 million euros. The total contribution to FP6 was about 98 million euros and the contribution requested from the EC is 71 million euros.

Under the FP6, the Czech Republic participates in the project ERA-STAR (Space Technologies Applications and Research for the Regions and medium-sized countries). ERA-STAR is a network of organisations that support programmes related to Galileo, GMES and space technology applications. This four-year project started in November 2004 with the objective to coordinate R&D management and funding activities in the field of space applications in the participating regions and countries with the final goal of launching joint calls for proposals.

Under the FP6, the Czech Republic also participates in the SURE programme, an ESA initiative funded by the EC. This programme gives the opportunity to scientists and SMEs to perform fundamental and applied research projects on board the International Space Station. The programme was opened to participants from all EU Member states and Associated States, with priority given to the 12 new EU Member States.

In addition to FP projects, the Czech Republic participates in the cluster network CASTLE (Clusters in Aerospace and Satellite Navigation Technology Applications linked to Entrepreneurial Innovation). CASTLE is one of the thirty cluster networks supported by the DG Enterprise of the European Commission within its Europe Innova initiative. Three of these thirty networks specialise in space-related fields (FINANCE Space, INVESaT and CASTLE). As presented in Table 11, three Czech partners participate in CASTLE.

Consortium	Participants	Country
Coordinator	GründerRegio M	Germany
Scientific Coordinator	Centre for Technology and Innovation Management	Netherlands
Partners	AnyWi Technologies BV	Netherlands
	Eureka AG	Germany
	GAF AG	Germany
	Czech Space Office	Czech Republic
	Czech Technical University Faculty of Transportation Sciences	Czech Republic
	AUTOTAG Group	Czech Republic

Table 11: CASTLE partners

3.2. European Space Agency

3.2.1. Milestones in the cooperation with ESA

1992	Beginning of the relationships with ESA
7 November 1996 5 November 1998	Signature of the Cooperation Framework Agreement Entry into force of the Cooperation Framework Agreement
13 June 2000	Signature and entry into force of the Agreement concerning the participation in PRODEX
2002	"Assessment of potential space suppliers in the Czech Republic" by Nodal Consultants for ESA
24 November 2003 14 October 2004	Signature of the Plan for European Cooperating State Agreement ECS Agreement approved by the Czech Parliament
24 November 2004	Signature of the Plan for European Cooperating State (PECS) Charter
2006	Statute of observer in the International Relations Committee and Earth Observation Programme Board

3.2.2. Participation in PRODEX

In June 1986, the ESA Council adopted a resolution for the creation of an optional programme called PRODEX (Programme de Développement d'Expériences scientifiques). This programme aimed at providing funding for the industrial development of scientific instruments or experiments proposed by research institutes or universities. The Programme was opened to ESA Member States but also to non-Member States.
After Hungary, the Czech Republic was the second non-Member State (and Eastern European country) and the last participant to join PRODEX. The total contribution of the Czech Republic to PRODEX from 2000 to 2004 was 1.25 million euros. With PRODEX, for the first time a budgetary line dedicated to space appeared in the state budget. The PRODEX activities undertaken by Czech organisations are summarised in Table 12.

Mission	Czech organisation	Experiment
INTEGRAL	Astronomical Institute in Ondrejov	Participation to Optical Monitoring Camera at the Integral Science and Data Centre
PROBA II	Academy of Sciences	1. Thermal Plasma Measurement Unit 2. Dual Segment Langmuir Probe
ISS	BBT	Advanced TITUS Facility - Cryst.
ERS	GISAT	Application of ERS data
Cluster II	Institute of Atmospheric Physics	Data Processing Simulation Facility

Table 12: Czech PRODEX activities

3.2.3. Participation in PECS

The Czech Republic will contribute five million euros over five years (2004-2009) to the PECS programme. Table 13 summarises the Czech PECS projects in realisation phase.

Science		
Cluster II	Data processing and simulation facility, numerical modelling and interpretation of wave and particle data*	Academy of Sciences
Cluster & Double Star	Investigation of waves and turbulence in space plasmas	
INTEGRAL	Czech participation on INTEGRAL*	
SOHO	SOHO observations and data analysis	
Earth Observation		
SPECTRA	Spectral-spatial scaling from leaf to canopy level using spectro-directional approaches in support of the SPECTRA mission	Institute of Landscape Ecology, Academy of Sciences
ENVISAT	New model for knowledge management in forestry based on integration of principles of ambient mobile intelligence, new methods of navigation and integration of space imaging	
EARTH EXPLORERS	Assessment of the porting of different EO processors to GRID technology	Iguassu Software Systems
Navigation		
GNSS	Development of SISNeT-related software and applications	Iguassu Software Systems
Technology		
Ground support ESOC	Advanced monitoring for modern generic Mission Control System	ANF Data

* *Continuation of PRODEX activities*

Table 13: PECS projects in the realisation phase

As shown in Figure 16, half of the total funding for these projects in realisation phase is for science projects and one third for Earth observation projects.

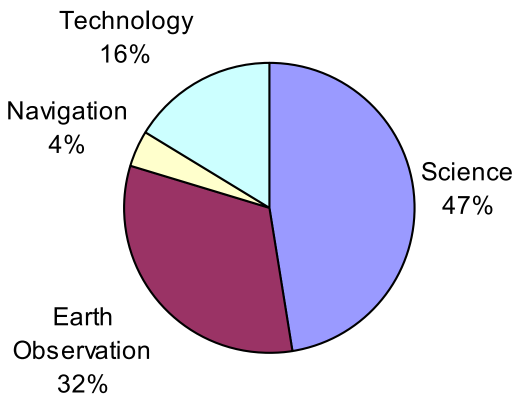


Figure 16: Distribution of the PECS funding for the projects in the realisation phase

There are other projects that are currently under evaluation at ESA related to:[58]

- Bepi Colombo
- GSE Land
- XMM Satellite
- X-RAY OPTICS
- DOBIES
- SISNET - phase 2
- Motion Hazard Information Service
- SWARM

[58] Source CSO

3.3. Participation in the joint EU/ESA programmes

3.3.1. Galileo

In the Czech Republic, the Ministry of Transport is responsible for Galileo-related activities. For the 2001-2006 period the ministry funded the "Involvement of the Czech Republic in the Galileo Programme" project with a total budget of 2.3 million euros.

In addition, Czech organisations participated in several European projects related to Galileo and co-financed by the Galileo Joint Undertaking within the FP6 Galileo activities. Two Czech companies, VARS and ICE, were members of the consortium led by Alcatel Space for the project SCORE (Service of Coordinated Operational Emergency & Rescue using EGNOS) which took place from 2004 to 2006. The Technical University in Prague was a member of the consortium led by Alenia Spazio-Laben for the project GARDA (Galileo Receiver Development Activity). The Czech company Ekotoxa Opava was a member of the consortium led by Alterra for the project FieldFact (Introduction and Promotion of GNSS in Agriculture).
Prague is also one of the 11 candidate cities for the Galileo Supervisory Authority (GSA) seat.

3.3.2. GMES

Czech organisations participate in space-related GMES projects. For instance, the Czech Hydrometeorological Institute participates in GEMS (Global and Regional Earth-System Monitoring using Satellite and In-Situ Data) under the FP6. In addition, the Czech Space Office is a partner of the GMES Information Centre established by the GMES-Poland project.

HUNGARY

1. The space activities in Hungary

1.1. Institutional Organisation of the space activities

- *Ministers responsible for space activities*

The Minister of Informatics and Communications supervised Hungary's space activities from 2002 until 2006. Since August 2006, the Minister of Environment and Water, Miklós Pérsányi, supervises these activities.
The Minister is supported by an advisory body, the Hungarian Space Board (HSB), which is headed by the secretary of state of the Ministry of Environment and Water, Kálmán Kovács. The HSB consists of representatives from the ministries with an interest in space activities and various experts from different space research fields.

- *The Hungarian Space Office*

The Hungarian Space Office (HSO) was established in January 1992 as an independent governmental office under the responsibility of the Minister of Informatics and Communications. It was then integrated at the end of 2005 into the Ministry of Informatics and Communications and finally it was moved in August 2006 to the Ministry of Environment and Water.

The HSO manages, co-ordinates and represents the Hungarian space activities. The advisory body of the HSO is the Scientific Council on Space Research (SCSR). The SCSR consists of experts from all the fields of space research. It provides the scientific background of all Hungarian space activities.

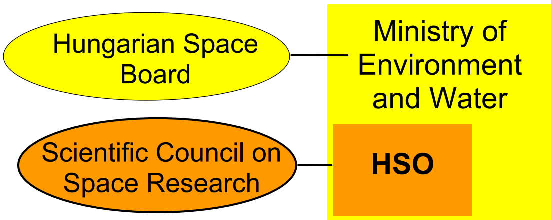


Figure 17: Main institutions responsible for space activities in Hungary

1.2. Financial framework

1.2.1. R&D in Hungary

<u>R&D Expenditures</u>

The total R&D expenditure (GERD) in Hungary in 2005 was about 840 million euros,[59] which represents 0.94% of the GDP. This percentage is still very low compared to the 3% Lisbon targets in 2010.
The central budget represents more than half of this funding, as shown in Figure 18. As a result, the level of business expenditure on R&D is also much lower from the European objectives.
In addition, Hungary faces two other important challenges:[60] first, an insufficient cooperation between academia and industry that hinders the exploitation of R&D results and second, a human resources shortage,

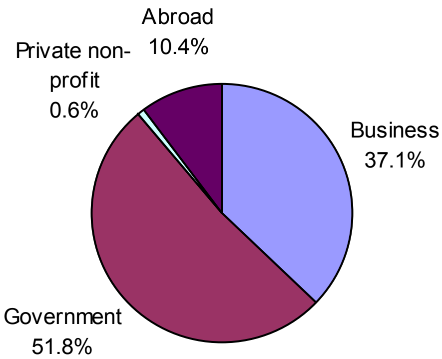


Figure 18: Sources of R&D expenditures

[59] 2005 GERD, Source Eurostat

[60] Annual Innovation Policy Trends and Appraisal Report, Hungary, 2004-2005, Innovation/SMEs Programme, DG Entreprise, European Commission

as the number of science and engineering graduates is still very low and brain drain remains a serious threat.

R&D Funding mechanisms

As shown in Figure 19, there are many actors in the R&D system in Hungary.
In the field of R&D and innovation policy, the Education and Science Committee of the Parliament is the highest-level political consultative body and the Science and Technology Policy Council (TTPK) is the highest-level coordination body.
The Ministry of Education and Culture and its advisory body, the Higher Education and Research Council (FTT), play a central role in the definition and implementation of science policies. The Ministry of Economy and Transport implements a number of innovation policy measures and supervises several innovation-related government offices, and the Minister of Economy and Transport supervises the activities of the National Office of Research and Technology (NKTH).

NKTH is responsible for the national technology policy, the definition of R&D and innovation programmes, and international R&D cooperation. NKTH submits its strategic proposals to the Research and Technological Innovation Council (KTIT) and implements KTIT's decisions on the use of the main R&D and innovation fund, the Research and Technological Innovation Fund. The Agency for Research Fund Management and Research Exploitation manages this Fund, which amounted to 120 million euros in 2005. About half of the Fund comes from the contribution to innovation paid by companies.

Last but not least, the Hungarian Academy of Sciences supervises the Hungarian Scientific Research Fund (OTKA), which amounted to 25 million euros. This Fund aims at supporting basic research projects and the R&D infrastructure development.

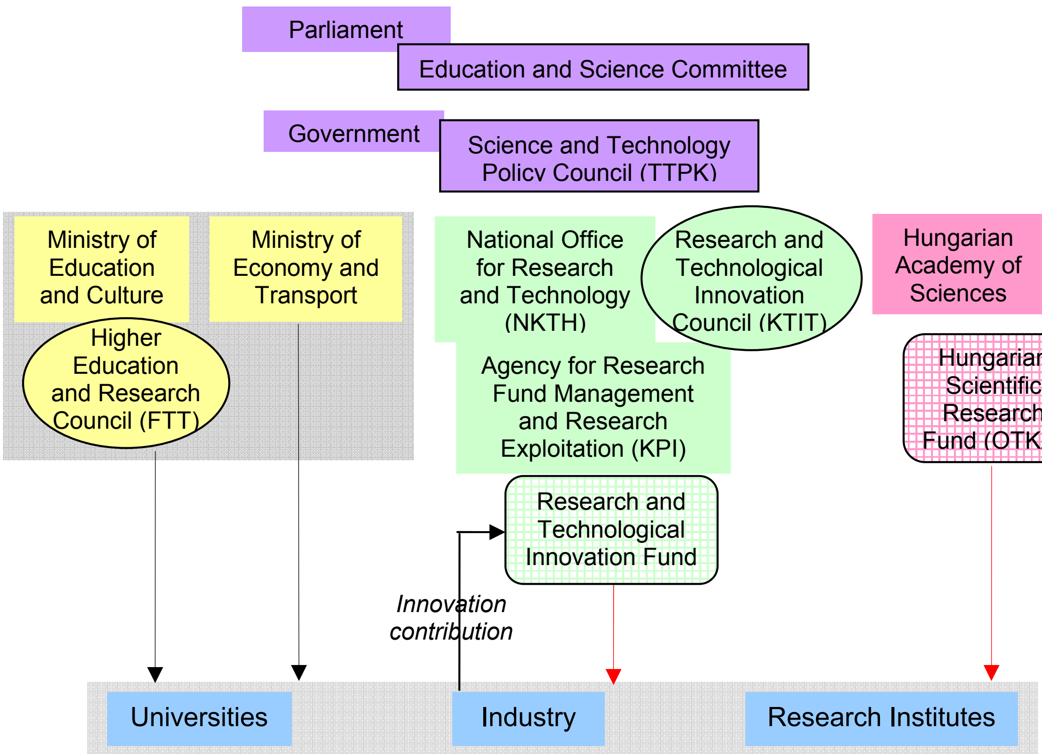


Figure 19: R&D funding mechanisms

1.2.2. Space activities budget and funding mechanisms

Budget for space activities

The budget of the Hungarian Space Office is about two million euros, which represents less than 0.5% of the total public funding for R&D. As presented in Figure 20, half of this budget funds the ESA PECS programme and more than one third is allocated to national projects. As shown in Figure 21, most of this budget finances onboard instruments and space applications. To the HSO budget, a contribution of about 0.2 million euros to EUMETSAT should be added.

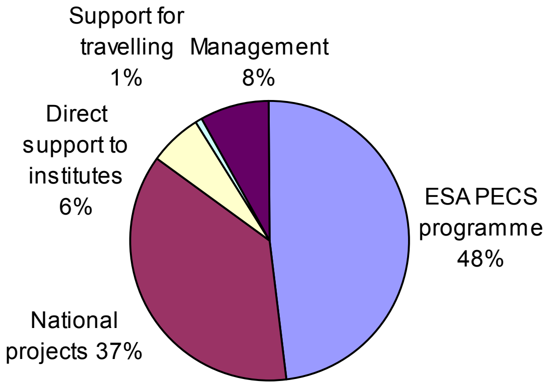


Figure 20: 2005 HSO funding[61]

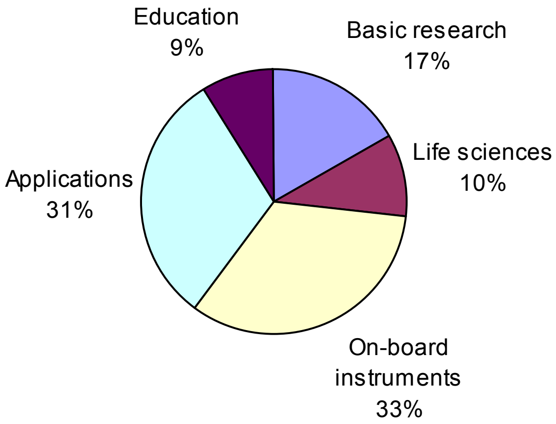


Figure 21: Distribution of the 2005 HSO budget per field[61]

Funding mechanisms for space activities

The State Treasury is responsible for the EUMETSAT contribution and the funding of the ESA PECS Programme. As detailed in Figure 22, the HSO funds the national programmes and provides funding to some research institutes. In addition to these two sources of funding, the Ministry of Economy finances Galileo activities and the Ministry of Agriculture and the Academy of Sciences supports space-related projects in research institutes.

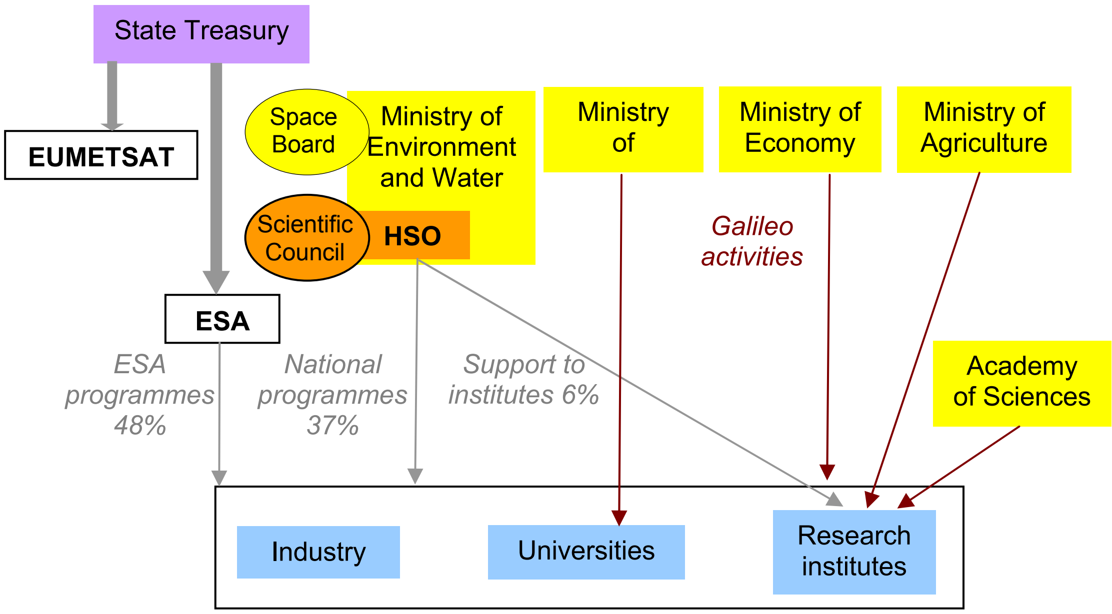


Figure 22: Funding mechanisms for space activities

1.3. Scientific and technical capabilities

1.3.1. Main achievements

Hungarian space activities started in 1946 with the Moon radar experiments carried out by Zoltan Bay. Hungary then actively participated in the Intercosmos Programme. The first Hungarian on-board instrument was launched in 1971. In the seventies, several Hungarian micrometeorite traps

[61] Source HSO

and analysers were installed onboard Intercosmos and Prognoz spacecraft. The first Hungarian cosmonaut, Bertalan Farkas, flew on May 26 1980. Different versions of the Pille dosimeter were taken onboard Salyut-6, MIR and the ISS between 1980 and 2003. In 1986, Hungary participated in the VEGA mission. Moreover, Hungarian organisations were involved in two instruments that flew onboard Cassini (plasma analyser and magnetometer).

The Hungarian equipment onboard spacecraft until 1996 is listed in Table 14.

Started	Space vehicle	Hungarian equipment	Name
1970	Vertical-1	Plastic foil micrometeorite trap	Tanja
1971	Vertical-2	Plastic foil micrometeorite trap	Tanja
1972	Intercosmos-6	Plastic foil micrometeorite trap	Tanja
1974	Intercosmos-12	Electronic unit for micrometeorite detector	K-1-3
1975	Intercosmos-14	Electronic unit for micrometeorite detector	K-1-3
1976	Intercosmos-15	Power Supply Unit for the Standard Telemetry System	ETMS-PS
1977	Intercosmos-17	▪ Electronic unit for micrometeorite detector ▪ Power Supply Units for the Standard Telemetry System	K-1-4 ETMS-PS, BP-BPCH
1977	Vertical-6	Retarding potential analyser	LAM-1
1978	Intercosmos-18	General onboard power supply unit	BP-21
1978	Prognoz-7	LAM-3 particle analyser	D-173 B
1978	Vertical-7	Retarding potential analyser	LAM-1 and -2
1979	Intercosmos-19	Power supply unit for onboard data collection system	SSPI / BE-7
1979	Progress-5 / Salyut-6	Thermoluminescent dosimeter (TLD) capsules	Integral
1979	Progress-6 / Salyut-6	TLD capsules	Integral
1979	Soyuz-34 / Salyut-6	TLD capsules	Integral
1979	Intercosmos-20	Power Supply Unit for onboard data collection system	SSPI / BE-7
1980	Oscar-9	Power subsystem	BCR
1980	Soyuz-36 / Salyut-6	▪ TLD capsules ▪ TLD reader and dosimeters ▪ Equipment for the determination of the mental working capacity ▪ Al+ 4% Cu alloy sample in glass capsule ▪ Ga-As, In-Sb and Ga-Sb capsules ▪ Molecular biology equipment	▪ Integral ▪ Pille 79 ▪ Balaton ▪ Ötvös Eötvös ▪ Bealuca ▪ Interferon-I,-II
1980	Soyuz-38	TLD capsules	Integral
1981	Intercosmos-21	Power supply unit for onboard data collection system	SSPI / BE-7
1981	Soyuz-40 / Salyut-6	Molecular biology equipment	Interferon-I, -II
1983	Cosmos-1443 / Salyut-7	TLD reader and dosimeters	Pille K
1983	Cosmos-1443	Ultra-thin TLDs	
1983	Oscar-10	Onboard power subsystem	BCR
1983	Cosmos-1514	Ultra-thin TLDs	
1984	STS 41-G	TLD reader and dosimeters	Pille S
1984	VEGA-1 and -2	Data collection system TV electronics, Particle analysers	BLISI, TV-guidance Plasmag & Tünde
1986	Cosmos-1760	Ultra-thin TLDs	
1988	Oscar-13	Onboard power subsystem	BCR
1988	Phobos-1 and -2	▪ Computer of the lander ▪ Radiation analysers ▪ Particle analyser ▪ Particle spectrometer	BUSI LET and SLED HARP TAUS

1989	Intercosmos-24 Active	▪ SAS data collector and 460MHz transmitter ▪ Onboard data collection system	SAS ODCS
1989-1991-1995	Magion-2, -3, and -4	Onboard data collection systems	STS-A,-AP,-C2-X
1989	Kvant-2 / Mir	Onboard computer	Microsvit
1991	Intercosmos-25 Apex	Onboard data collection system	ODCS
1995	Interbol-1 Tail	Onboard data collection system	ODCS
1995	Magion-4	Electromagnetic field detector	ULF
1995	Progress-M-28/ Mir	Pille 95 TLD reader and dosimeters	18D-TLD
1995	Progress-M-29 / Mir	Pille 95 TLD reader (back-up)	18D-TLD

Table 14: Hungarian equipment onboard spacecraft (1970-1995)[62]

1.3.2. Main activities and capabilities

The key sectors of the Hungarian space activities are the following:

- Earth observation
    - Remote sensing and its application, land cover mapping, space geodesy, geophysics, meteorology
- Space physics
    - Astronomy, planetology, physics of interplanetary field, cosmic materials
- Life sciences
    - Biophysics, microbiology, psychology, vestibular research, aerospace medicine
- Space technology
    - On-board instruments, dosimetry, EGSE, on-board computers, materials sciences, telecommunications

1.3.3. Scientific institutes

Hungary has many scientific institutes with space-related activities as listed below.

Earth observation
- Institute of Geodesy, Cartography and Remote Sensing (FÖMI)
    - Remote Sensing Centre
        - Department of Remote Sensing Applications to Agriculture
        - Department of Remote Sensing Applications to Environmental Management
    - Satellite Geodetic Observatory
- Hungarian Meteorological Service, Satellite Research Laboratory
- Hungarian Academy of Sciences, Geodetic and Geophysical Research Institute
- University of West Hungary, Faculty of Forestry, College of Geoinformatics
- Eötvös Loránd Geophysical Institute, Division of Earth Physics
- Eötvös Loránd University
    - Institute of Geography and Earth Science
        - Centre of Geology and Environmental Physics
            - Department of Meteorology
            - Space Research Group
- Department of Geodesy, Technical University of Budapest

Space physics
- Hungarian Academy of Sciences, KFKI Research Institute for Particle and Nuclear Physics (RMKI)
    - Department of Space Technology
    - Department of Space Physics

[62] "Space Activities in Hungary - 50 years", Hungarian Space Office, 1996

- Eötvös Loránd University
    - Institute of Physics
    - Institute of Geography and Earth Science
        - Centre of Geology and Environmental Physics
            - Department of Geophysics
            - Department of Astronomy
- Konkoly Observatory of the Hungarian Academy of Sciences
- Debrecen Heliophysical Observatory

Life sciences
- Aeromedical Hospital of the Hungarian Home Defense Forces
- Albert Szent-Györgyi Medical University, Department of Biochemistry
- Semmelweis Univ. Med. School, Dep. of Anatomy, Laboratory of Sensorimotor Adaptation,
- Hungarian Academy of Sciences
    - Institute for Psychology, Department of Psychophysiology
    - Research Laboratory for Biophysics
- University Medical School of Debrecen, Institute of Pathophysiology
- "Johan Béla" National Institute of Hungary, Microbiological Research Group

Space technology
- Hungarian Academy of Sciences, KFKI Atomic Energy Research Institute (AEKI)
    - Health and Environmental Physics Department
- University of Miskolc, Institute of Material Sciences
- Technical University of Budapest, Department of Broadband Infocommunications and Electromagnetic Theory, Space Research Group

Navigation applications
- Hungarian Academy of Sciences, Department of Telecommunication and Geoinformation, Computer and Automation Research Institute

1.3.4. Industry

Hungarian space industry consists of SMEs mainly in the field of electronics.

Bonn Hungary Electronics	Electronics
SGF Ltd	Electronics
BL-Electronics Space Research	Electronics
Siemens PSE	IT (Management information system for ESA)
Datakart	GPS applications Reseller of the Ikonos space images
GeoAdat	Geographic information products Reseller of the QuickBird, Ikonos, Spot, Formosat, Landsat and Kompsat space images
Bay Zoltan Institute For Materials Science And Technology	Material sciences
Admatis	Thermal systems - microgravity research equipments

Table 15: Hungarian companies with space-related activities

A Hungarian Aerospace Cluster was founded by four small aircraft developers and an Aerospace Research Platform was created in September 2006.
A Hungarian Association for Geo-information (Hunagi) was founded in November 1994 in order to promote, stimulate, encourage and support the development and use of Geographic Information (GI) and its associated technologies and to strengthen the institutional links between the multidisciplinary GI communities in Hungary and abroad.

1.4. Legal framework

1.4.1. National space legislation

Hungary does not have specific national space-related laws.

1.4.2. International treaties and arrangements

Hungary ratified the main international treaties governing space activities, as detailed in Table 16.

Outer Space Treaty	R
Rescue Agreement	R
Liability Convention	R
Registration Convention	R
Moon Agreement	-
Nuclear Tests Ban	R
ITU	R

R: Ratified -: Not ratified

Table 16: Ratification of the United Nations treaties by Hungary

Furthermore, Hungary has been a partner of the Missile Technology Control Regime (MTCR) since 1993 and is a participating state of the Wassenaar Agreement.

1.4.3. Export control

The main authority of the national export control system is the Hungarian Trade Licensing Office.

2. National Policies

2.1. Rationales for space activities

The main rationales for space activities in Hungary are:

- The development of the economy
- The maintenance and development of the knowledge and skills already gained in various space-related fields both in research and in industry
- The demonstration of their expertise to their international partners

2.2. National priorities in the space field

In September 2006, Hungary defined a "Medium-Term Future Vision of the Hungarian Space Activity 2006-2010".
In the field of international relations, the main objective mentioned is Hungary's full ESA membership. Hungary wishes to be the first country of the EU10 to become an ESA member. The development of relations with their neighbouring countries and the main space nations is also emphasised.
The participation in European programmes is one of the main priorities, however, it remains important for Hungary to have national space projects. The two areas of focus for the national activities are: the development of space-based applications that could contribute to the development of the economy; and the programmes that provide an opportunity to send Hungarian equipment in space. The development of a fully or partly Hungarian satellite is also a medium-term objective. The national projects are selected by the Scientific Council on Space Research with today a priority given to:

- Earth Observation applications, i.e., projects applying EO to environmental issues, water management and quality, geodesy, etc.
- Scientific research projects related to advanced technologies, used in international programs and/or with terrestrial applications

Promotion of space activities to a larger public is also listed as a priority.

2.3. Foreign policy objectives

The main foreign policy objective that influences space activities is the willingness of Hungary to be further integrated into Europe.

2.4. Existing international cooperation

Hungary signed cooperation agreements at government level with Russia in October 1999 and with the United States in May 2001. The Hungarian Space Office signed cooperation agreements with the Ukrainian Space Agency in May 1994, the Russian Space Agency in January 1995, with Indian Space Research Organisation in October 1995, with the Polish Academy of Sciences in May 1997, and the Romanian Space Agency in 1998. Hungary is a member of the main space-related international organisations, as shown in Table 17.

ITSO / Intelsat	X
Intersputnik	X
Intercosmos	X
IMSO / Inmarsat	X
Eutelsat	X
Eumetsat	Cooperating state since 1999
ESO	X

Table 17: Membership of Hungary in space-related international organisations

3. Relationship with Europe and contribution to the European space activities

3.1. European Union

Participation in EU projects

Under the FP6, Hungary participates in the SURE programme, an ESA initiative funded by the EC. This programme gives the opportunity to scientists and SMEs to perform fundamental and applied research projects on board the International Space Station. The programme was opened to participants from all EU Member states and Associated States, with priority given to the 12 new EU Member States.

3.2. European Space Agency

3.2.1. Milestones in the cooperation with ESA

10 April 1991	Signature of the Cooperation Framework Agreement
23 January 1998	Signature and entry into force of the Agreement concerning the participation in PRODEX
7 April 2003	Signature of the ECS Agreement
5 November 2003	Signature of the PECS Charter
2004	“Industry assessment of Greece, Luxembourg, Hungary, Poland and Romania” by Bertin Technologies for ESA
2006	Statute of observer in the International Relations Committee

3.2.2. Participation in PRODEX

In June 1986, the ESA Council adopted a resolution for the creation of an optional programme called PRODEX (Programme de Développement d'Expériences scientifiques). This programme aimed at providing funding for the industrial development of scientific instruments or experiments proposed by scientific institutes or universities. The Programme was opened to ESA Member States but also to non-Member States.

Hungary was the first non-Member State (and Eastern European country) to join PRODEX. The total contribution of Hungary to PRODEX from 1997 to 2002 was 3.45 million euros. The PRODEX Hungarian activities are summarised in Table 18.

Mission	Hungarian organisation	Experiment
Life sciences		
ISS	RGB	ISS-EXPOSE
Material sciences		
ISS	SZFKI	Modelling of nucleation and phase selection
	Miskolc University	Microstructure formation in casting of technical alloys (MICAST)
Science		
ISO	Konkoly Observatory	ISOPHOT data processing
Cluster II	RMKI	Cluster data exploitation
Rosetta		Communication and data management subsystem
		Rosetta plasma consortium
	Technical University of Budapest	Lander power supply unit
	AEKI	Simple plasma monitor
		Dust impact monitor
Mars Express	GGKI	Netlander participation
	RMKI	Netlander participation
Earth observation		
ENVISAT	FOMI	Flood-waterlog & draught-crop monitoring

Table 18: Hungarian PRODEX activities

3.2.3. Participation in PECS

Hungary left the PRODEX programme in November 2003 to join PECS. It has contributed 5.5 million euros to the PECS programme from 2003 to 2007 and should get back 5.16 million euros (93%). Table 19 summarises the Hungarian PECS projects.

Material Sciences		
ISS	Modelling of solidification of composites*	Research Institute for Solid State Physics and Optics
ISS	Modelling of nucleation and phase selection phenomena in undercooled melts*	Research Institute for Solid State Physics and Optics
ISS	Development of advanced foams under microgravity	ADMATIS
ISS	MICAST*	Academy of Sciences
Life Sciences		
ISS	Advanced Dosimeter telescope for the European Technology Exposure Facility in Columbus	AEKI
MAP	Participation in the ESA topical teams SSIOUX	MTA SOTE Research Group for Biophysics
ISS	Neutron detection outside of the ISS on MATROSHKA phantom and on BIOPAN	AEKI
ISS EXPOSE	Study of separate and combined space parameters on potentially flying nucleic acid samples	MTA SOTE Research Group for Biophysics
Earth Observation		
ENVISAT	Flood-waterlog monitoring*	FOMI
Technology		
PROBA II	PALAGMI	Optopal
	Advanced monitoring for a modern generic mission control system	Siemens PSE
Space Physics		
Rosetta	ROSETTA plasma consortium experiment on board the orbiter (RPC) - commissioning, mission, planning	RMKI
	Command and data management subsystem (CDMS) for the lander -support of the flight exploitation*	
	CDMS for the lander - support of the commissioning phase*	
	Simple plasma monitor (SPM) for the lander*	AEKI
	Dust impact monitor (DIM) for the lander*	
	Lander Power Supply*	Budapest University of Technology
Cluster II	Cluster data exploitation*	RMKI
Herschel /Planck	Herschel/PACS calibration	Konkoly Observatory
Mars Express	Investigation of Martian dark dune spots	Collegium Budapest
Venus Express	ASPERA-4 instrument*	RMKI
SOHO	SOHO/VIRGO	Heliophysical Observatory

** Continuation of PRODEX activities*

Table 19: PECS projects

As presented in Figure 23, the funding of the Hungarian PECS projects covered mainly space science projects, and to a lower extent life and material sciences projects.

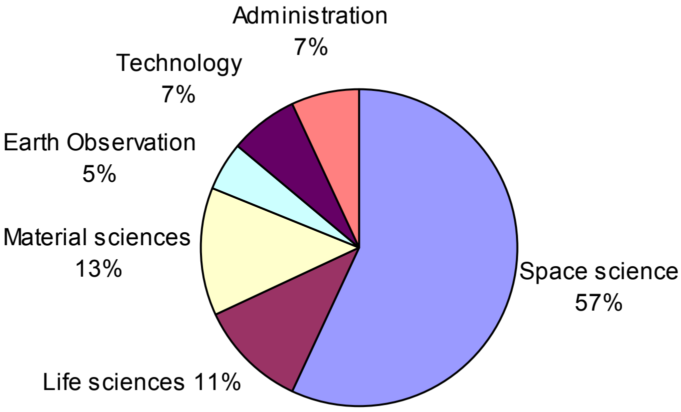


Figure 23: Breakdown of the PECS activities per field

3.2.4. ESA educational programmes

Hungarian students successfully participate in the main ESA educational programmes: students' presentations and posters at the IAC, student parabolic flight campaigns, the SSETI ESEO student satellite programme and the Young Graduate Traineeship programme.

3.3. Participation in the joint EU/ESA programmes

Hungarian organisations have participated in EU-funded GMES activities. In particular, the Environmental Protection and Water Management Research Institute is a partner of the FP6 PREVIEW (PREVention, Information and Early Warning pre-operational services to support the management of risks) project, and FOMI is a partner of the GSE (GMES Service Element) Land consortium.

POLAND

1. The space activities in Poland

1.1. Organisation of the space activities

- *Ministries responsible for space activities*

In Poland, space activities are supervised by different ministries. Firstly, the Ministry of Science and Higher Education supervises research and R&D activities. Then the Ministry of Environment supervises the GMES activities and the Ministry of Transport supervises the Galileo activities. The Ministry of Economy is responsible for the funding of the ESA PECS programme. Lastly, the Ministry of National Defence is in charge of the security aspects.
An Inter-ministerial Consultative Board for Space Affairs was established in 2000 as an advisory group for the government. It consists of representatives of the ministries and government agencies with an interest in space activities, of the Space Research Centre and of the Polish Academy of Sciences.

- *The Space Research Centre and the Polish Space Office*

The Space Research Centre (SRC) in Warsaw is the focal point of the space activities in Poland. In addition to its role as a research centre, the SRC has a role of coordination of the Polish space activities. It was established in 1977 in connection with the first Polish cosmonaut flight (1978).

The Polish Space Office (PSO), established by the Polish Academy of Sciences in 2001, is hosted by the Space Research Centre and consists today of three people. It supports the space sector in Poland by advising policy-makers on space-related issues at national and European levels, serving as a source of information on space technologies, developing public awareness with public relations activities, and supporting projects on space-based services. They are the ESA working contact and the contact point in Poland for Galileo and GMES. The PSO also looks at space-related security and crisis management issues.

- *The Academy of Sciences*

The Committee on Space and Satellite Research of the Academy of Sciences (PAN) is responsible for defining the national space research policy and coordinating the activities of the Polish research centres involved in international space projects. It was established in 1966 and consists of scientists from the various fields of space research.

The committee is structured in five commissions: Astronautics and Space Technology, Remote Sensing, Satellite Geodesy, Space Biology and Medicine and Space Physics.

1.2. Financial framework

1.2.1. R&D in Poland

The main document that shapes Poland's R&D is the "National Reform Programme for 2005-2008" defined by the Ministry of Science and Higher Education and adopted by the Council of Ministers in December 2005.

<u>R&D expenditures</u>

The total R&D expenditure (GERD) in Poland was about 1400 million euros in 2005. As shown in Figure 24, the government represents the major source of funding for R&D with two-thirds of the total expenditure. In 2005, the budget for science was estimated at 900 million euros.
The most important targets defined in the National Reform Programme are:

- Increasing the allocation for science from 686.5 million euros in 2004 to 1165.4 million euros by 2008
- Increasing the GERD from 0.58% of the GDP in 2004 to

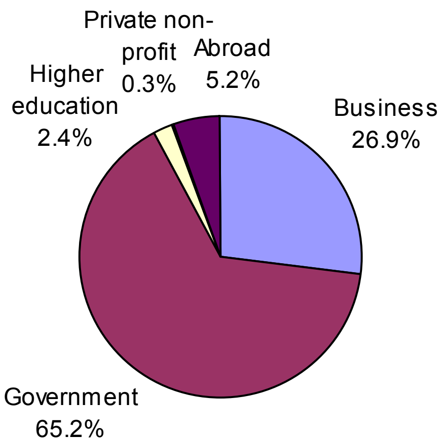


Figure 24: Sources of R&D expenditure

1.65% of the GDP by 2008
- Increasing the BERD from 0.17% of the GDP in 2004 to 0.55% of the GDP by 2008
- Reducing the number of the Research and Development Units (JBR) from 187 in 2004 to 130 in 2008

One final important challenge for Poland is the need to improve the cooperation between the R&D institutes and industry.

R&D funding mechanisms

As presented in Figure 25, the main source of R&D funding in Poland is the Ministry of Science and Higher Education, which provides both statutory, and grants and project-based, funding.

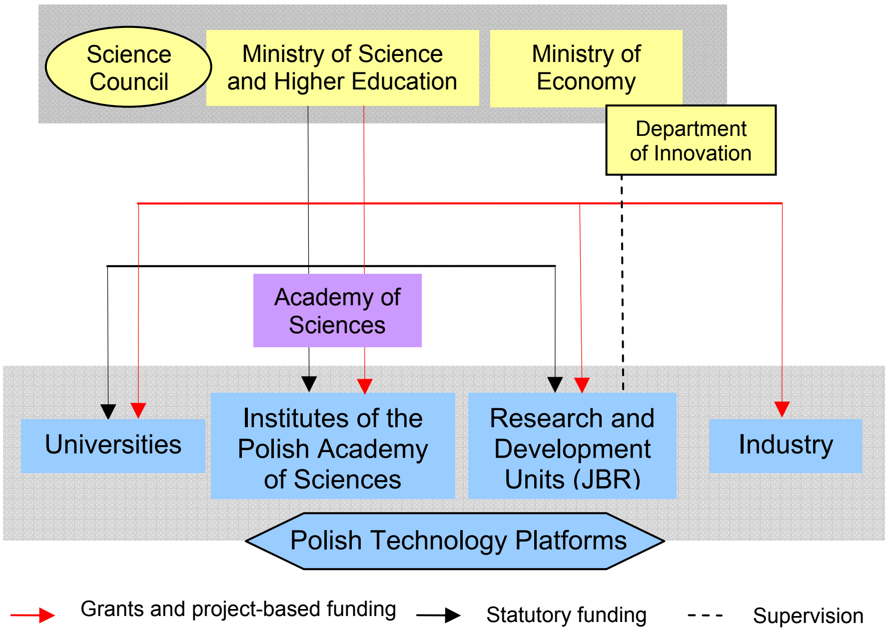


Figure 25: R&D funding mechanisms

1.2.2. Space activities budget and funding mechanisms

Budget for space activities

The planned resources for space activities in 2007 in Poland are detailed in Table 20.

Field	M€ 2006
Space science	2
Earth observation	1.2
Technology	0.4
Telecommunications	0.4
EUMETSAT contribution	0.6
TOTAL	4.6

Table 20: Estimated resources for Poland's space activities in 2006[63]

[63] Source Space Research Centre

As shown in Figure 26, space science accounts for almost half of this budget and Earth observation more than a quarter.

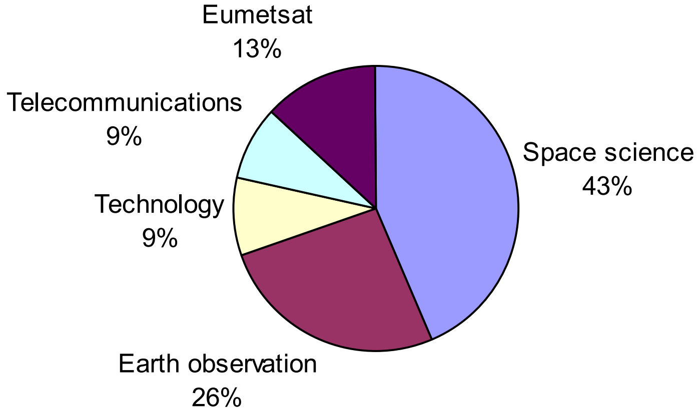


Figure 26: Budget for Poland's space activities

With the signature of the PECS Agreement, the budget will include an additional line of 1.1 million euros a year.

Funding mechanisms for space activities

As described in Figure 27, the Ministry of Science and Higher Education allocates statutory funding as well as grants and project-based funding for space activities. The Ministry of Transport funds Galileo projects and the Ministry of Environment funds GMES projects and is responsible for the Polish contribution to EUMETSAT. The Ministry of Economy is responsible for the ESA PECS Programme funding.

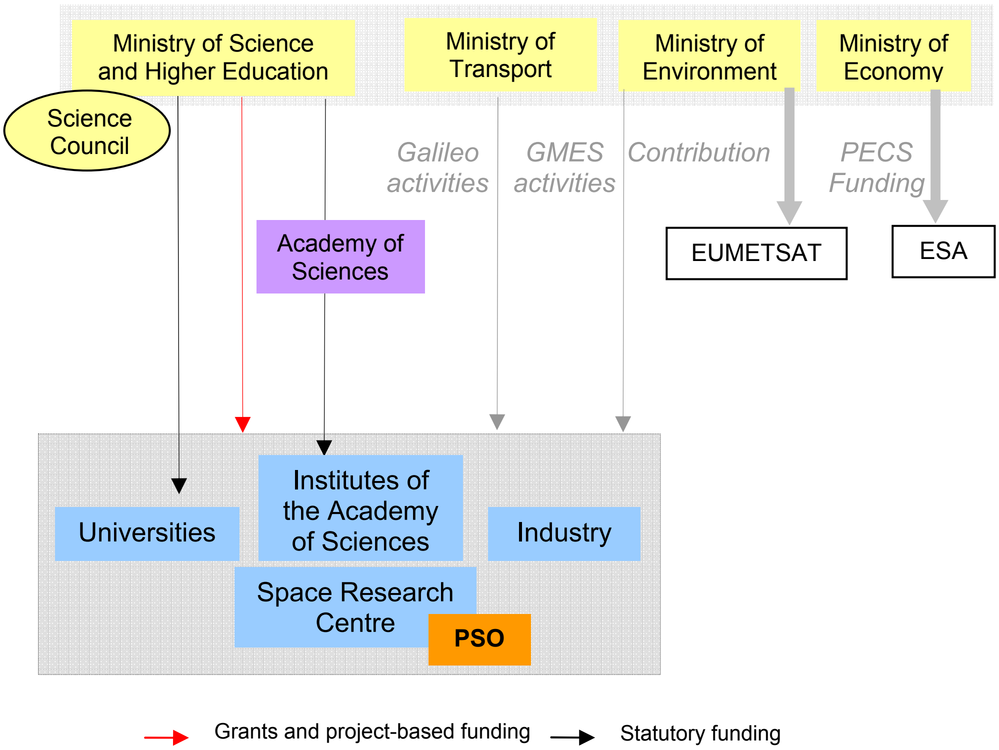


Figure 27: Space activities funding mechanisms

Thus, as shown in Figure 28, the Space Research Centre budget comes mainly from the Ministry of Science and Higher Education.

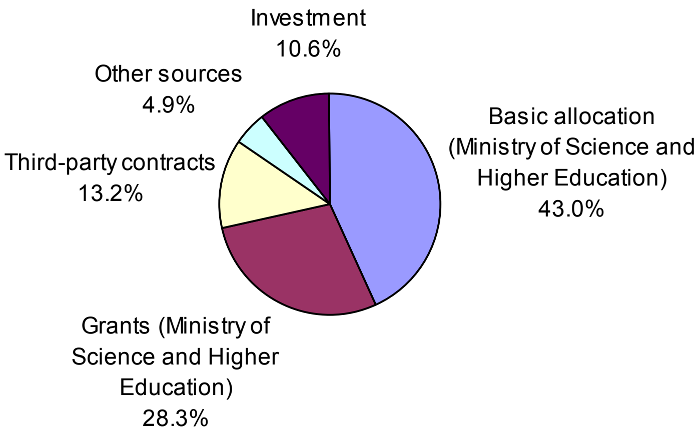


Figure 28: Sources of funding of the Space Research Centre (2005)

1.3. Scientific and technical capabilities

1.3.1. Main achievements

The milestones of the Polish space activities are listed below.

1963 First launch of Polish meteorological rocket METEOR
1967 Satellite Meteorological Data Receiving Station – PIHM, Kraków
1972 Ground station for satellite telecommunication – PSARY
1970 First Polish instrument (for X-ray examinations of the Sun) launched by the Soviet Vertikal 1 geophysics rocket
1973 Launch of the first Polish payload (instrument investigating the ionosphere) on Intercosmos 9 satellite
In the Intercosmos programme, Poland specialized in ionospheric physics
1976 Remote Sensing Centre – OPOLIS
1978 First Polish cosmonaut, Mirosław Hermaszewski, flight
1986 Participation in VEGA mission
1988 Participation in Phobos
1998 Payload specialist James Pawelczyk flight (Columbia space shuttle)
2004 IKONOS Satellite Ground Station
2004 RIMS- EGNOS Station

The main Polish instruments that flew onboard Russian spacecraft are listed in Table 21.

Launch	Launch vehicle	Polish instrument
1970	Vertical-1	X-Ray spectroheliograph
1971	Vertical-2	▪ X-Ray spectroheliograph ▪ X-ray broadband photometer
1973	Intercosmos-11	Radiospectrograph PC-500K
1976	Intercosmos-15	Sub-carrier frequency generator for the ETMS telemetric system
1977	Vertical-5	▪ Block of X-ray cameras ▪ X-ray broadband photometer
1978	Intercosmos-18	Sub-carrier frequency generator for the ETMS telemetric system
1979	Vertical-8	▪ Block of X-ray cameras ▪ X-ray telescope ▪ X-ray monochromatic spectrometer ▪ X-ray broadband photometer
1979	Intercosmos-19	▪ Radiospectrometer IRS-1 ▪ Sub-carrier frequency generator for the ETMS telemetric system
1980	Prognoz-8	Spectrum analyser BUD-A
1981	Vertical-9	▪ Block of X-ray cameras ▪ X-ray telescope ▪ X-ray monochromatic spectrometer

	▪ X-ray broadband photometer	
1981	Vertical Gruzya-60-S	▪ Radiospectrometer PRS-1 ▪ Radiospectrometer ISKRA
1981	Vertical-10	Low frequency spectrum analyser ASIN for ionospheric irregularities
1983	Volna-1 MR-12	Low frequency spectrum analyser
1983	Vertical-11	▪ X-ray dopplerometer ▪ Block of X-ray cameras ▪ X-ray telescope
1984	VEGA-1	Spectrum analyser APV-N
1984	VEGA-2	Spectrum analyser APV-N
1985	Plasma-1 MR-12	Radiospectrometer PRS-2RE
1985	Plasma-2 MR-12	Radiospectrometer PRS-2RR
1986	Cosmos 1809	Radiospectrometer AVCz-2F Antenna impedance meter
1988	Phobos-1	Spectrum analyser APV-F1
1988	Phobos-2	Spectrum analyser APV-F2
1989	Intercosmos-2 Active	▪ Radiospectrometer PRS-2 ▪ Antenna impedance meter ▪ Spectrum analyser ONCz-2 ▪ Sub-carrier frequency generator for the STO telemetric system
1989	Subsatellite Active	Radiospectrometer PRS-2S
1990	Gamma-1	Satellite star tracker Telezvezda
1991	Intercosmos-25 Apex	▪ Radiospectrometer PRS-3 ▪ Antenna impedance meter ▪ Radiospectrometer ISKRA ▪ Electrostatic energy analyser ▪ Sub-carrier frequency generator for the STO telemetric system
1991	Subsatellite Apex	Radiospectrometer PRS-3S
1994	Coronas-I	▪ Radiospectrometer SORS ▪ X-ray collimator system KRF
1995	Subsatellite Interball-1	Plasma wave analyser SAS-1
1996	PRIRODA module of MIR	Remote sensing Digital TV-CID camera WIZJER
1996	MARS-1996	▪ Plasma wave subsystem ADS of ELISMA complex ▪ Subsystem DC/DC of Planetary Fourier Spectrometer
1998	Interball-2	Radio-spectro polarimeter POLRAD
1998	Subsatellite Interball-2	Plasma wave analyser SAS-2
2001	Coronas-F	▪ X-ray spectrometer RESIK ▪ X-ray spectro-dopplerometer DIOGENES
2001	Kompas	Radiospectrometer RFA-2

Table 21: Polish instruments onboard spacecraft (1970-2001)[64]

[64] "Scientific Space Instruments Developed under Polish-Russian Cooperation in Space", Space Research Centre, Polish Academy of Sciences, November 2004

1.3.2. Main activities and capabilities

The key sectors of Polish space activities are the following:

- Space science and space science instrumentation
    - Astronomy
    - Planetology
    - Interstellar physics
    - Space weather – Plasma physics
- Navigation applications
    - Geodesy
- Remote sensing and its applications
    - Space- and ground-based instrumentation for Earth Observation
    - Remote sensing applications

1.3.3. Research institutes

The main research institutes with space-related activities are listed, by field, below.

Space science

- Space Research Centre, Academy of Sciences
    - Warsaw (Remote sensing, Planetary geodesy, Solar physics)
    - Wroclaw (Solar physics)
    - Borowieck (Astrogeodynamical observatory)
- Institute of Physics, Academy of Sciences
- Jagiellonian University, Faculty of Physics, Astronomy and Applied Computer Science
- Szczecin University
    - Faculty of Mathematics and Physics
        - Section of Astronomy and Astrophysics, Institute of Physics
        - Section of Cosmology and Gravitation Theory, Institute of Physics
- Adam Mickiewicz University, Faculty of Physics, Astronomical Observatory
- Nicolaus Copernicus Astronomical Centre, Academy of Sciences
- Warsaw University, Faculty of Physics, Institute of Astronomy
- University of Wroclaw, Faculty of Physics and Astronomy

Applications

- Institute of Meteorology and Water Management
- Warsaw University
    - Faculty of Geography, Remote Sensing of Environment Laboratory
- University of Warmia and Mazury
    - Institute of Geodesy
    - Chair of Satellite and Navigation
    - Chair of Surveying
- Jagiellonian University
    - Institute of Geography and Spatial Management
        - Department of Cartography and Remote Sensing
        - Department of Geographical Information Systems
- Nicolaus Copernicus University, Institute of Geography, Department of Cartography, Remote Sensing and Geographical Information Systems
- Institute of Geodesy and Cartography, Department of Remote Sensing – Opolis
- Military University of Technology, Department of Teledetection and Geoinformation

Ground stations

- Psary Station for Satellite Telecommunications
- Ikonos Satellite Ground station SCOR (Satellite Centre of Regional Operations)
- EGNOS RIMS (Ranging and Integrity Monitoring Station)

1.3.4. Industry

There are a limited number of space-related companies in Poland. First, Polspace is a consulting company that was established in 1993 as a subsidiary Public-Private Partnership (PPP) of the Space Research Centre. It was created in connection with the beginning of cooperation with ESA. It aims at supporting the development of space industry and space policy in Poland and provides advisory services to industrial clients and to public institutions. Polspace also plays an incubator role and is part of ESA's ESINET (European Space Incubators Network). Another company, VIGO System, is an optoelectronics firm that develops and manufactures infrared detectors and systems. There are also a few companies in the field of remote sensing data processing and/or distribution of satellite imagery in Poland: Geosystems Polska Sp. z o.o., Eurosense Sp. z o.o., and Intergis Sp. z o.o. Finally, there are a few companies involved in space applications: Infotron (navigation-related services), NAVI Sp. z o.o. (navigation-related equipment and services), and Armstrong & Bartnikiewicz Space Communications (satellite communications services).

A Polish Space Technology Platform was created in February 2006 as a consortium of high-tech companies and R&D institutions. The main objective of this Platform is to jointly prepare research and commercial space projects in international cooperation and to promote space activities in Poland. The members of the Platform are the following:

- EP&M Sp. z o.o.
- NOMA2 Sp. z o.o.
- QWED Sp. z o.o.
- AVIO Polska Sp. z o.o.
- POLSPACE Sp. z o.o.
- Space Research Centre, Polish Academy of Sciences
- Warsaw University of Technology
- WAT Military University of Technology
- Institute of Aviation
- National Institute of Telecommunications
- Tele & Radio Research Institute
- Institute of Meteorology and Water Management
- State School of Higher Education in Chelm
- Warsaw University
- Industrial Research Institute for Automation and Measurements
- Institute of Electronic Materials Technology
- Institute of Fundamental Technical Research, Polish Academy of Sciences

Some of these companies belong to the aviation industry which is well-developed. Poland has a long history in aeronautics and major aeronautical manufacturers have recently invested in Poland. Foreign companies like Pratt & Whitney or General Electric have established plants there. In the south-eastern part of the country, the “Aviation Valley” consists of more than 50 aeronautical companies.

1.4. Legal framework

1.4.1. National space legislation

Poland does not have specific national space-related laws.

1.4.2. International treaties and arrangements

Poland ratified the main international treaties governing space activities, as detailed in Table 22.

Outer Space Treaty	R
Rescue Agreement	R
Liability Convention	R
Registration Convention	R
Moon Agreement	-
Nuclear Tests Ban	R
ITU	R

R: Ratified -: Not ratified

Table 22: Ratification of the United Nations Treaties by Poland

Furthermore, Poland is a partner of the Missile Technology Control Regime (MTCR) since 1998 and is a participating state of the Wassenaar Agreement.

1.4.3. Export control

The main authority of the national export control system is the Export Control Department of the Ministry of Economy.

2. National Policies

2.1. Rationales for space activities

The main rationales for space activities in Poland are:

- The development of the economy
- The development of the industry and particularly SMEs
- The maintenance and development of the knowledge and skills already gained in various space-related fields both in research and in industry
- The development of innovation and new technologies
- Societal benefits from space applications
- A proper standing and visibility
- Recognition of Polish expertise vis-à-vis international partners

2.2. National priorities in space field

There is no Polish space policy as such. The participation in international space programmes is one of the main objectives, as it would enable Poland to develop its industry by joining international joint consortia but also to compensate for the national funding problems.
The next step for Poland is to build satellites with minimal external support and even small launchers.

A project launched in September 2006 by the Polish Space Office aims at focusing Polish resources on a limited number of space-related fields. The objective of this two-year project is to identify the areas in which space-based applications can be most useful to Polish citizens both in economic and social terms. Two time horizons are considered, 2012 and 2020. During the first year, a hundred applications will be shortlisted in five different areas: Earth observation, navigation, communications, space technology and security. Panels of experts were formed in each area. The list of applications will then be submitted to the space community and decision-makers so that at the end of the second year, 15 applications will be chosen as priority applications in these areas.

2.3. Foreign policy objectives

The main foreign policy objective that influences space activities is their strong willingness to be further integrated into Europe. ESA is considered a good tool for European integration.

2.4. Existing international cooperation

In addition to Poland's participation in Intercosmos, the Polish Academy of Sciences signed two agreements with the Russian Academy of Sciences on fundamental space research in 1993 and 2005.
Poland participated in several Russian missions after the end of the Intercosmos Programme: CORONAS-I and F (solar research), INTERBALL (study of the Earth's magnetosphere), OBSTANOVKA (studies on the Russian segment of the ISS), and KOMPAS-2 (study of Earth's electromagnetic emission).
Poland participated in the French mission DEMETER (study of the electromagnetic signals in the ionosphere) in the American mission IBEX (interstellar boundary explorer) and in the Swedish mission NANOSPACE 1 (nanotechnology for small satellite applications). Moreover, Poland is a member of the main space-related international organisations, as detailed in Table 23.

.

ITSO / Intelsat	X
Intersputnik	X
Intercosmos	X
IMSO / Inmarsat	X
Eutelsat	X
Eumetsat	Cooperating state
ESO	X

Table 23: Membership of Poland in international space-related organisations

3. Relationship with Europe and contribution to European space activities

3.1. European Union

Participation in EU projects

Poland has participated in various EU-funded projects. The Space Research Centre participated in the projects RTN (Turbulent Boundary Layers in Geospace Plasmas) and RIN (European Sea Level Observing System) within the FP5 and in the projects PEARL (Port Environmental Information Collector) and EUROPLANET (European Planetology Network) within the FP6. It has also participated in several space-related COST (European Cooperation in the field of Scientific and Technical Research) projects: COST 271 (Atmosphere's effect on communication), COST 251 (Improved Quality of Services in Ionospheric Telecommunication Systems Planning and Operation), and COST 724 (Developing the scientist basis for monitoring, modelling and predicting space weather). Founded in 1971, COST is an intergovernmental framework for European Co-operation in the field of Scientific and Technical Research. The COST projects are supported by the EU Framework Programmes.

In 2003, the Space Research Centre was part of the team that won the Descartes Prize, supported by the FP6, with the project "DESCARTES-nutation" (new model of the Earth nutation and precession). In addition, the Warsaw University of Technology participates in the FP6 project TWISTER (Terrestrial Wireless Infrastructure integrated with Satellite Telecommunications for E-Rural) and the Institute of Geodesy and Cartography participates in the FP6 project Geoland (Land cover and forest change observatory).

The Space Research Centre is also partner of the project DIAS (Digital Upper Atmosphere Server), which is a pan-European distributed information server providing information on the ionospheric conditions over Europe. This project is co-funded by the e-content programme of the DG-Information Society of the European Commission.

3.2. European Space Agency

3.2.1. Milestones in the cooperation with ESA

28 January 1994	Signature of the Cooperation Framework Agreement
24 January 2002	Renewal of the Cooperation Framework Agreement
2004	"Industry assessment of Greece, Luxembourg, Hungary, Poland and Romania" by Bertin Technologies for ESA
27 April 2007	Signature of the ECS Agreement

3.2.2. Participation in ESA Programmes

The Space Research Centre participated in several ESA projects and was involved with:
- the thermal probe for the Titan surface package for the Cassini-Huygens mission
- the electronics box of anticoincidence subsystem of the gamma ray telescope for the Integral mission
- the scanner of the planetary Fourier spectrometer for Mars Express and Venus Express
- the penetrator of cometary nucleus surface for Rosetta
- the HIFI local oscillator control unit for Herschel

3.2.3. Participation in PECS

Poland and ESA signed on April 27 2007 a European Cooperating State (ECS) Agreement. Poland is the fourth country to join the ECS Programme.

3.2.4. ESA educational programmes

Polish students successfully participate in the main ESA educational programmes: students' presentations and posters at the IAC, student parabolic flight campaigns and the SSETI ESEO student satellite programme.

3.3. Participation in the joint EU/ESA programmes

3.3.1. EGNOS

The Space Research Centre also participates in EGNOS with a RIMS (Ranging and Integrity Monitoring Station).

3.3.2. Galileo

Ecorys Poland participates in the FP6 project ProDDAGE (Project for the Development and Demonstration of Applications for Galileo and EGNOS), co-funded by the Galileo Joint Undertaking.
The Space Research Centre participates in Galileo-related FP6 activities; in particular it coordinates the support for the development and utilisation of Galileo application in Poland and other accession countries.

The Space Research Centre also participates in Fidelity (Implementation of Galileo Time Service Provider Prototype) funded by the Galileo Joint Undertaking and coordinated by Helios Technology Ltd.
Polspace was involved in the EC-funded NAVOBS (Action to launch New Economic Activities from Satellite Communications, Earth Observation or Geo-localisation) and will be involved in NAVOBS+.

3.3.3. GMES

Fifteen different Polish institutions participate in the FP6 project GMES Poland aimed at supporting the participation of Poland and other accession countries in GMES. Institutions from other Eastern European countries are also involved.
The Polish Geological Institute participates in TerraFirma (Pan European Ground Motion Hazard Information Service) funded by the GMES Service Element of ESA.
The Space Research Centre participated in the FP6 project ASTRO+ (Advanced Space Technologies to Support Security Operations).
The Ministry of Environment and the Space Research Centre are partners of GSE (GMES Service Element) – Forest monitoring.

ROMANIA

1. The space activities in Romania

1.1. Organisation of the space activities

- *The Romanian Space Agency*

The Romanian Space Agency (ROSA) was established in 1991 as an independent public institution under the responsibility of the Ministry of Education and Research. Its mission is to coordinate the national space research and applications programmes, to promote space development in Romania and to undertake specific research projects. As the government representative in international relations, it has also the role to promote international cooperation.

In addition to its board, created in 1991, ROSA has had a scientific council since 1993, which consists of experts from the various aerospace fields. ROSA has a staff of 35 people and consists of its Headquarters and a Research Centre in Bucharest.

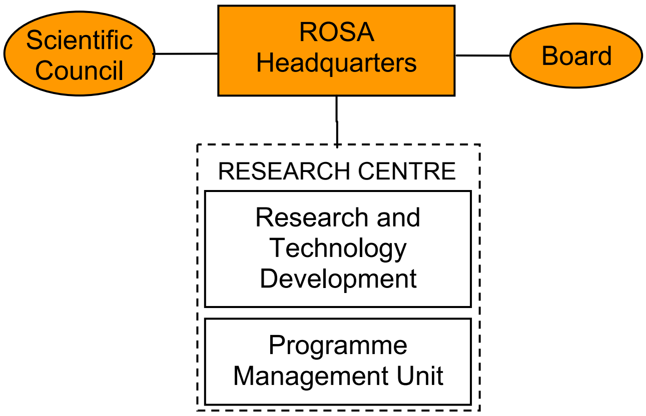


Figure 29: ROSA's Structure

It is important to bear in mind that the scope of ROSA activities is broader than just space, as it supervises aeronautics, space and security activities. It has been the contract authority for the national R&D programme on aeronautics and space, AEROSPATIAL, for 2001-2006, and is the contract authority for the national R&D programme on security since its creation in 2005. Its involvement in security activities is reflected by its participation in different security-related councils and committees, in particular those presented on Figure 30.

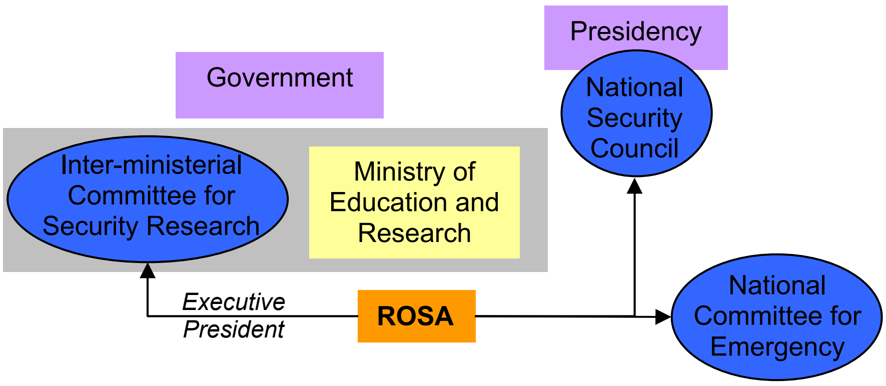


Figure 30: ROSA's involvement in security committees

ROSA's role might evolve with the new R&D National Plan for 2007-2013. ROSA was the contract authority for the AEROSPATIAL programme, but, for the new "Space and Security" programme, this responsibility is being transferred to the National Centre for Programme Management. ROSA will become a contractor but also provide its expertise to the Centre.

1.2. Financial framework

1.2.1. R&D in Romania

R&D expenditures

In 2004, the total expenditure in R&D (GERD) in Romania was about 235 million euros, which represented 0.39% of the GDP. As shown on Figure 31, half of it came from the government.

These levels of public and private expenditure are still very low given the European objectives. As presented in Table 24, an increase in the R&D budget is planned for the coming years in order to reach the level of 1% in 2010.

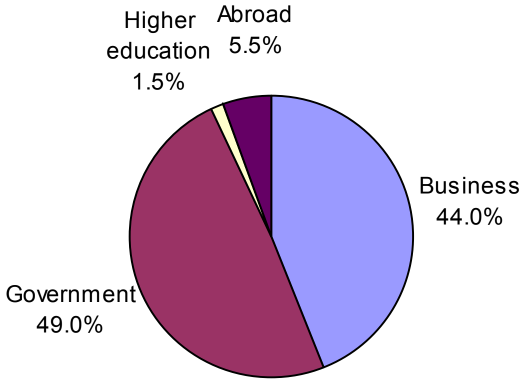


Figure 31: Sources of R&D expenditures

2005	2006	2007	2010
0.22% of GDP	0.48% of GDP	0.58% of GDP	1% of GDP

Table 24: Planned evolution of the R&D budget

R&D funding mechanisms

As presented in Figure 32, the main actors responsible for the R&D policy in Romania are the National Council for Science and Technology Policy and the Ministry of Education and research. The three main sources of R&D funding are the National Authority for Scientific Research (NASR) of the Ministry of Education and Research, other government ministries and the Romanian Academy.

There are several publicly-funded R&D and innovation programmes in Romania. First, National Plans for R&D and Innovation are coordinated by the NASR. The first one was defined for the period 2001-2006, and the second one, for the period 2007-2013, is currently being prepared. In addition, sectoral plans and nucleus research programmes were launched in 2003. Sectoral plans aim at covering sectoral R&D objectives and are financed by ministries coordinating the respective sectors while nucleus programmes are the responsibility of the main public R&D institutes in relation to their specific sectoral strategies. Finally, the programme of grants for scientific research, coordinated by the Ministry of Education and Research, supports the formation and development of scientific careers.

In 2005, a new programme "Research of Excellence" (CEEX) coordinated by the Ministry of Education and Research was launched. This programme aims at structuring and consolidating Romanian research, and to ensure the preparation of the Romanian research community for a more efficient integration in the European Research area and the participation to the EU FP7. This programme addressed the low return rate of the money Romania invested in European projects, which was about 30%.

The first National Plan for R&D and Innovation 2001-2006 consisted of 15 programmes divided in five main directions.

1- Modernisation and relaunch of traditional economic sectors
    - Agriculture and food - AGRAL
    - Life and health - VIASAN
    - Environment, energy and resources - MENER
    - Planning, infrastructures and transportation - AMTRANS
    - Stimulation of the application of inventions - INVENT
    - Economic relaunch through research and innovation - RELANSIN
    - Quality and standards - CALIST
    - Infrastructures for standardisation - INFRAS
2- Consolidation of the elements of the new knowledge-based society
    - Information Society Technologies - INFOSOC
    - Biotechnology - BIOTECH
    - New materials, micro- and nanotechnologies - MATNANTECH
    - Technologies for the space and aeronautics fields – AEROSPATIAL
3- Basic and socio-economic research - CERES
4- International S&T cooperation and partnership - CORINT
5- Security research - SECURITY (launched in 2005)

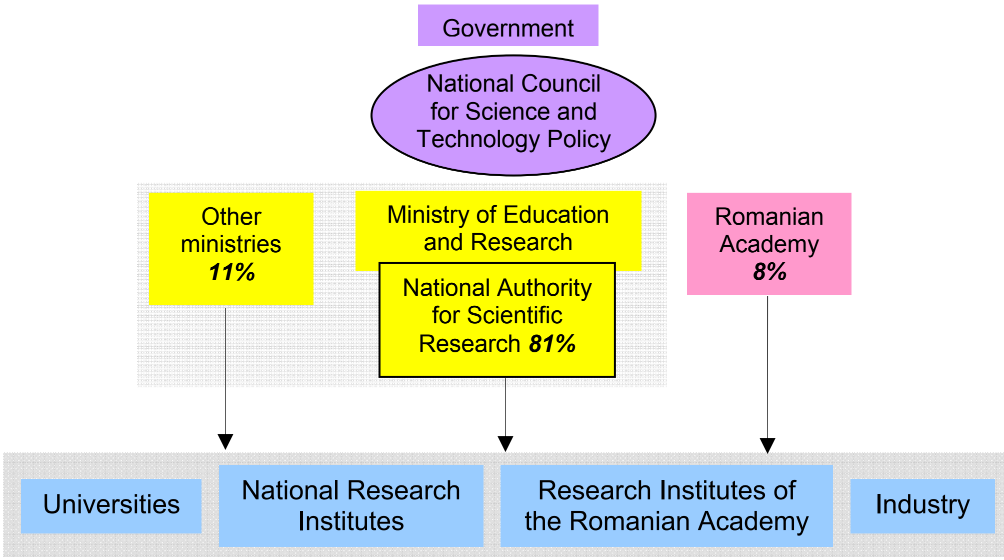


Figure 32: Sources of public R&D funding[65]

The Second RTDI National Plan 2007-2013 represents 15 billion RON (about 4.5 million euros) over the whole period. In a similar way to the EU Framework Programme, it is composed of the following programmes:

A. Human resources
B. Capacities
C. Ideas
D. Cooperation in Priority Fields
    - Information and Communication Technology
    - Energy
    - Environment
    - Health
    - Agriculture, Food Safety and Security
    - Biotechnologies
    - Materials, Processing and Innovative Products
    - Space and Security
    - Socio-economic and Humanistic Research
E. Innovation
F. Sustaining the Institutional Performance

1.2.2. Space activities budget and funding mechanisms

Budget for space activities

ROSA's budget for aerospace activities was about 4.9 million euros in 2006, as detailed in Table 25, which includes about 25% for aeronautics. The core funding for space science covers the funding for the Institute of Space Science and the Astronomical Institute of Bucharest. As shown in Figure 33, this budget covers all the main space fields.

[65] R&D Budget distribution in 2006

Field	Million euros 2006
AEROSPATIAL Programme	
Infrastructure and policy	0.06
Space exploration	0.53
Space applications	0.61
Technology and systems	0.46
Products and applications	0.54
Programme management	0.04
"Research of Excellence" (CEEX) Space	1.28
Core funding for space science	0.91
Basic research in astronomy and space science	0.48
Total	4.90

Table 25: ROSA Budget 2006[66]

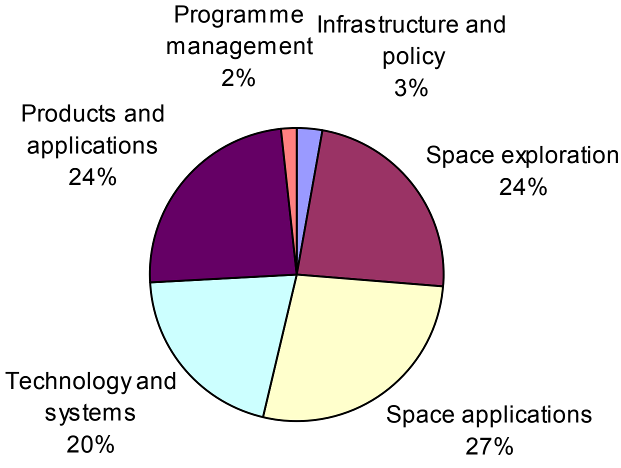


Figure 33: Distribution of ROSA budget for the AEROSPATIAL programme

Most of ROSA's space-related funding came from the AEROSPATIAL programme of the first National Plan for R&D and Innovation 2001-2006. AEROSPATIAL represents 171 projects in which 121 organisations participate. The budget engagement limit for AEROSPATIAL for 2001-2006 was 31.25 million euros with a co-financing rate by public and private partners of 31%.
However, the total budget of ROSA for the AEROSPATIAL programme has been 12.5 million euros over six years. Moreover, over the same period, 22% of the overall expenditures of ROSA were spent for aeronautical activities.
To this budget, a contribution to EUMETSAT of about 0.15 million euros should be added.

In the second National RTDI Plan 2007-2013, space activities should be funded mainly in the programmes "Ideas", for basic science, and "Cooperation" in the sub-programme Space and Security. Over five years, "Ideas" represents 2 billion RON (about 600 million euros) for all scientific fields, while the sub-programme "Space and Security" represents 8% of the 6 billion RON of the "Cooperation" programme, i.e., 480 million RON (about 145 million euros).
The sub-programme "Space and security" is divided into the following fields, which include aeronautical activities:

- Space exploration
- Space applications
- Aerospace technologies and infrastructures
- Security technology
- Security systems and infrastructures

Funding mechanisms for space activities

The relevant organisations defining the funding of Romanian space activities are presented in Figure 34.
Most of the space activities are funded by the National RTDI Plan, coordinated by the NASR. In addition to the national programmes (AEROSPATIAL, CEEX, etc.), ROSA receives funding from abroad, mainly for projects with other countries (Moldova, Azerbaijan, etc.) and for European projects.

[66] Source ROSA

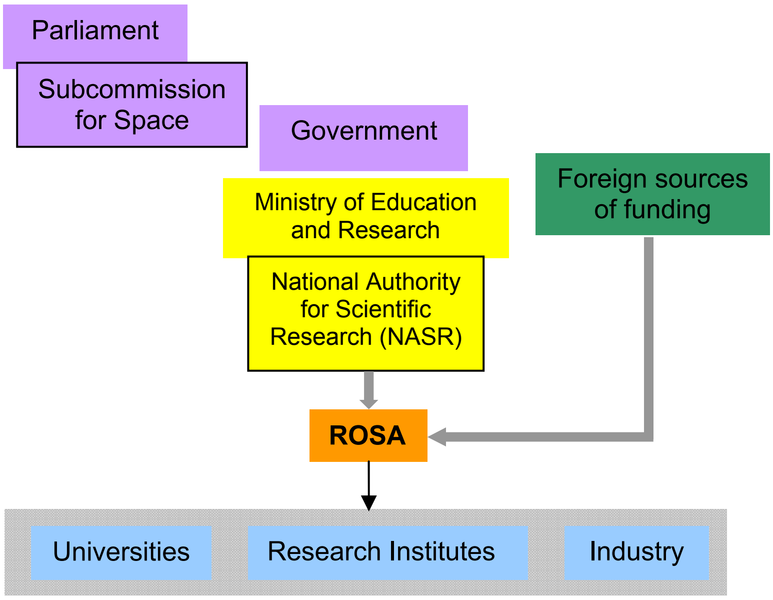


Figure 34: Space activities funding

At the Parliament level, a Subcommission for Space consists of people from various relevant Commissions: the Commission for Education, Science, and Youth, for Information Technology and for Defence.
As mentioned in 1.1., the scheme described in Figure will evolve with the second National RDTI Plan 2007-2013. As described in Figure 35, the National Centre for Programme Management will become the contract authority for the programmes and ROSA will act as a contractor and will support the Centre with its expertise.

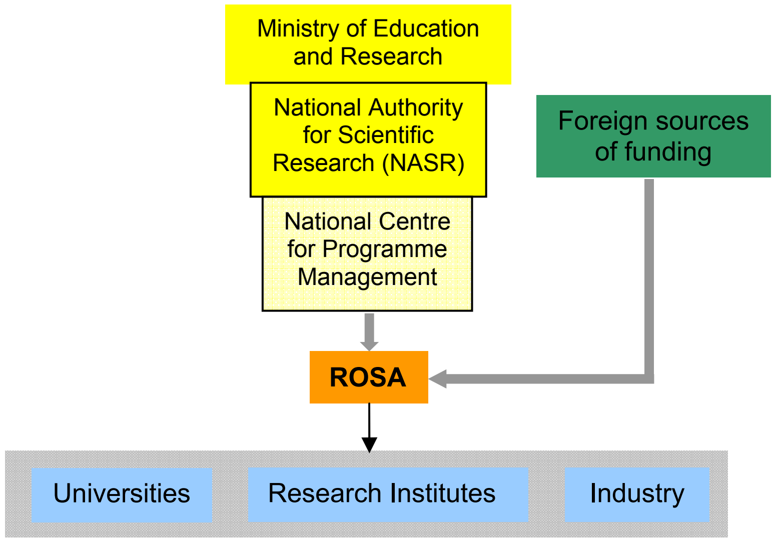


Figure 35: The new organisation of space activities with the Second National RDTI Plan

1.3. Scientific and technical capabilities

1.3.1. Main achievements

Romania participated in many Soviet missions as listed below.

<u>Magnetometry and cosmic plasma</u>
1978 Intercosmos 18
1980 Intercosmos 20
1981 Intercosmos 21
1989 Intercosmos 24 Aktivnii - Magion 2
1991 Intercosmos 25 Apex - Magion 3

1995 Interball 1 - Magion 4 - Tail
1996 Interball 2 - Magion 5 - Auroral
1996 Fast
1997 Equator - S

Cosmic rays
1972 Intercosmos 6
1974 Cosmos 690
1975 Cosmos 782
1977 Intercosmos 17 & Cosmos 936
1979 Cosmos 1129 & Salyut 6
1981 Salyut 6 - Scientific programme of the Romanian cosmonaut
1982 Cosmos 1514 & Salyut 7
1985 Salyut 7
1986 Cosmos 1781
1989 Cosmos 2044
1993 Cosmos 2229

Remote sensing
1996 MIR – PRIRODA

1.3.2. Main activities/capabilities

The key sectors of the Romanian space activities are the ones that follow.

Space science
- Space Physics
- Astronomy

Space systems
- Construction of nanosatellites (first one, Goliath, to be launched in October 2007)
- Microgravity experiments

Space applications
- Telemedicine
- Earth Observation data processing
  - Disaster management (flood management, earthquakes, mining areas, etc.)
  - Land use and cover
  - Agriculture (precision farming, land parcel and crop information systems, etc.)
- GNSS and location-based services (LBS)

1.3.3. Scientific institutes

- ROSA Research Centre
  Including a ground station for EO satellites
- National Institute for Aerospace Research
- Institute for Space Science
  - Space Research Laboratory
  - Space Engineering Laboratory
  - Gravitational Research Laboratory
- Romanian Academy
  - Section of Physical Sciences
    - Institute of Physics
  - Section of Engineering Sciences
    - Institute of Applied Mechanics
  - Section of Geonomical Sciences
    - Institute of Geodynamics
    - Institute of Geography
  - Section of Mathematical Sciences
    - Astronomical Institute
    - Institute of Statistical and Applied Mathematics
  - Institute of Information Science and Technology
- National Institute for Laser, Plasma and Radiation Physics

- National Institute for Material Physics
- National Institute for Research and Development in Microtechnologies
- National Institute of Research and Development for Optoelectronics
- "Polytechnica" University of Bucharest
    - Faculty of Electronics, Telecommunications and Information Technology
    - Faculty of Aerospace Engineering
- University of Bucharest
    - Faculty of Physics
    - Faculty of Geography
- Military Technical Academy

Remote sensing applications
- Technical University of Civil Engineering Bucharest, Remote Sensing Laboratory
- National Institute of Meteorology and Hydrology
- CRUTA Remote Sensing Centre (Romanian Centre for Remote Sensing in Agriculture)
- "Danube Delta" National Institute for Research and Development
- ICPA (Research Institute for Soil Science and Agrochemistry)
- ICAS (Forest Research and Management Institute)

1.3.4. Industry
There are only a few Romanian companies with space-related activities. The main ones are Geosystems Romania (remote sensing data processing), Intergis Grup (navigation applications), Rartel and Bitnet (satellite-based services: telecommunications and imagery).

1.4. Legal framework

1.4.1. National space legislation
Romania does not have specific national space-related laws.

1.4.2. International treaties and arrangements
Romania ratified the main international treaties governing space activities, except the Registration Convention, as detailed in Table 26.

Outer Space Treaty	R
Rescue Agreement	R
Liability Convention	R
Registration Convention	-
Moon Agreement	S
Nuclear Tests Ban	R
ITU	R

R: Ratified -: Not ratified S: signature only

Table 26: Ratification of the United Nations Treaties by Romania

Furthermore, Romania is a participating state of the Wassenaar Agreement but is not a partner of the Missile Technology Control Regime (MTCR). However, it has pledged to abide by the MTCR without joining it.

1.4.3. Export control
The main authority of the national export control system is the National Agency for Export Control (ANCEX) of the Ministry of Foreign Affairs.

2. National Policies

2.1. Rationales for space activities

The main rationales for space activities in Romania are:

- The development of industry
- The development of technological niches and the sale of national specificities
- The development of the economy and the infrastructure
- Capacity building
- The improvement of the national and regional security

2.2. National priorities in space field

There is no Romanian space policy as such. Participation in international missions and the integration into ESA are important objectives, however national programmes run in parallel with international programmes are deemed crucial.
Romania focuses mainly on space research projects sustained by international cooperation and specific space infrastructure projects (hazard monitoring, global information systems, nanosatellites, etc.).
Romania aims at developing centres of excellence and small companies specialised in space and space-related fields.

2.3. Foreign policy objectives

The main foreign policy objective that influences space activities is a strong willingness to be further integrated into Europe and into the Western community.

2.4. Existing international cooperation

ROSA signed cooperation agreements with several space agencies: in 1997 with the Bulgarian Aerospace Agency, in 1998 with the Hungarian Space Office, in 1998 with the Italian Space Agency, and in 2003 with the Azerbaijan National Aerospace Agency. Romania signed a cooperation agreement in 2000 with the French Space Agency and participated in several projects in cooperation with CNES. In particular, it participated in the precision farming project ADAM and in the COROT mission.
In 2000, an agreement of cooperation was signed by the Romanian prime minister and NASA administrator. It included projects on telemedicine and precision farming.
Finally, an agreement on scientific cooperation was signed in 2003 with the National Research Council of Italy.
Romania is a member of the main space-related international organisations, as detailed in Table 27.

ITSO / Intelsat	X
Intersputnik	X
Intercosmos	X
IMSO / Inmarsat	X
Eutelsat	X
Eumetsat	Cooperating state
ESO	X

Table 27: Membership of Romania in international space-related organisations

3. Relationship with Europe and contribution to European space activities

3.1. European Union

Participation in EU projects

Even though it became a member of the EU in January 2007, Romania participated in European programmes and especially in the Framework Programmes 5 and 6. At national level, both the programme CORINT of the National Plan for R&D and the programme "Research of Excellence" have supported the participation of Romanian organisations in European R&D programmes.

Under the FP6, Romania participates in the SURE programme, an ESA initiative funded by the EC. This programme gives the opportunity to scientists and SMEs to perform fundamental and applied research projects on board the International Space Station. The programme was opened to participants from all EU Member states and Associated States, with priority given to the 12 new EU Member States.

3.2. European Space Agency

3.2.1. Milestones in the cooperation with ESA

11 December 1992	Signature of the Cooperation Agreement
12 October 1999	Signature of a five-year Framework Cooperation Agreement
2004	"Industry assessment of Greece, Luxembourg, Hungary, Poland and Romania" by Bertin Technologies for ESA
17 February 2006 January 2007	Signature of the ECS Agreement Entry into force of the ECS Agreement
14 February 2007	Signature of the PECS Charter

3.2.2. Participation in ESA programmes

Romania already participated in several ESA projects, mostly in space science missions (Planck, SPORt, Rosetta, Cluster and Cluster II and Fast), but also in microgravity experiments, software (Leoworks) and telemedicine projects (SHARED) and in applications projects in Earth observation and navigation (EGNOS).

Part II

Ukraine

Introduction

Ukraine is the largest country in Central and Eastern Europe, but, in comparison with some of its neighbours, its relations with Western Europe are still limited.

However, since the Orange Revolution in early 2005, President Yuschenko has clearly stated his willingness for the country to move closer to Europe, which has put Ukraine back on the map of Europe. Moreover, since the EU enlargement Ukraine lies at the Union's **new Eastern border** and Ukraine is considered a **priority partner** within the 2004 European Neighbourhood Policy. The joint Action Plan endorsed in February 2005 aimed to bring the country out of its isolation from the West.

In the space field, Ukraine is the **largest actor** in Central and Eastern Europe. It gained tremendous expertise during the Soviet era in many fields and after the dissolution of the USSR, it inherited a significant share of the Soviet capabilities. Yet the funding for space activities has been scarce and Ukrainian society, still under restructuring, has to deal with many other priorities. **Ukraine needs partners in space** and is looking for new ones in order to lessen its dependency on Russia. Given the country's new political context, **the space sector is turning westwards**. There have been a few early attempts at cooperation between Europe and Ukraine but the results are still limited.

This study investigates the strengths and weaknesses of Ukraine's space sector and assesses the possible futures of the country's space activities. The opportunities and challenges of further cooperation with Europe are then assessed and specific recommendations are made.

1. Ukraine today - The political and economic context

After Russia, Ukraine is the largest country of the European continent, with a total area of 603,700 km^2, and has the sixth largest population with 47 million inhabitants.

1.1. The Ukrainian economy

After its independence in 1991, Ukraine underwent an economic downturn that lasted until 2000. Immediately following the collapse of the USSR, Ukrainian production and GDP dropped significantly, like in all the other countries of the former Union. Moreover, the slow implementation of structural reforms and the Russian financial and economic crisis in 1998 hindered any improvement of the situation. As a result, the real GDP reached its lowest level in 1999, at 36% of its 1990 level, as shown in Figure 36.

As shown in Figure 37, Ukraine finally resumed growth in 2000 and until 2004 it experienced significant GDP growth, with a yearly average increase above 8%. This growth has slowed down since 2005.

In parallel, after a period of hyperinflation, inflation was reduced to 0.8% in 2002 but later increased to 13.5% in 2005, as presented in Figure 38.

The **Ukrainian economy remains vulnerable** to external markets and its development is strongly linked to **structural reforms**, which have not been completed or even implemented yet.

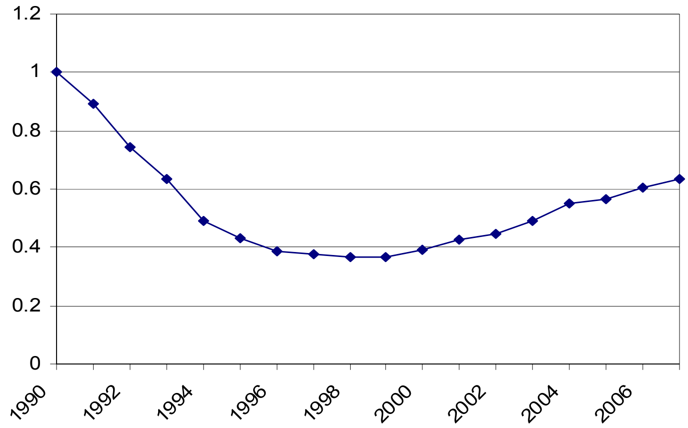


Figure 36: Real GDP compared to the GDP in 1990 (1990=1)

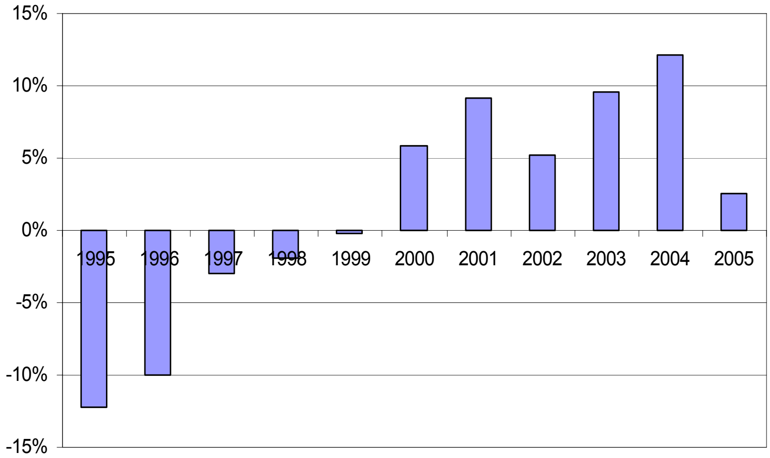


Figure 37: Real GDP growth rate

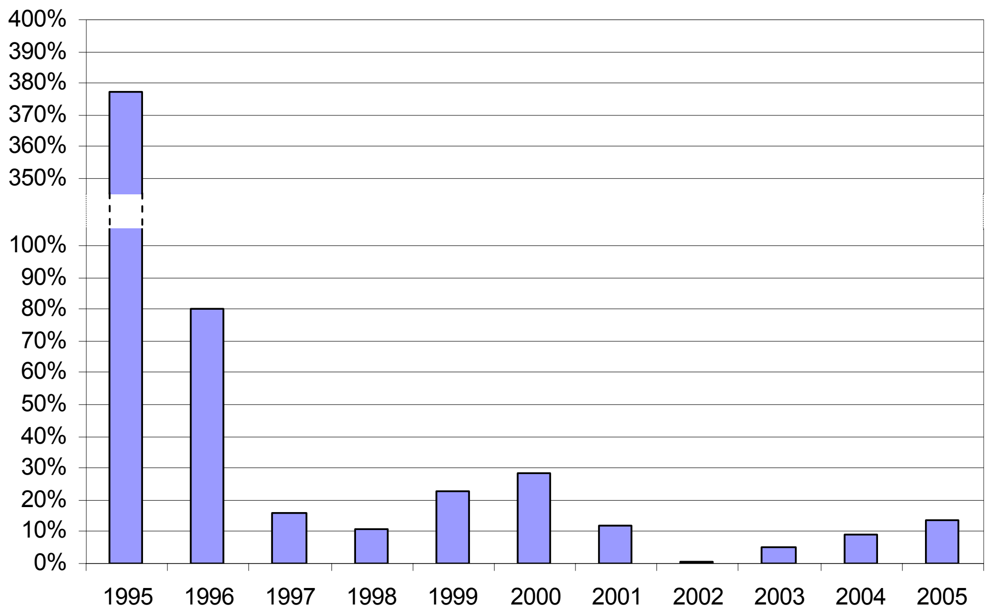


Figure 38: Inflation rate

Ukraine's industry and trade structures are still unbalanced. Two sectors, agriculture and the military-industrial complex, used to form the backbone of the Ukrainian economy. Both are still undergoing a profound restructuring. The heavy industries, mainly metallurgy and petrochemicals, still have a key role in the economy, yet light and food industries are today among the fastest growing in Ukraine.
The enlarged EU has replaced Russia as Ukraine's main trading partner. On the other hand, Ukraine represented in 2006 about 1% of total EU trade. Russia still represented 22% of the total exports value and 35.5% of the total imports value in 2005.[67] The main export product of Ukraine is metals, which represent 37% of the total exports value.[68] Ukraine produces steel at low cost but the steel industry remains very much dependent on the export demand, as the domestic demand represents only 25% of the production. The main import product is energy, i.e., oil and gas, which represented one third of the total imports value in 2005.[68] Ukraine imports half of the energy it uses and this energy vulnerability is one of the country's main weaknesses.
Finally, the level of foreign investment still remains low compared to other countries of Central and Eastern Europe, because of the economic and political situation of the country as well as its low level of intellectual property protection.

1.2. The Ukrainian political situation

Since the Orange Revolution, politics in Ukraine has been unsteady. On January 20 2005 the pro-Western Viktor Yuschenko was elected president of Ukraine and defeated his pro-Russian opponent Viktor Yanoukovitch, after a cancellation by the Supreme Court of the elections held in November 2004. Ioula Timochenko became prime minister in early February but was dismissed a few months later, in September, because of tensions inside the government and accusations of corruption. A new prime minister, Iouri Ekhanourov, was nominated by the parliament two weeks later. From June 2005 to January 2006, the "gas crisis" with Russia demonstrated the willingness of Russia to influence Ukrainian politics. In January 2006, Yuschenko was blamed for the agreement he signed with Putin to put an end to the crisis and the prime minister was disavowed. In March 2006, Yuschenko's coalition was defeated at the parliamentary elections by Yanoukovitch's party. In August 2006, Yuschenko resigned himself to nominate his opponent, Yanoukovitch, as prime minister. The present political crisis linked to the dissolution of the parliament by Yuschenko in April 2007 demonstrates Ukraine's division and the strong opposition between pro-Russians and pro-Westerners that tend to paralyse the country.

[67] Source French Economic Mission in Ukraine
[68] Source World Bank

1.3. Ukraine and the West

The political instability in Ukraine and the opposition between pro-Westerners and pro-Russians in the government have hindered the definition and implementation of a coherent foreign policy and have made the **relationship between Ukraine and the West quite chaotic**. A major obstacle that has significantly slowed down any evolution towards either the West or the East is the inertia of the current bureaucracy.[69] To a certain extent, the EU twinning activities should help address this issue as they aim to support the transformation of the Ukrainian public administration.

The relationship between Ukraine and NATO has also suffered from the lack of a coherent and sustainable foreign policy. After the Orange Revolution, Ukraine was on the path towards a NATO membership, even though the support among its population has been quite low and did not exceed 40%. The possibility of Ukraine joining the alliance has certainly improved its relationships with Western countries but at the same time has created tensions with Russia. However the nomination of Yanoukovitch as prime minister has darkened the prospects for further integration. More specifically, during a visit in Brussels in September 2006, Yanoukovitch declared that his country was not yet ready for a NATO membership.

[69] T.Valasek, "Ukraine's Real Problem", Centre for European Reform Bulletin, Issue 53, April/May 2007

2. Strengths and weaknesses of the Ukrainian space sector

2.1. Ukraine's space potential inherited from the Soviet era

2.1.1. A tremendous expertise gained during the Soviet times

When part of the USSR, Ukraine gained **significant expertise and experience in many space-related domains**. The Yuzhnoye design office and the Yuzhmash plant in Dnipropetrovs'k formed the backbone of the Ukrainian space sector. Most of the other companies were acting as subcontractors of those two giants.

- The military expertise

Ukraine's aerospace activities were previously military-focused and its main aerospace products during the Soviet era had military purposes. Starting in the fifties, Ukraine was the primary producer of strategic missiles for the USSR.
Over 40 years, the Ukrainian enterprises developed four generations of strategic missiles, as detailed in Appendix B. Of the more than 20 types of Soviet Inter-continental Ballistic Missiles (ICBMs), 12 were developed in Dnipropetrovs'k, where at its peak 120 ICBMs could be produced per year.[70]
Ukraine also produced military satellites for Moscow, including electronic intelligence, early warning and reconnaissance satellites.

- The civil expertise

Ukraine used its military technology also for civil applications. It developed and produced numerous launch vehicles and satellites, in collaboration with other Soviet republics, as detailed in Appendix B. Ukraine was associated with almost all of the Soviet achievements in space. During Soviet times, more than 300 launch vehicles of Cosmos, Intercosmos, Cyclone and Zenit series and 400 spacecraft, mostly scientific and Earth observation satellites, were developed and launched.

2.1.2. And important space capabilities in heritage

After the collapse of the Soviet Union, **Ukraine inherited between 15% and 30% of the Soviet space potential and support infrastructure.** It inherited a particularly large share of the testing capabilities of the former Soviet Union. The key Ukrainian facilities consist of the Yuzhnoye design office and the Yuzhmash plant in Dnipropetrovs'k, as well as the ground station in Yevpatoriya. Moreover, unique expertise in missiles/launchers guidance systems is found in Kharkiv.

2.1.3. However Ukraine was left in a difficult situation

The space potential that Ukraine inherited was mostly **military and incomplete**. Ukraine was left with expertise and facilities that were initially developed for military purposes without having any substantial national military programmes. In addition, this potential was not complete as the facilities situated in Ukraine were only components of a much larger space industry located throughout the Soviet republics.

Furthermore, with the collapse of the USSR, **Ukraine has lost its traditional source of funding** for its space activities. It has lost a large "market", despite still working with Russia, and the internal market is limited, if not inexistent in some segments. As a result, the sizeable infrastructure has deteriorated in the nineties and the designs and technologies are ageing.

2.2. The transition towards a space nation

Ukraine gained its independence in 1991 and the National Space Agency of Ukraine was established in February 1992.

[70] L. Fritz and J. Bourestion, "Ukraine's Missile Industry: Still armed or Dangerous?", FirstWatch International, 27 June 2006

2.2.1. Space in the independent Ukraine

Despite the political difficulties and the lack of funding, **space remained an important domain for the public authorities**, as demonstrated by the numerous space-related presidential decrees and resolutions of the Cabinet of Ministers since 1991, and is still considered a key sector of the economy. Space has been treated as a separate sector of the economy, as demonstrated by the status of the National Space Agency and its control over the main companies of the sector. Contrary to many other countries, the space sector in Ukraine has always been separated from the aeronautical sector, which is also well-developed especially with Antonov.

In addition, Ukraine received considerable **foreign support**, mainly from North America and Europe, to help with the transition towards a market-oriented economy and democracy. An important share of that support was directed to science and technology, and part of it to space, as detailed in Appendix B.

This political and financial support facilitated two difficult transitions of the space sector after the disbanding of the Soviet republics: the conversion of a military potential into a civil-oriented industry; and the transition from mass production to low-volume production.

2.2.2. The conversion from military to civil-oriented space activities

Ukraine inherited a major missiles design office and production plant in Dnipropetrovs'k but also part of the USSR nuclear arsenal, i.e., more than 180 ICBMs, some of them with nuclear warheads. Like Kazakhstan and Belarus, Ukraine finally decided some years after its independence to become a non-nuclear state. After obtaining commitments of aid from the US and Europe, it chose to return nuclear weapons and delivery systems to Russia, to join the Nuclear Non-proliferation Treaty in November 1994 and to sign the START I treaty in December 1994.

As a result, ICBMs were taken off military duty and destroyed and the Ukrainian industry was reoriented towards peaceful purposes. The decommissioning of the missiles and the disposal of their fuel could be achieved by 2020.

This choice led to the conversion of the **missile** industry into an industry that would focus exclusively on **launch vehicles.** The Dnepr launcher illustrates this conversion. This launcher uses the largest ICBM ever deployed, the SS-18 Satan[71] (or RS-20), produced in Dnipropetrovs'k and decommissioned under the START II treaty. Until 2020, between 30 and 100 of those missiles could be used as launch vehicles.

2.2.3. The transition from mass production to low-volume production

The second transition the Ukrainian space sector had to face was a sudden decline in state orders which led to a **drop in the production**, from more than 100 missiles a year to less than ten launch vehicles a year. The large facilities had an insufficient turnover and employment has dropped, for instance Yuzhnoye lost half of its workforce.

2.2.4. Ukraine managed to remain a major space nation

Despite the difficulties mentioned earlier, Ukraine managed to remain a major space nation.

Launch vehicles remained the priority for the country and Ukraine is today one of the key players on the international market. It managed to keep its standing among major space nations by creating **joint ventures** (JV) **with foreign partners**, especially Russia and the US, to **commercialise the launch vehicles** it produces. Following the Russian example, Yuzhnoye and Yuzhmash created Sea Launch in 1993 with Boeing and Kvaerner. The JV commercialises the Zenit-3SL launch services from an equator-located platform in the Pacific Ocean. Yuzhnoye and Yuzhmash are mainly responsible for the first and the second stages of the launcher and between them control 15% of the company. In 2003, the Sea Launch partners decided to commercialise a new version of the Zenit 3SL launcher, the Zenit 3SLB, from Baikonour and created the Land Launch system. Land Launch is commercialised by the Sea Launch Company with a subcontracting arrangement with Space International Services. The first launch is planned for 2007. A second JV, ISC Kosmotras, was created in 1997 to commercialize Dnepr launches from Baikonour. The company ISC Kosmotras is located in Moscow and is equally owned between the Russian and Ukrainian partners. Finally, Alcantara Cyclone Space is a joint venture established between the Brazilian

[71] NATO denomination

Space Agency (AEB) and the National Space Agency of Ukraine (NSAU) to commercialise Cyclone 4 launch services from Alcantara in Brazil. The JV statute came into force in Ukraine in 2005 and in Brazil in September 2006. The shares of the JV are equally distributed between Ukraine and Brazil.
In addition to joint ventures in the launchers sector, Ukrainian enterprises are extending joint ventures to satellites and their applications. The first example is the joint venture Elsacom Ukraine that was created in the field of space communications in 1996. Further details about those JVs can be found in Appendix B.
As also detailed in Appendix B, between 1991 and 2007, more than 90 launch vehicles designed and manufactured in Ukraine (Zenit, Cyclone and Dnepr) were launched, out of a total of 1,220 launches over that period, and almost 200 satellites from ten different countries were put into orbit.
In addition to launchers, launchers' components and engines, Ukraine develops and manufactures its own satellites. Yuzhnoye and Yuzhmash produced scientific and remote sensing satellites, as well as electronic intelligence (ELINT) satellites for the Russian Armed Forces (Tselina), and are developing telecommunications satellites. The first Ukrainian satellite, Sich-1, an oceanographic weather satellite, was launched in 1995.
In brief, Yuzhnoye and Yuzhmash cover today as prime contractors **almost the whole range of space activities**, except telecommunications satellites (not really developed yet), propulsion based on hydrogen and on methane and reusable launchers.

2.3. Ukraine's competitive advantage

In addition to its technical know-how, Ukraine's main competitive advantage in the international market remains its low production costs.

2.3.1. The low production costs in Ukraine

One of the key elements of the low production costs is the low labour costs. As shown in Figure 39, the average monthly wage is much lower than in European countries, even when compared with its close neighbours.

According to NSAU, the average monthly wage in the space sector was 747 hrvynas (about 117 euros) in 2005. The average wage at Yuzhnoye was higher and reached 1066 hrvynas (167 euros).

Ukraine is a large metal producer and therefore benefits from low prices on metals. It also takes advantage of the low prices of energy, especially that bought from Russia.

2.3.2. But for how long?

The Ukrainian economy is developing, as demonstrated by the significant increase in its GDP since 2000. One can therefore wonder for how long Ukraine will be able to keep its costs (and prices) significantly lower

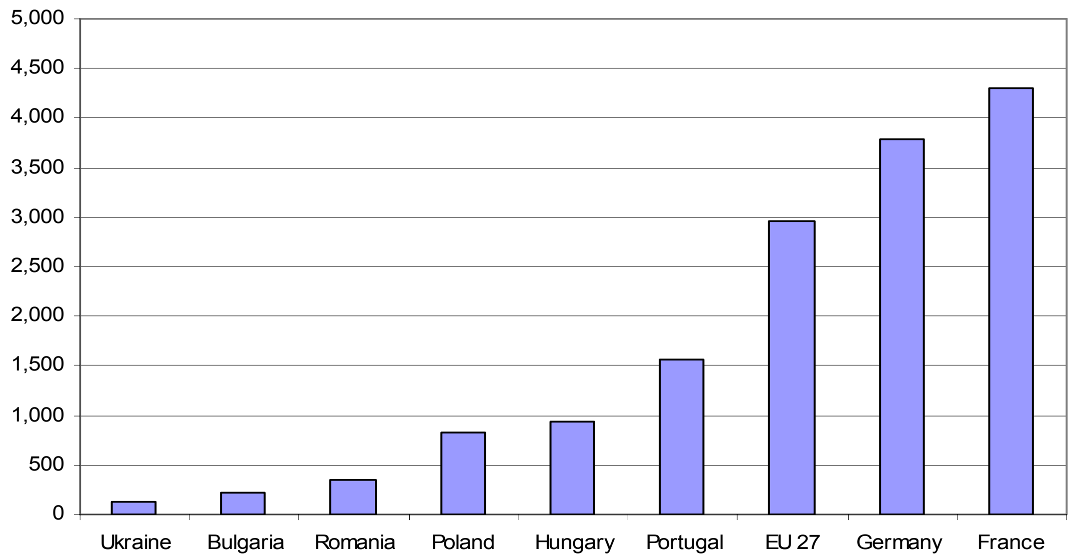


Figure 39: Average monthly wage (in euros)

than its current competitors. Furthermore, new competitors, China and India, with low, but also increasing, production costs, are entering the market.
Even if the wages remain very low they have been considerably increasing in the past decade as shown in nominal terms in Figure 40 and in real terms in Figure 41. From 2001 to 2005, the average monthly wage has more than doubled in real terms in five years.

In addition, the prices of raw materials are also increasing and the low prices of energy, and especially of gas, from which Ukraine benefits, might increase in relation with future political events. In particular, the artificially-low prices of gas set by Russia could suddenly increase, as demonstrated during the "gas crisis" that took place in late 2005 between Ukraine and Russia.

2.4. Political and institutional issues

2.4.1. Political issues

The current political situation in Ukraine has a detrimental impact on space activities as the dissolution of the parliament by the president on April 2 2007 has impeded the adoption of the new National Space Programme for the period 2007-2010. Thus scientific and engineering teams are put in a difficult situation as they do not know whether funding will be available for existing and new programmes for this year and the years to come. Legislative elections should take place on June 24 2007 but even in the best case scenario the Programme will not be adopted before the summer.
An audit of the Accounting Chamber of Ukraine detected a number of flaws in

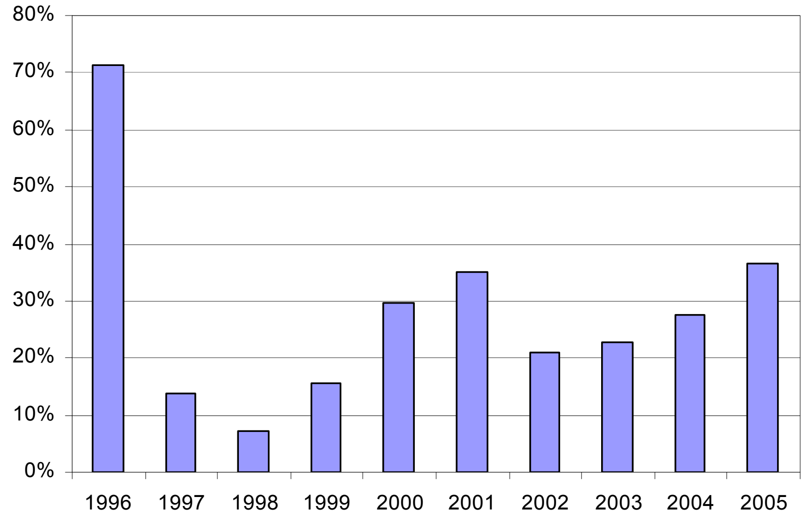


Figure 40: Nominal wage growth rate

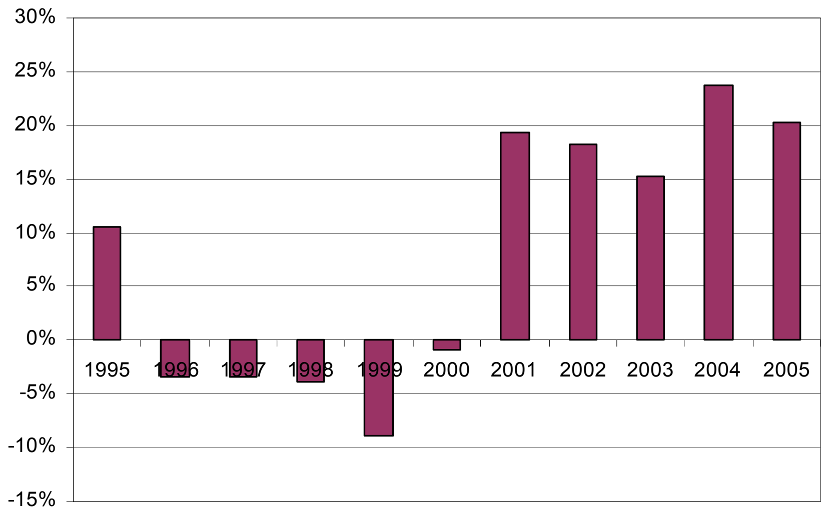


Figure 41: Real wage growth rate

financing and use of the budget funds in the space sector. The irrelevant tasks NSAU has to fulfil as well as its lack of control on the enterprises of the sector are among the main flaws listed in the results of the audit.[72]

2.4.2. The role of the National Space Agency

NSAU spends a large share of its budget (estimated between 25% and 50%) on **activities that are not directly space-related**. NSAU actually bears the responsibility for the sector transition from military to civil-oriented applications, which includes missiles, solid propellant stock and weaponry disposal.
Moreover, since 1999 NSAU has supervised the main companies of the sector, about 30 design offices, research institutes and enterprises. NSAU appoints the executives of those state-run organisations, defines their budget and activities, distributes state contracts and participates in their commercial projects as a partner.

All those responsibilities, a **limited budget** (officially about 52 million euros in 2007) and **staff** (115 people in the headquarters in Kiev) prevent NSAU from effectively supporting the space sector.

2.4.3. Limits to its independence

Furthermore, NSAU independence from the Ukrainian space industry is limited. The industry is monopolistic and NSAU has to deal with two giants. This incestuous relation is reinforced by the fact that many NSAU employees are former employees of either Yuzhnoye or Yuzhmash.

2.5. Challenges to the development of space activities

Ukraine has to face several other challenges in order for its space industry to develop and persist.

2.5.1. Adaptation to market principles

Ukraine has been granted the status of market economy by the EU and the US in 2006 and might complete the World Trade Organisation (WTO) accession process in 2007. However important structural reforms remains necessary and Ukrainian companies still need to further adapt to an open economy and market principles. Furthermore, because of the nature and importance of the space sector in the economy, **the main space enterprises are run by the state** (and are unlikely to be privatised in the short- to medium-term) and seriously lack transparency, which is a significant obstacle to the development of international cooperation.

2.5.2. Insufficient intellectual property protection

Ukraine still lags in the implementation of effective legislation on intellectual property rights. The low level of protection is even considered as one of the largest obstacles to foreign direct investments.[73] In the space domain, the Bistro projects funded by the EU aimed at making specific recommendations for intellectual property rights protection for space technology commercialisation (see details in Appendix B).

2.5.3. Adaptation to Western technical standards

The successful experience of international cooperation demonstrated that the Ukrainian space industry is able to, if needed, comply with American and European technical standards, but much remains to be done if it is to be considered by its Western counterparts as in line with their standards.

2.5.4. Limited benefits to citizens

Despite significant projects developed by the Ukrainian industry, **Ukrainian citizens do not derive much benefit from space technologies**. There is a huge gap between the systems developed and how they support the country's policy and development. This phenomenon is due first to the focus on launch vehicles and what is sometimes criticized as the "rocket oligarchy" in the space sector. Then, the internal market for space systems and applications is very limited and lacks funding. As a result, most of the numerous products of the Ukrainian aerospace industry are sold abroad and do not benefit Ukrainian citizens.

[72] "To make space flight needs earthwork", Official Announcement of the Accounting Chamber of Ukraine, February 10 2006 - http://www.ac-rada.gov.ua/achamber

[73] "La Crise Politique en Ukraine Risque de Refroidir les Investisseurs Etrangers", France Ukraine, 5 April 2007, France-Ukraine.com

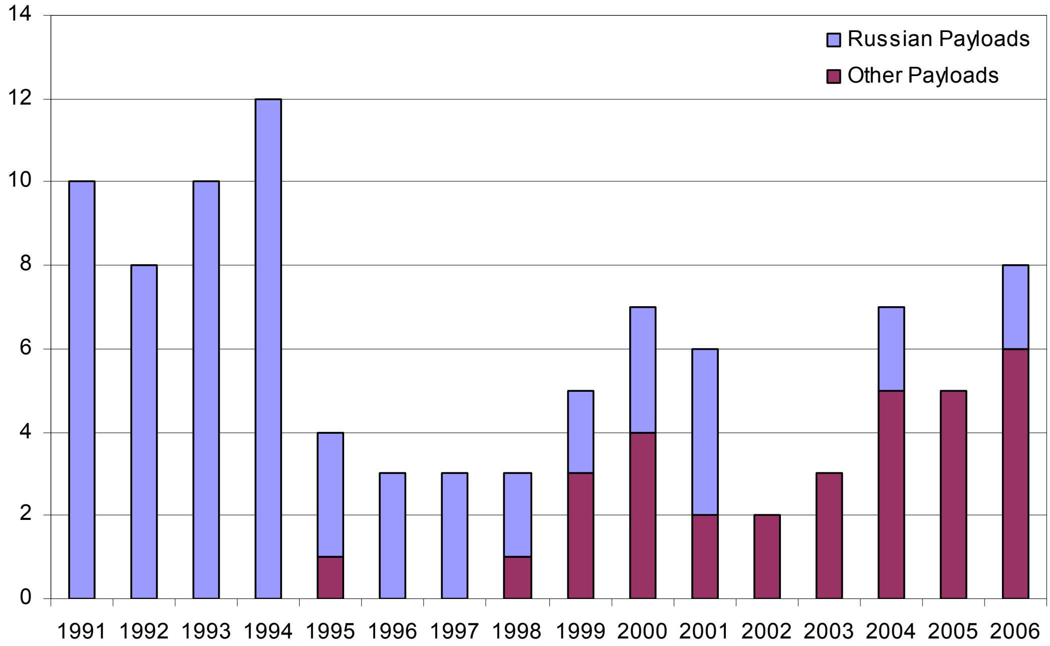


Figure 42: Payloads launched by launchers developed and manufactured in Ukraine

2.5.5. The interdependence with Russia

Ukraine and Russia are still very **interdependent** from an economic standpoint and this relationship is particularly reflected in the space sector.

In the past, the cooperation between Ukraine and Russia regarding space activities has been greatly facilitated by the good relations between Vladimir Putin and the former president of Ukraine, Leonid Kuchma, who made his career at Yuzhmash and left the position of Director General in 1992 to become the country's prime minister. The overall attitude of Russia towards Ukraine has changed since the Orange Revolution and the Ukrainian space sector remains today very dependent on Russia.

Russia is first of all the traditional partner: Ukrainian systems include many Russian components and subsystems. For instance, 70% of the Zenit launcher components (including the engines and the DMSL upper stage) are Russian. Russia is a partner in the main Ukrainian joint ventures, Sea Launch, SIS and ISC Kosmotras (Russia is even involved in the implementation of Cyclone 4 in Alcantara). Ukraine, which lacks a spaceport, depends on Russia for the cosmodrome of Plesetsk from which Cyclone 3 is launched. Russia also represents a market for the Ukrainian space industry. "Ukrainian" launchers put into orbit Russian payloads and Ukraine develops and produces spacecraft for Russia, like the ocean-monitoring satellites, Okean. Even after the disintegration of the USSR, Ukraine went on producing ELINT satellites for Russia which remained a unique example of a country acquiring such satellites for a foreign country. Lastly, Russia is also a competitor on the international market and is increasingly seen as such by Ukraine.

As shown on Figure 42, since Ukraine's independence, fewer and fewer Russian payloads are launched by launch vehicles built and manufactured in Ukraine.

The complex relationship between the two countries and their recent political evolutions could lead to an argument that Russia might want to "squeeze" the Ukrainian space sector and constrain it to become subcontractor, and no longer partner, in Russian-led projects.[74]

[74] Y. Zaitsev, "Squeezing Ukraine in Space", Reissued in Space Daily, 18 December 2005

3. The future of space activities in Ukraine

3.1. The main challenges

The main challenges for the future of Ukrainian space activities are of different nature but are strongly intertwined. Those are financial and human resources as well as the need for new projects.

3.1.1. Funding

Funding is the main challenge to the survival and development of the Ukrainian space sector. With the collapse of the Soviet Union, the main source of funding, i.e., the state orders, has dwindled and Ukraine is left with tremendous expertise and large capabilities to maintain. Moreover, the poor economic situation of the country allows only for a scanty budget for space activities, even if the maintenance of the sector has remained a priority.

Funding can then only come from abroad and, as a consequence, most of the production had to be exported. Ukraine had to find partners and managed, with the joint ventures created, to commercialise their main products, i.e., their launch vehicles.

Those foreign partners have allowed Ukrainian organisations to maintain their expertise and capabilities, which was the first, short-term priority. Launch vehicle commercialisation represents today more than 75% of the funding of space activities in Ukraine (see details in Appendix B).

But Ukrainian expertise and products are ageing and in the longer term Ukraine will need partners to develop large-scale cooperation on new developments in order to survive.

3.1.2. Human resources

The second major challenge that Ukraine will have to face is **human resources**. The workforce in the space sector is ageing, the average age in the space industry being 52. While the older generation is retiring and taking with it its expertise, the younger generation does not find space careers appealing. Companies already suffer staffing shortages. Those in the younger generation now have more career choice and are no longer attracted by the field, because of the low salaries and lack of prospects. Because of this, brain drain remains a serious threat for Ukrainian science and engineering in all domains. In addition to low numbers pursuing a space career, candidates tend to lack qualifications. The Ukrainian education system has suffered from the economic difficulties of the country.

3.1.3. The need for new projects

Due to insufficient funding, the prospects in the space sector are today limited. There are **no major developments under way or foreseen**; the only sizeable on-going efforts are the modernisation of an existing launcher, Cyclone, into the Cyclone-4 that should be launched from Alcantara, Brazil, as well as the modernisation effort of the ground facilities in Yevpatoriya.

Yuzhnoye does work on newer products, such as the new Mayak launchers, but will not be able to pursue those efforts without foreign partners. The only new development which Yuzhnoye might be able to pursue is a microsatellite production capability. Yuzhnoye got involved in microsatellites development quite recently. It won the contract for Egyptsat in 2001 (launched in April 2007), and plans to go on with those activities.

The absence of new large-scale projects has a significant negative impact on the attractiveness of the sector.

3.2. Options

Given the current situation and the challenges identified above, the options Ukraine has for the future of its space activities can now be analysed. There are three predominant scenarios to be considered:[75] **an independent Ukrainian space industry, the development of large-scale cooperation with a partner other than Russia, and the continuation of close cooperation with Russia**.

[75] A. Ionin, "Has Ukrainian Space a Future?", Export of Armaments, Number 2, 2005

3.2.1. An independent Ukrainian space industry

The lack of funding and internal market will prevent the Ukrainian industry from becoming independent in the short- and even medium-term. Compared to the new space-faring nations, i.e., China and India, Ukraine will not be able to have its own programme, even if it is trying to reduce its dependency on its partners, especially Russia.
One of the main weaknesses of Ukraine will remain its lack of spaceport. Ukraine is the only space faring nation without its own spaceport and even if it develops air-based launch, as proposed by Yuzhnoye, it will remain dependent on other countries for the majority of such launches.

3.2.2. Development of large-scale cooperation with new partners

Apart from Sea Launch, the main projects are done in cooperation with Russia. Ukraine is looking for other partners in order to diversify its partnerships and limit its dependency on Russia. Specifically, it is looking for partners in order to develop joint ventures for new launchers as well as in the fields of satellites. Ukraine could join traditional partners, the United States or Europe, but also new partners that are not yet involved in space (this last situation could create a risk of sensitive technology transfer).
Europe is the favoured partner as this is where the current leadership leans towards. The question is then what Ukraine has to offer to those partners. The Ukrainian industry can certainly produce well-proven systems at low prices but its ability to innovate under the current circumstances is uncertain.

3.2.3. Continuing the cooperation with Russia

The last option, and the most likely, is to continue working with Russia with the risks involved. Since Ukraine leans to the West, Russia is getting more and more independent from Ukraine. Russia is actually developing new systems which could replace the ones they get form Ukraine. An example of this tendency is the development and production of new Russian Topol-Bulava missiles in Russia without the help of the Dnipropetrovs'k experts.
This option is particularly critical in the context of the rise of the new space-faring nations, China and India, which might offer, in the next decade, launchers for a better quality/price ratio and this competition might be fatal to the Ukrainian space sector if Russia decides to limit its cooperation with, or even no longer rely on, Ukraine.

4. Cooperation with Europe - Opportunities and challenges

4.1. Rationales for cooperation

As underlined in the recent report of the Interparliamentary European Security and Defence Assembly,[76] **the main rationale for the European Union to cooperate with Ukraine is political**. The EU has initiated political steps towards Ukraine, which has become a **priority partner of the EU Neighbourhood Policy**. The EC is now **trying to involve operational agencies** in the next steps. Furthermore, Ukraine has already demonstrated its ability to cooperate with international partners with its participation in several international programmes and joint ventures like Sea Launch.

When considering potential cooperation, the first relevant element of the European situation is the overcapacity of its space industry. Europe already has an industry that is oversized for today's market and is unlikely to cooperate with Ukraine on products that it already has difficulties in selling. Second, Europe has chosen to maintain an independent access to space. Thus, for the time being, the Europeans will certainly not develop any cooperation that would make them dependent on Ukraine for accessing space. Finally, Europe has already developed relations with Russia, in particular with the projects Soyuz in Kourou and Oural, which tend to be considered as excluding relations with Ukraine for now.

From a Ukrainian perspective, launchers remain the priority. They also consider developing joint ventures for the commercialisation of their satellites, on the same model they used for launch vehicles. The industry has been encouraged to look for European partners. But the industry is looking for different partners, so that there will probably be no exclusivity in any relationship.

[76] "Ukraine's Aerospace Industry – Cooperation with Europe", Technological And Aerospace Committee of the Interparliamentary European Security and Defence Assembly, Document A/1947, 20 December 2006

4.2. Challenges to Europe-Ukraine cooperation

4.2.1. Different definitions of cooperation

The first problem when considering the cooperation between Ukraine and Europe is semantic. Ukrainians and Europeans do not have the same **definition of** what **cooperation** is and, to a certain extent, this difference has prevented the development of closer relationships between them. On the one hand, Europeans are looking for cooperation based on a non-exchange of funds. Alternatively, Ukrainians, like Russians, tend to call cooperation the sheer sale of their technologies and products. Both definitions are hardly compatible and as a result cooperation is today still limited, especially on a large scale as it would require funds that Ukraine cannot provide.

4.2.2. Lack of transparency and long-term vision

The **lack of transparency** of the Ukrainian space enterprises is also a major obstacle to cooperation. Another important challenge is the lack of long-term, even medium-term, visibility on the future of the Ukrainian space activities. Even Ukrainians cannot say what the sector will look like in a decade as Ukraine does not have the key to its future, which is partly in the hands of Russia. This lack of long-term vision hinders cooperation even on small space projects, which usually last several years.

4.2.3. Will Ukraine's competitive advantage last?

In the context of the rise of new space faring nations from the developing world, **the competitive advantage of Ukraine might not last**. As explained earlier, production costs in Ukraine are increasing. As a result, the rationale for cooperation with Ukraine, based on their lower production costs, might not remain valid in the close future, which limits their attractiveness for international partners in the present context.

4.2.4. Language problems

Despite their long experience in international relations, there are still issues that impede cooperation with Ukraine, the first of them being language. Communicating in languages other than Ukrainian and Russian is still difficult as most people do not speak much English, but it should become less of a problem if the younger generations join the aerospace workforce, in spite of the limited attractiveness of the sector.

4.2.5. The issue of missile proliferation

One issue of concern for potential European partners that might influence the cooperation in a field of dual-purpose systems is the risk of missile proliferation. The economic difficulties the country has undergone and the ineffective export controls resulted in missiles and technologies transfer. Despite its participation in the MTCR, which it joined in 1998, Ukraine is still suspected of arms transfer towards failed states and conflict zones. Shortly after being elected president, Yuschenko admitted in 2005 the export of cruise missiles to Iran and China in 2001. The level of involvement of the public authorities in the various cases reported since independence is not clear. Furthermore, questions were raised as to a possible support from Ukrainian scientists to China, North Korea and Iran in their efforts to develop missiles[70].

4.3. Potential opportunities and mechanisms for cooperation

4.3.1. Cooperation supported by the European Union

The European Union and its members support Ukrainian scientists and engineers and their integration in international projects through different channels. Those mechanisms have in common an effective and flexible management by Western teams, which is much appreciated by Ukrainian research teams. They will have to evolve but such avenues should be continued in the space fields as well as in other areas.
A first means to support science in Ukraine was the **International Association for the Promotion of Cooperation with Scientists from the New Independent States (INTAS)**, an international non-profit association that promoted East-West scientific cooperation. INTAS has jointly funded a variety of initiatives with other organisations, namely CNES and ESA in the space field. For legal reasons, this successful programme will terminate with FP6 activities but its functions and expertise might be preserved during the FP7 in a new arrangement within the EC.
Another mechanism supported by the European Union within the DG Research is the **Science and Technology Centre in Ukraine (STCU)** that aims to assist former Soviet experts in weapons of mass destruction in the transition to peaceful research activities. The mission of STCU is likely to evolve in the coming years and should support increasingly the integration of scientists and engineers from the former Soviet countries in international projects.
More details on those programmes can be found in Appendix B.

4.3.2. Participation in EU programmes

The political framework for the cooperation between EU and Ukraine is the European Neighbourhood Policy and, in particular, an agreement covering science and technology. Apart form INTAS, Ukraine's participation in the sixth Framework Programme has been very limited but should increase in the **seventh Framework Programme**. As an International Cooperation Partner Country (ICPC), Ukraine could benefit from dedicated actions and calls in thematic areas, including the space area. A large share of the FP7 activities is related to GMES which, as described below, is a topic of interest to Ukrainian scientists and engineers.

4.3.3. Participation in ESA programmes

First of all, there is today **no framework for cooperation between ESA and Ukraine**. A framework agreement between the Ukrainian government, or Cabinet of Ministers of Ukraine, and ESA is under preparation and could be signed in 2007. But even if this agreement might facilitate any cooperation, the opportunities would remain limited as Europe's policies hinder cooperation in major fields.
Ukraine's priority is launchers. But Ukraine and Europe are competitors on that market and the access to space is of strategic importance to Europe. Europe's decision to achieve independent access to space and of cooperation with Russia **deters cooperation with Ukraine in that field, at least for heavy launchers.** Ukraine has technologies

that Europe does not have (such as certain types of propulsion systems or material technologies), but it does not have technologies that are today critical for the implementation of the European Space Programme. Moreover, Ukraine and Europe have made different technological choices, for instance on propulsion. Ukraine is using mainly kerosene engines, because its launch vehicles are derived from their former missiles that were based on that technology. Europe has chosen for many reasons a more environmentally-friendly propulsion technology with liquid oxygen and hydrogen. **Opportunities might exist in smaller launchers**, as demonstrated by the cooperation on Vega, but the development of new launchers is obviously infrequent.
Concerning the launch market, it would be in both parties' interest to increase discussion on how to better organise the launch market, especially in the context of the rise of new space faring nations.
The main opportunities for cooperation are offered by new programmes and the joint EU/ESA applications programmes.
The most favourable field for cooperation between ESA and Ukraine is **science**. In particular, Ukraine has well-recognised expertise in astrophysics, astronomy, magnetospheric and ionospheric research, and in life sciences in microgravity conditions. The ideal case would be that complementary missions are built and data shared. The Yevpatoriya ground facilities that are being modernised could also be used to support European scientific missions. Another potential field of cooperation is exploration. Ukraine already expressed its interest in participating in the American or European exploration programmes and Europe might consider cooperating with Ukraine in that field. Ukraine was actually invited to participate in the space exploration strategy workshop organised by ESA in Edinburgh in January 2007. One of the Ukrainian proposals to potential partners is a lunar orbital mission based on Dnepr and the Block E developed in the sixties for a Soviet lunar mission.

4.3.4. Participation in the joint EU/ESA programmes

The field of **applications** is more favourable to cooperation than space hardware development and production, on which Ukraine and Europe are direct competitors. However, this domain has not been a priority for Ukraine so far, as demonstrated by the lack of benefit Ukrainian citizens derive from space activities. It is a field in which the barriers to entry remain rather low, so that Ukrainian companies, even SMEs, could develop with limited initial funds, but developing such applications will obviously not help Ukraine maintain its large industrial infrastructure.

- Galileo

Ukraine has several operational ground stations that could be used for Galileo in the future. An agreement between the EU and Ukraine on Galileo and EGNOS was signed in December 2005. Ukraine was the third non-EU country after China and Israel to sign such an agreement. According to the agreement, Ukraine should participate in the development and management of the Galileo system while receiving EU funding. Such an agreement offers Ukrainian companies opportunities to participate in new international projects and to cooperate with foreign partners. The Ukrainian agency is currently preparing its strategy regarding Galileo and should submit it in the coming months to the EU Directorate for External Relations. Ukraine could support Galileo and EGNOS principally with ground systems.

- GMES

Ukraine is interested in developing capabilities complementary to and compatible with GMES and GEOSS, and is making a step towards Europe by launching the project Geo Ukraine, which aims at becoming the Ukrainian segment for GMES. A regional GMES service centre could be created in Ukraine. Geo Ukraine is one of the two projects common to NSAU and the National Academy of Sciences of Ukraine (NASU). Each organisation will contribute 10 million hryvnas (about 1.5 million euros) in order to jointly fund GMES-related R&D projects. Those projects will cover topics like disaster management, Black Sea monitoring, crop monitoring, atmospheric and environmental load (such as pollution) monitoring. The FP7 activities related to space comprise a large share of GMES projects and Ukraine hopes to participate in such projects and benefit from those activities through EU funding.

Conclusions - Recommendations

Ukraine is a **major space nation** with significant know-how but its space activities **lack funding and markets**. As a result the future of the Ukrainian space sector remains **uncertain**. Ukraine is looking for new partners in order to limit its dependence on Russia and is trying to move closer to Europe. On the other hand, Europe has taken political steps towards Ukraine, which has now become a priority partner in the European Neighbourhood Policy, and the "operational" agencies are expected to take similar steps. Space is a strategic field for both Ukraine and Europe and both parties could benefit from cooperation in that domain.

Large-scale cooperation is for now excluded. Cooperation on a non-exchange of funds basis is prevented by the lack of funding, and the creation of European-Ukrainian joint ventures is unlikely, in particular, for launch vehicles. Europe and Ukraine are competitors on that market and, given the industry overcapacity and the European policy of independent access to space, European companies are not interested in creating joint ventures with Ukraine to commercialise new launchers or even satellites. Ukrainian enterprises could get involved in large scale projects but either as subcontractors, like for Vega, or if they bring one of the building blocks of a large programme. Otherwise cooperation will take place only on small-scale projects. Today the **main opportunities for cooperation are in space science and applications.** Ukraine could participate in European scientific missions in various fields. It could use or develop space and ground segments that would complement the ESA ones and data could be shared. Then, Ukraine could get involved in applications, and in particular in Galileo and GMES, which could support the national policies and deliver benefits to its citizens.

This cooperation would certainly be facilitated by the development of a **political framework**, i.e., ESA-Ukraine agreement, and by the **EU twinning action**, as well as by the adoption of the Fourth National Space Programme by the next parliament. **However, any political framework is likely to remain an empty shell if,** despite the efforts made by the Ukrainian administration in the twinning programmes, **no operational activities are undertaken**. **Dedicated actions with Ukraine in the space thematic area in the FP7, as well as actions that would follow-up on INTAS mechanisms would also support cooperation** in the field of science and applications (GMES) **and a further integration** of the Ukrainian research teams in the European research community.

Appendix A

Fact Sheet on Ukraine

UKRAINE

Ukraine[77]

KEY DATES

November 2004 - January 2005	Orange Revolution
June 1996	Adoption of the Constitution of Ukraine
December 1991	Formation of the Commonwealth of Independent States
December 1991	First presidential elections
August 1991	Declaration of Independence

POPULATION[78]

47,110,920

POLITICS

Government type
Republic under a semi-presidential system

Executive branch
- Chief of state: President Viktor A. Yushchenko (since 23 January 2005)
- Head of government: Prime Minister Viktor Yanukovych (since 4 August 2006)

Elections
- President
  - Elected by popular vote
  - 5-year term
  - Eligible for a second term
  - Last successful election held in December 2004 after invalidation by the Supreme Court of the November 2004 elections (next election to be held 2009)
- Prime minister appointed by the majority in the parliament

Legislative branch
Unicameral Supreme Council (or Verkhovna Rada)
  - 450 seats

[77] Map Collection, Perry-Castañeda Library, University of Texas

[78] 2005, Source The World Bank

- Allocated on a proportional basis to those parties that gain 3% or more of the national electoral vote
- Five-year terms
- Last elections held in March 2006

Note: The parliament is likely to be dissolved in April 2007

ECONOMY

GDP (Purchasing Power Parity) [79]	$320.5 billion PPP
GDP at current prices[3]	$81.7 billion
Real GDP growth rate	2.6% (2005)[80] - 5% (2006 est.)[81]
GDP per capita (PPP)[3]	$6,803 PPP
Budget[82]	Expenditure: $37.48 billion Revenue: $36.34 billion
Public debt[83]	19.4% of GDP
Inflation rate[84]	10.8%
GERD[85]	1.32% of GDP
Unemployment rate[86]	2.9% officially registered (according to ILO the real rate is around 9-10%)
Economic aid EU Technical Assistance[87]	151.9 million euros (2005) ~2.5 billion euros (1991-2006)
Military expenditures[88]	1.4% of GDP

[79] 2005, World Bank
[80] Source Bulletin of the National Bank of Ukraine, September 2006
[81] Source IMF
[82] 2005, Source Ministry of Finance
[83] 2005, Source IMF
[84] 2006 Estimate Inflation rate (CPI), Source Bulletin of the National Bank of Ukraine, September 2006
[85] 2005 Gross Domestic Expenditure on R&D, Source The State Statistics Committee of Ukraine
[86] 2006 Estimate, The World Factbook, CIA
[87] Source European Commission DG External Relations
[88] 2002, The World Factbook, CIA

Appendix B

Space Activities and their Environment

in Ukraine

1. The space activities in Ukraine

1.1. Institutional framework

The main institution responsible for space activities in Ukraine is the National Space Agency of Ukraine. In addition, the National Academy of Sciences supervises space research in its institutes. The Agency and the Academy have joint space research institutions.

1.1.1. National Space Agency of Ukraine (NSAU)

The National Space Agency of Ukraine, established in February 1992, is responsible for space activities in Ukraine. In July 1997, a presidential decree "On the Statute of the National Space Agency of Ukraine" defined NSAU as the central executive authority that should guarantee the implementation of the national space policy, supervise Ukrainian space activities and be responsible for the sector.
NSAU activities are coordinated by the Cabinet of Ministers. According to a decision of the Cabinet of Ministers in February 2006, they were coordinated via the Minister of Industrial Policy, but NSAU regained its initial status soon after.
NSAU's mission is to develop the national space policy, both in peaceful uses of space and security applications, to organise and develop space activities, to contribute to state national security and defence capability and to organise and develop Ukraine's cooperation with other states and international space organisations.
Its tasks include the development of the National Space Programme of Ukraine, with the National Academy of Sciences and other ministries. It also participates in drafting international space agreements. Moreover, NSAU is the main contractor for Ukrainian space activities and conducts and coordinates launches, spacecraft control activities, space data receiving and processing. Furthermore it is responsible for the licensing of space activities and spacecraft registration.
Finally, NSAU is responsible for about 30 design offices, research institutes and enterprises that represent most of the sector in Ukraine. Indeed in 1999 the status of NSAU was modified and the main organisations of the sector were subordinated to it. A year earlier, the Russian space sector had been subordinated to the Russian Space Agency. NSAU appoints the executives of those state-run organisations, defines their budget and activities, distributes state contracts and participates in their commercial projects as a partner. It is also responsible for the conversion of those space enterprises.
The structure of the agency is presented on Figure 43. About 115 people work at NSAU headquarters in Kiev, to which should be added the employees of the Yevpatoriya Centre.

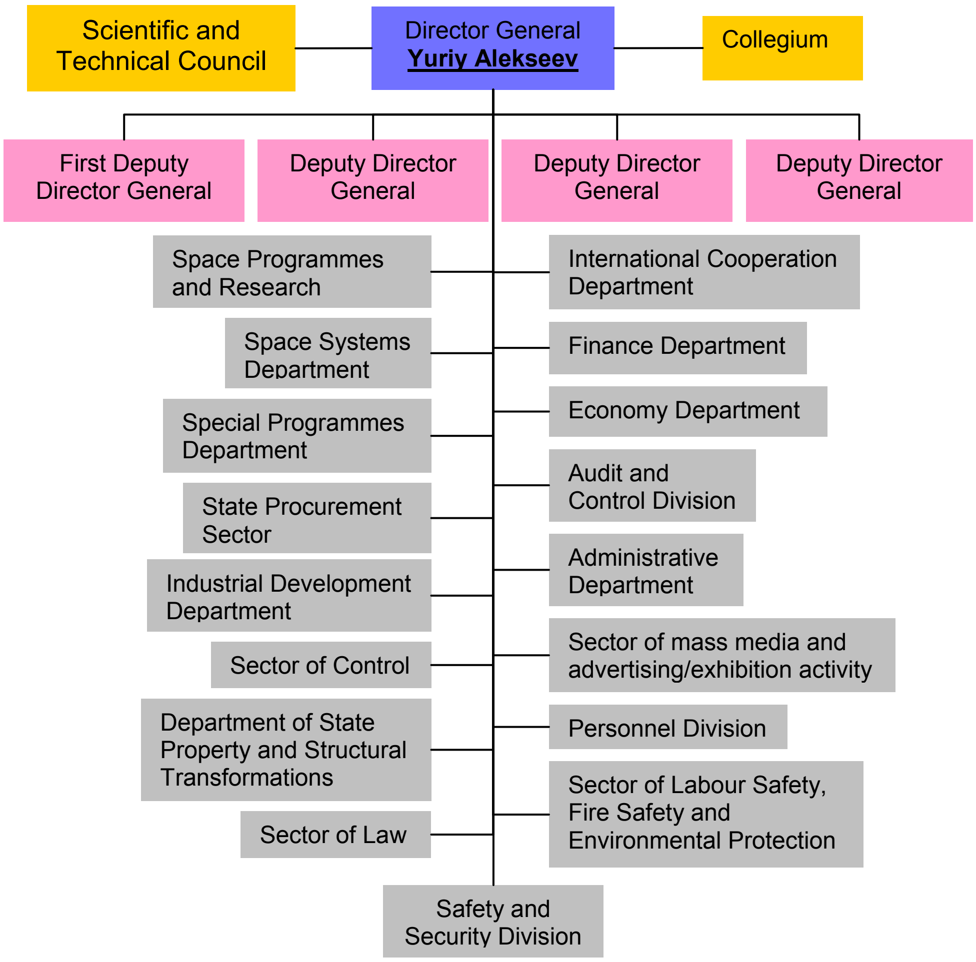


Figure 43: Structure of the NSAU

1.1.2. National Academy of Sciences of Ukraine (NASU)

Established in 1918, the National Academy of Sciences of Ukraine is the highest research organisation in Ukraine. It conducts, organises and coordinates fundamental and applied research and is responsible for making basic research policy. It comprises about 170 institutes and other research institutions, with over 13,000 researchers.
The Academy is self-governed but reports to the Cabinet of Ministers about its results and the use of funding from the national budget.
It has today 14 departments divided in three sections, as presented in Figure 45. The main institutes with space-related activities belong to the divisions of physics and astronomy and of atomic physics and energy (see details in 1.3.3).

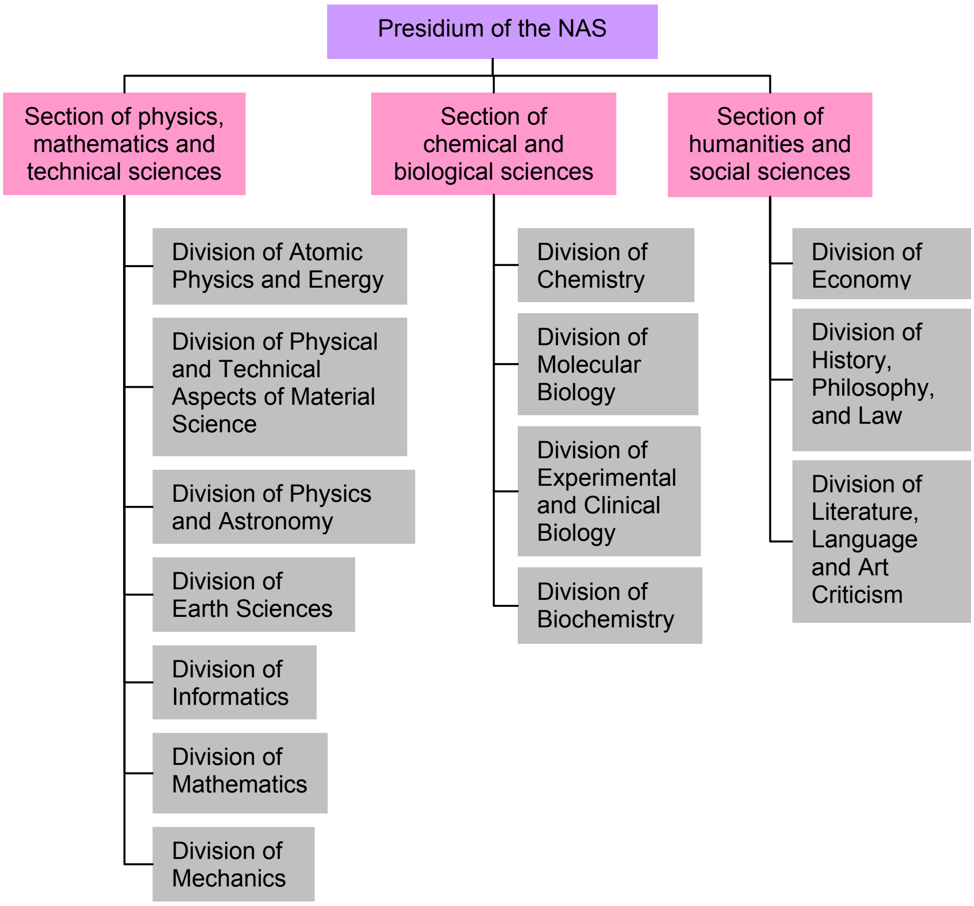


Figure 45: Structure of the National Academy of Sciences of Ukraine

1.2. Financial framework

1.2.1. R&D in Ukraine

Historical perspectives
Ukraine inherited about 15% of the scientific and engineering potential of the USSR, but about 20% of its experimental facilities. Ukraine has been a leader in various research areas, in particular space, theoretical physics, mathematics, biotechnologies and materials (welding, coatings, etc.).

R&D Expenditures
In 2005, the R&D expenditures in Ukraine amounted to about 85 million euros. As detailed in Table 28, in the past decade the level of R&D expenditure has remained fairly low, between 1.1 and 1.4% of the GDP. Moreover, alternative analyses argue that actual numbers might be even lower.

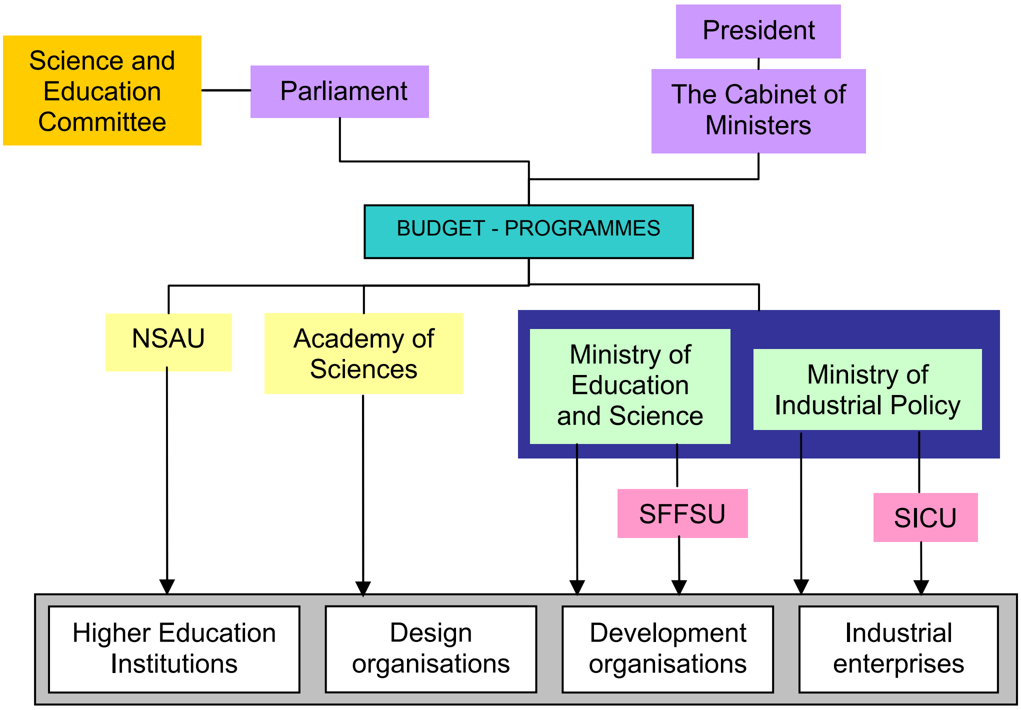
1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1.38	1.36	1.22	1.20	1.14	1.13	1.11	1.24	1.19	1.13

Table 28: Level of the R&D expenditures in Ukraine (as a percentage of the GDP)[89]

R&D Policy-making and funding mechanisms
As presented in Figure 45, the main players in the science and technology policy in Ukraine are:
- The Verkhovna Rada (Parliament), which approves the national priorities and programmes and is supported by its Science and Education Committee

[89] The State Statistics Committee of Ukraine

- The Cabinet of Ministers, which devises science and technology policy, submits recommendations on priorities to the parliament and is responsible for the implementation of the national programmes
- The Ministry of Education and Science, which coordinates the implementation of science and technology activities



SFFSU: State Fund for Fundamental Studies of Ukraine
SICU: State Innovation Company of Ukraine

Figure 45: The science and technology system in Ukraine

The main sources of funding for science and technology, and especially R&D, are the Ministry of Education and Science and its Fund for Fundamental Studies, the State Innovation Company of Ukraine and the Academy of Sciences.

- The Ministry of Education and Science

The Ministry was given a budget of 6.9 billion hryvnas (about 1 billion euros) in 2007. The Ministry includes a dedicated Research Development Department and an Innovation Development Department as well as an International Cooperation Department. It oversees applied and fundamental research, especially in higher education institutions. Its State Fund for Fundamental Studies of Ukraine supports research activities by granting on a competitive basis financial support to fundamental research projects.[90]

- The State Innovation Company of Ukraine

The State Innovation Company of Ukraine (SICU)[91] was established in 2000 under the responsibility of the Ministry of Industrial Policy and replaced the State Innovation Fund of Ukraine as a financial credit organisation that supports innovation projects.

- The National Academy of Sciences of Ukraine

The 2007 budget of the Academy of Sciences is about 1.4 billion hrvynas (about 220 million euros), which represents 75% of its funding as detailed on Figure 46.

[90] http://www.dffd.gov.ua/en/index.php?nn=13
[91] http://www.udik.com.ua/eng/

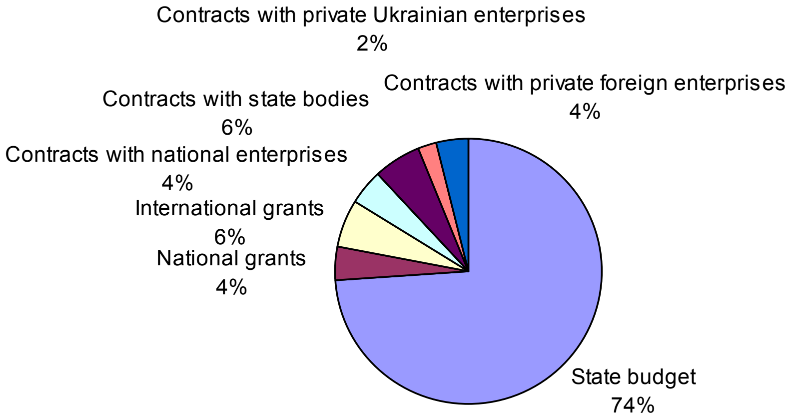


Figure 46: Sources of the funding of the Academy of Sciences

As mentioned above, the Academy conducts and coordinates fundamental and applied research in its numerous institutes.

- Foreign support to R&D

The International Association for the Promotion of Cooperation with Scientists from the New Independent States

The International Association for the Promotion of Cooperation with Scientists from the New Independent States (INTAS) was founded in May 1993 as an international non-profit association formed by the European Community, European Union Member States and like-minded countries to promote East-West scientific cooperation between INTAS members and INTAS-NIS partner countries. It has been in liquidation since January 2007.

INTAS has funded many Ukrainian research teams. From 1993 to March 2005, it has funded 2,792 Ukrainian research projects, worth about 200 million euros, and granted more than a thousand fellowships. The European Union provided 93% of INTAS budget; the remaining 7% came from EU member states, partner countries and European organisations.

The Science and Technology Centre in Ukraine

The Science and Technology Centre (STCU) in Ukraine was established in 1993 to support research and development activities for peaceful applications by Ukrainian, Georgian and Uzbekistani scientists and engineers formerly involved with the development of WMD and their means of delivery. It aims at assisting them in the transition from a military to a civil, market-oriented environment. Since 1993, private companies and government agencies from the European Union, United States, and Canada have used the STCU to manage over a thousand R&D projects, worth over 150 million dollars. The STCU has awarded research grants, training and travel grants and provided scientists with commercialisation and patent support.

NATO Science for Peace[92]

NATO also supports Ukrainian researchers within the framework of its Science for Peace and Security (SPS) programme. This programme is administered by the Science for Peace and Security Committee, which is the result of the merger of the NATO Science Committee (SCOM) and the Committee on the Challenges of Modern Society (CCMS) in June 2006. The SPS programme supports cooperation in civil science and innovation, with a focus on security and environmental sustainability. It includes grants, training and workshops, funded by NATO, as well as by partner countries like Ukraine.

Civilian Research & Development Foundation [93]

The Civilian Research & Development Foundation (CRDF) is a non-profit organisation established in 1995 by the US National Science Foundation. It promotes international scientific and technical collaboration, primarily between the United States and Eurasia, through grants, technical resources, and training.

CRDF's mission is to:

[92] http://www.nato.int/science

[93] http://www.crdf.org

- Support research projects that offer scientists and engineers alternatives to emigration and strengthen the scientific and technological infrastructure of their home countries
- Aid the transition of foreign weapons scientists to civilian work by funding collaborative non-weapons research and development projects
- Help move applied research to the marketplace and bring economic benefits both to the United States and the countries with which CRDF works
- Strengthen research and education in universities abroad

CRDF has offices in Russia and in Kiev, Ukraine.
In Ukraine, the CRDF works with the Ministry of Education and Science to develop and implement joint scientific programs. Since 1996, it has awarded more than 500 grants, involving more than 2,000 Ukrainian researchers, and committed more than ten million dollars. Additionally, the Ukrainian government has committed almost two million dollars to further support those projects.

1.2.2. Space activities budget and funding mechanisms

The national budget funds space activities but commercial contracts represent the main source of funding. To give an order of magnitude, Figure 47 represents a rough distribution of the sources of funding for space activities in Ukraine.

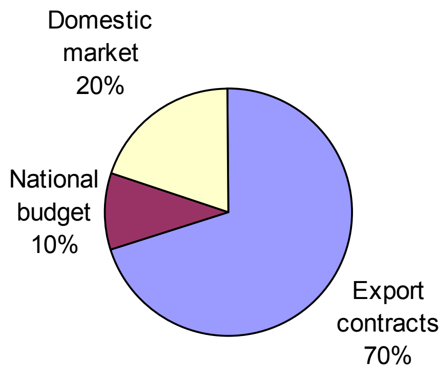


Figure 47: Sources of funding for space activities in Ukraine

<u>NSAU Budget</u>
The official NSAU budget for 2007 is 333.5 million hrvynas (about 52 million euros). 150 million hryvnas (about 23 million euros) should be annually added to the NSAU budget for the conversion and modernisation of the ground facilities in Yevpatoriya.
In current prices, NSAU's budget is slightly more than the space budget of Finland or Norway, but at purchasing power parity it is equivalent to the space budget of Belgium. This budget represents 0.06% of the Ukrainian national budget. As a percentage, the Ukrainian situation is comparable to countries like Germany, despite the latter's space budget being ten times the size.
As presented in Figure 48, this budget has increased by more than 40% from 2005 to 2006 but has then slightly decreased from 2006 to 2007. NSAU's objective is to triple its budget, up to 1.5 billion hrvynas (300 million euros) a year, but it appears today as unrealistic.

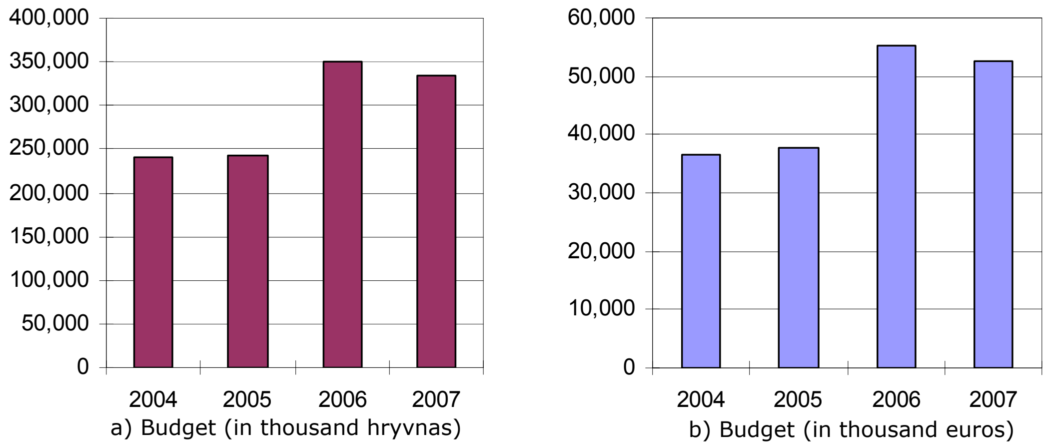


Figure 48: Evolution of the NSAU budget

However, one should bear in mind that a large share of the NSAU budget is used for activities that are not directly space-related. NSAU undertakes activities of the National Space Programme as well as its own activities, and, as presented in Table 29 and Figure 49, some of its own activities are not linked to space per se. In fact, NSAU bears the responsibility for the sector transition from military to civil applications. As detailed in Table 29, the 2007 NSAU budget includes the disposal of both weaponry and solid rocket fuel. The NSAU "space-related budget" is then closer to the space budget of Denmark at current prices and to that of Switzerland at PPP. As a percentage of the national budget, the Ukrainian "space-related budget" is closer to that of Denmark.

Administration	19,507
R&D	659
Space education	2,500
National Space Programme	65,000
Spacecraft development, manufacturing and testing	87,380
Solid rocket fuel disposal	60,000
"Cyclone 4"	56,622
Reconstruction of the Yuzhmash power plant	15,816
Disposal of out-of-use weaponry	26,000
TOTAL	**333,485**

Table 29: 2007 NSAU Budget (in thousand hrvynas)

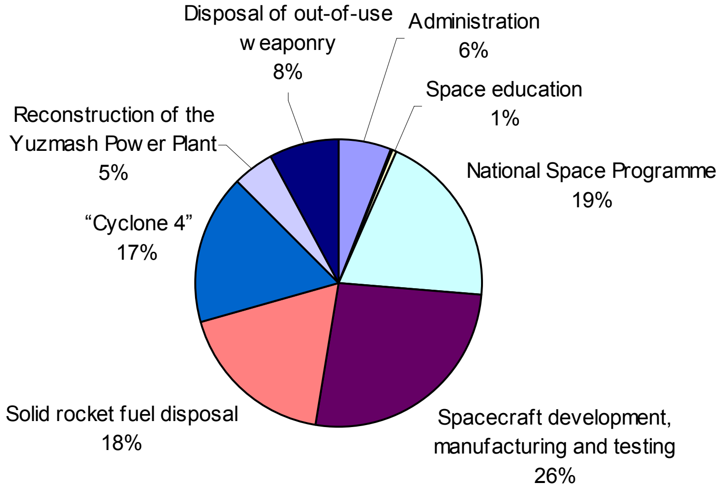


Figure 49: NSAU budgeted expenditures for 2007

Moreover, an audit of the Accounting Chamber of Ukraine detected a number of flaws in financing and use of the budget funds in the space industry. The lack of proper financing for space activities from the national budget, the irrelevant tasks NSAU has to fulfil, as well as its lack of control on the enterprises of the sector are some of the flaws listed in the results of the audit.[94]

The NSAU budget for 2007 will be used to achieve the following priorities, defined by its Collegium:
- to approve the Fourth National Space Programme (2007-2011)
- to implement the joint Ukraine-Brazil Cyclone 4 project
- to arrange for Egyptsat launch
- to arrange for Sich-2 launch (planned for the first half of 2008)
- to further implement the Programme on Utilization of Unserviceable Solid Missile Fuel and Conventional Ammunition
- to strengthen and widen international cooperation with Russia, the USA, China, ESA and other countries from Europe, Asia and Latin America
- to implement activities increasing the enterprises' profitability
- to provide growth of the production volume and wages for the space industry enterprises' workers
- to elaborate and sign the Industry Agreement for 2007-2009 between the NSAU and the Ukrainian Space and General Engineering Trade Union
- to implement activities on the space industry restructuring and development in accordance with the approved Programme

The National Space Programmes
Space activities in Ukraine are conducted in accordance with the National Space Programme, which is approved for a four-year period by the Verkhovna Rada (parliament) of Ukraine.
The First National Space Programme (1993-1997) was devoted to preservation of the scientific and production potential of the space industry in the interests of the national economy and security of the country, as well as the promoting Ukraine's entry into the international market of space services. The Second Programme (1998-2002) was aimed at establishing the domestic market of space services, introducing their own products and services in the international market, and integrating Ukraine into the international space community. The objective of the Third Programme (2003-2007) is the development of space technologies, taking into account the new trends in space activity and the needs for economic and scientific/technical progress of the country. It includes the following activities:
1. Scientific space research
   - Studies of Earth and its environment
   - Astronomy and astrophysics
   - Life sciences and microgravity
2. Remote sensing of the Earth
3. Satellite telecommunication systems
4. Development of the ground-based infrastructure for navigation and special information system
5. Space activities in the interests of national security and defence
6. Space complexes
   - Launchers
   - Spacecraft
7. Development of base elements and advanced space technologies
   - Avionics
   - Propulsion
   - Materials and technological processes
8. Development of research, test and production base of the space sector

The allocation of the budget for the Third National Space Programme (2003-2007), presented in Figure 50, shows the importance recently given to applications.

94 "To make space flight needs earthwork", Official Announcement of the Accounting Chamber of Ukraine, February 10th, 2006 - http://www.ac-rada.gov.ua/achamber

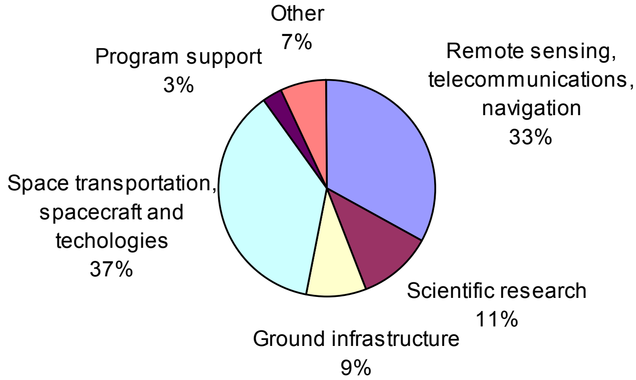


Figure 50: 2003-2007 National Space Programme Budget

The allocation of the budget for 2006 only, presented in Figure 51 in a different way than in Figure 49, shows the importance of technologies development and spacecraft manufacturing.

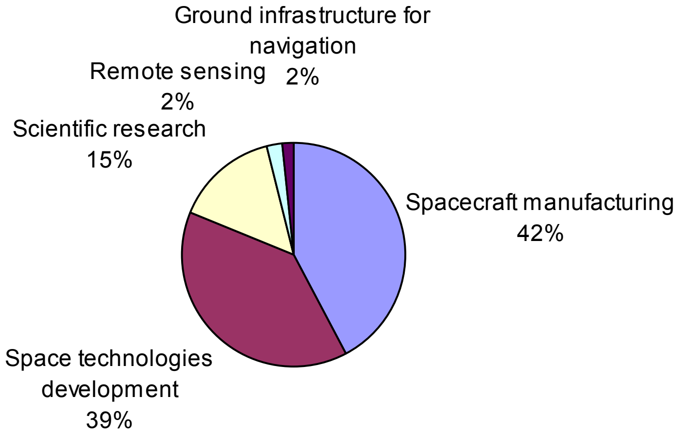


Figure 51: Budget allocations for the National Space Programme in 2006

The Fourth National Space Programme (2007-2013) is currently being prepared. This new Programme will aim at addressing Ukrainian citizens' needs, developing high technologies and strengthening international cooperation.

Academy of Sciences
The Academy of Sciences funds space-related activities and has three joint institutes with NSAU: the Technical Mechanics Institute (Dnipropetrovs'k), the Space Research Institute (Kiev) and the Lviv Space Research Institute (Lviv).

<u>Funding mechanisms for space activities</u>
The main stakeholders of the Ukrainian space sector are presented on Figure 52. First, the president of Ukraine influences space activities mainly through presidential decrees. More than a dozen space-related decrees have been issued since 1991. Since February 2006, the president is advised by a Commission on space activities. In addition to the presidential decrees, the Cabinet of Ministers adopts resolutions that also regulate the Ukrainian space sector. The national budget is adopted by the Parliament. This includes the budget of the NASU and NSAU and the budget of the multi-annual National Space Programmes. NSAU has the responsibility of drafting the National Space Programme, in concordance with the Academy of Sciences and other ministries, and submitting it to the Cabinet of Ministers. The Programme is then approved by the parliament. In addition to the organisations that each of them supervises, NSAU and NASU have joint institutes, i.e., they commonly appoint their executives and co-fund them. They also have a joint coordination council and ad hoc joint working groups (such as the one formed for the Ukrainian experiments on-board ISS). Moreover, NASU has its own advisory body on space, the Space Research Council. As detailed in Figure 51, NSAU works with various ministries and their academies or institutes. An inter-ministerial body dedicated to Earth Observation coordinates such activities between the various ministries.

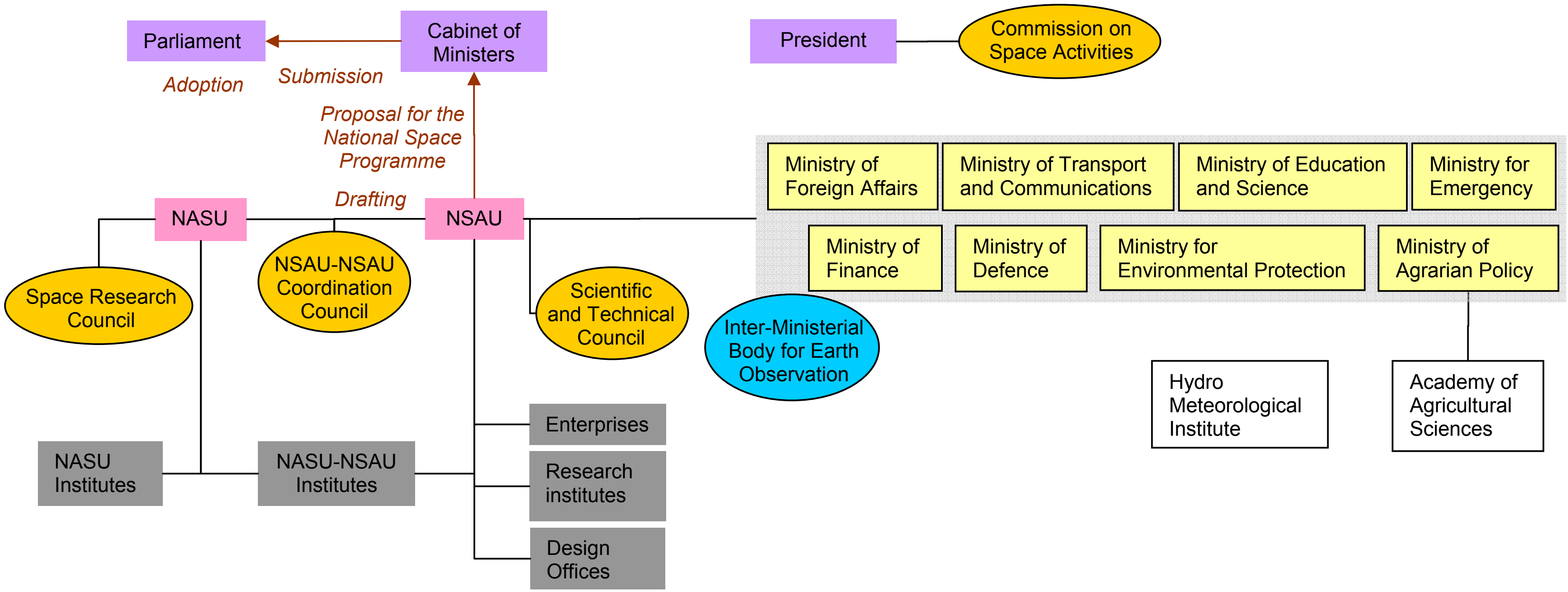


Figure 52: Space activities in Ukraine - The main stakeholders

Commercial activities
Commercial contracts are the main source of funding and launch services are the most profitable field of those commercial space activities.
In 2006, the commercial production from the Ukrainian space industry amounted to 1.88 billion hrvynas (about 300 million euros), which represents an increase of 31.5% in comparison with 2005. One must keep in mind that companies that are included in the Ukrainian space industry also sell products that are not space-related. For instance, Yuzhmash produces rockets and spacecraft but also buses and tractors, etc. In terms of production volume, space and special products represented 63% of the total volume produced by the so-called space sector in 2005. The same year, those enterprises made a profit of 11.4 million hrvynas (1.8 million euros).

1.3. Scientific and technical capabilities

1.3.1. Main achievements

The list of space-related achievements of Ukraine during the Soviet era and since its independence is long. Only the main milestones are listed below.

The Soviet era
During Soviet times, the main space products of Ukraine were strategic missiles and military satellites. Over 40 years, Ukrainian enterprises developed four generations of strategic missiles and produced more than 10,000 ballistic missiles.

1946 The development and production of the first Soviet missiles was assigned to a newly established design office headed by Chief Designer Korolev in Dnipropetrovs'k
1954 An independent design office, Yuzhnoye, was established at the missile plant
1957 The first Yuzhnoye-Yuzhmash missile was launched (SS-4)
1962 The first Yuzhnoye-Yuzhmash launch vehicle (SL-7) injected into orbit the first Yuzhnoye-Yuzhmash spacecraft (DS-2)

All the missiles developed and produced after the SS-4 are presented in Figure 53.

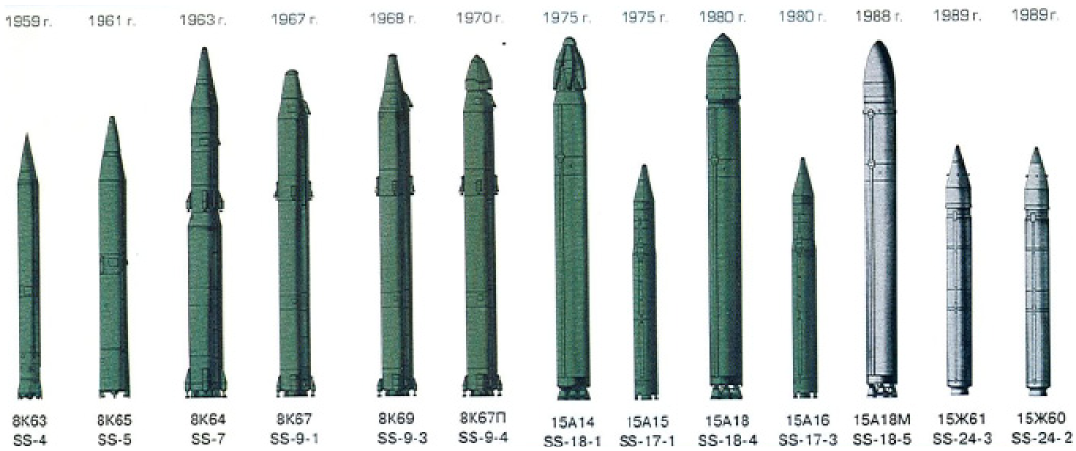


Figure 53: Strategic missiles developed by Ukraine[95]

The independent Ukraine
After the disintegration of the Soviet Union, Ukraine inherited between 15% and 30% of the Soviet space potential, mainly military potential.
Ukraine inherited part of the USSR nuclear arsenal and, along with Kazakhstan and Belarus, it finally decided to become a non-nuclear state. After obtaining commitments of aid from the US and Europe, it chose to return weapons and delivery systems to Russia, to join the Nuclear Non-proliferation Treaty in November 1994 and to sign the START I treaty in December 1994, which helped the transfer of all strategic and tactical nuclear warheads and the dismantlement and/or removal of all their associated launch systems and delivery vehicles. As a

[95] Source NSAU

result, ICBMs were taken off military duty and destroyed and the Ukrainian industry was reoriented towards peaceful purposes.

Feb. 1992	The National Space Agency of Ukraine is established
August 1995	The first Ukrainian spacecraft Sich-1 is launched
Nov. 1997	Leonid Kadenyuk is the first cosmonaut of the independent Ukraine onboard Columbia
March 1999	The first Zenit-3SL is successfully launched under the Sea Launch Programme
April 1999	Dnepr is launched for the first time commercially under the Russian-Ukrainian agreement

Between 1991 and 2007, more than 90 launch vehicles designed and manufactured in Ukraine (Zenit, Cyclone and Dnepr) were launched, and almost 200 satellites from ten different countries were put into orbit.

1.3.2. Main activities and capabilities

Ukraine has gained extensive expertise in many fields. Only the main activities and capabilities are listed below.

<u>Scientific research</u> (Including the development of on-board instruments)
- Astrophysics and astronomy
- Ionosphere and magnetosphere research
- Microgravity and life sciences

<u>Launch vehicles and launch services</u> (Development, production and testing)
Operational launch vehicles
- Zenit
  - Zenit-2
  - Zenit-3SL
- Cyclone
  - Cyclone-2
  - Cyclone-3 (last launch in 2001)
- Dnepr

Launch vehicles under development
- Cyclone 4
- Dnepr-M
- Mayak

The launch vehicles developed by Ukraine are summarised on Figure 54.

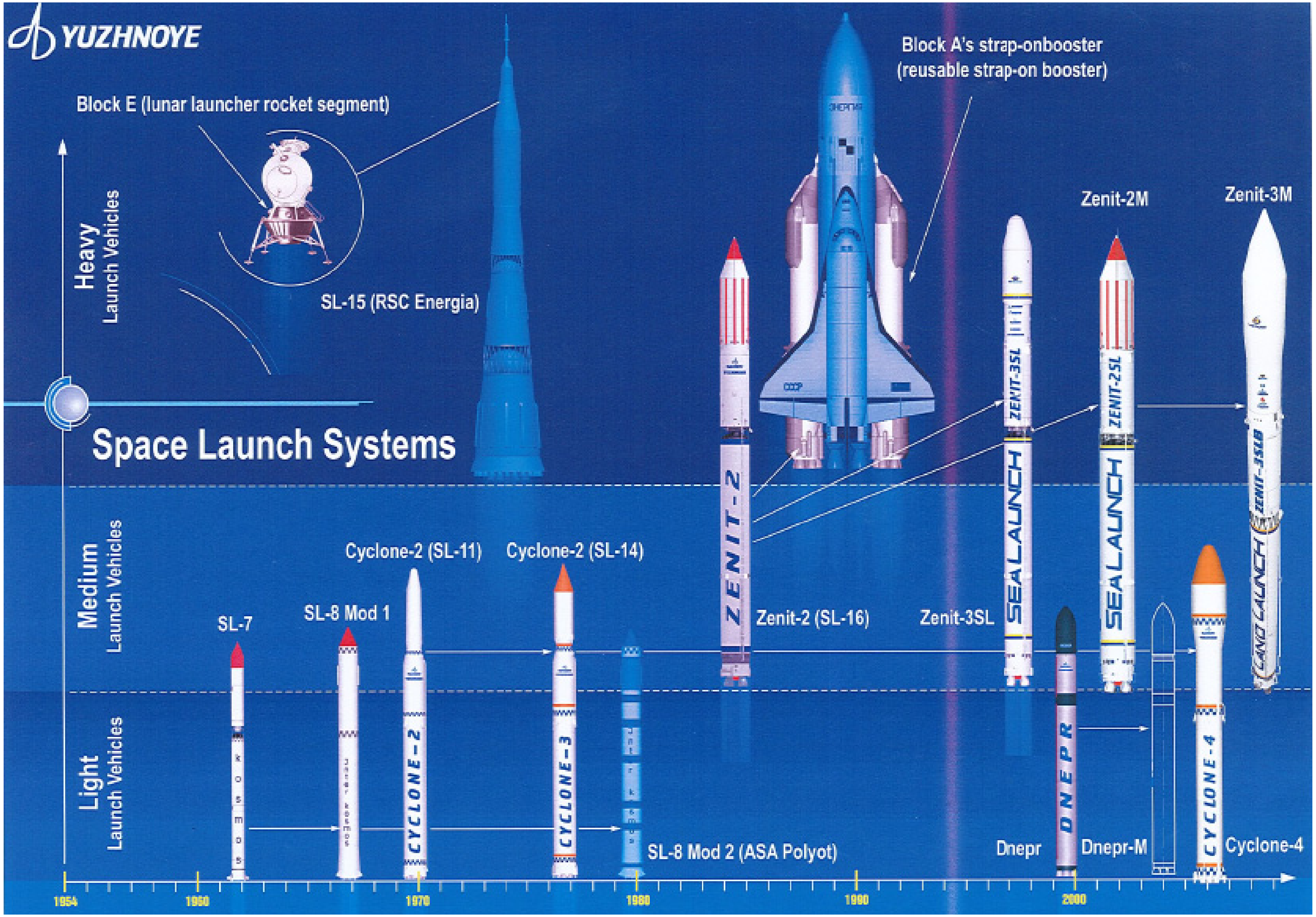


Figure 54: Yuzhnoye's launch vehicles (Source: Yuzhnoye)

The technical characteristics of the launch vehicles designed and manufactured in Ukraine are summarised in Table 30, Table 31 and Table 32.

Launch vehicle	**Cyclone-2**	**Cyclone-3**	**Cyclone-4**
Launch mass (tons)	183	187	193
Dimensions (m) Diameter Length	 3.00 39.27	 3.00 39.27	 3.00 41.19
Maximal payload mass LEO (tons) GTO (tons)	2.8 (H=700km,i=65º) -	3.6 (H=700km,i=73.5º) 0.6	5.7 (H=200km,i=2.3º) 1.7
Orbit inclination (degrees)	51 / 65 / 97	73.5 / 82.5	0 -180
Payload accommodation area (m) Diameter Length	 2.4 8.7	 2.4 6.1	 3.67 8.1
Launch site	Baikonour	Plesetsk	Alcantara
Launch costs	22.5 M$ (2006)[96]	20-25 M$ (2004)[97]	
Number of European payloads launched	0	0	-

Table 30: Cyclone launchers[98]

Launch vehicle	**Dnepr-1**	**Dnepr-M**
Launch mass (tons)	211	210.84
Dimensions (m) Diameter Length	 3.00 34.30	 3.00 37.69
Maximal payload mass LEO (tons) GTO (tons)	 3.5 -	 5 0.5
Orbit inclination (degrees)	46 / 51 / 65 / 87 / 98	46 / 51 / 65 / 87 / 98
Payload accommodation area (m) Diameter Length	 2.4 8.7	 2.4 6.1
Launch site	Baikonour, Yazny	Baikonour, Yazny
Launch costs (in M$ 2007)[99]	9.5	-
Number of European payloads launched	3 (with other payloads)	-

Table 31: Dnepr launchers[98]

[96] "Quarterly Launch Report", US Federal Aviation Administration (FAA), 3rd Quarter 2006

[97] "Quarterly Launch Report", US Federal Aviation Administration (FAA), 4th Quarter 2004

[98] Source Yuzhnoye

[99] "Quarterly Launch Report", US Federal Aviation Administration (FAA), 1st Quarter 2007

Launch vehicle	**Zenit-2**	**Zenit-2SLB**	**Zenit-3SLB**	**Zenit-3SL**
Launch mass (tons)	460	458.2	466.2	472
Dimensions (m) Diameter Length	3.90 57	3.90 57.35	3.90 58.65	3.90 59.60
Maximal payload mass (tons) LEO GTO GEO	13.7 - -	12.03 - -	- 3.75 -	14.5 5.9 2.7
Orbit inclination (degrees)	51 / 97	51 / 97	51 / 97	0 - 360
Payload accommodation area (m) Diameter Length	3.9 11.2 /13.6 /15.6	3.9 11.4 / 16	4.1 11.4 / 16	4.2 11.4 / 16
Launch site	Baikonour	Baikonour	Baikonour	Platform in the Pacific Ocean
Launch costs	37.5 M$(2007)[99]	-	50 M$ (2007)[99]	70 M$ (2007)[99]
Number of European payloads launched	3 (with other payloads)	-	-	2 (including 1 failure)

Table 32: Zenit launchers[98]

To the current launcher families can be added the one under development, "Mayak", described in Table 33.

Launch vehicle	**Mayak-12**	**Mayak-22**	**Mayak-23**
Launch mass (tons)	130	250	320
Dimensions (m) Diameter Length	3.00 32.10	3.90 37.00	3.90 44.80
Maximal payload mass LEO (tons) GTO (tons)	2.8 (H=200km,i=50º) -	6.4 (H=200km,i=50º) 1.8	5.7 (H=200km,i=50º) 3.0
Orbit inclination (degrees)	50	2.1 / 50	2.1 / 50 / 97.7

Table 33: Mayak launchers

To give an overview of Ukrainian activities in the launchers sector, Table 34 and Figure 55 presents the launch record of the vehicles developed in Ukraine, since the country's independence in 1991.

Launch Date	Fail-ure	Launcher	Location	Payload	Client Country
17.04.2007		Dnepr	Baikonur	EgyptSat-1, SaudiSat-3, 5 SaudiComSats, 7 CubeSats	Egypt, Saudi Arabia, USA
31.01.2007	F	Zenit-3SL	Odyssey	NSS-8	The Netherlands
31.10.2006		Zenit-3SL	Odyssey	XM 4	USA
22.08.2006		Zenit-3SL	Odyssey	Koreasat-5	Korea
26.07.2006	F	Dnepr	Baikonur	Baumanets, BelKA	Russia, Belarus
12.07.2006		Dnepr	Yasny	Genesis-1	USA
25.06.2006		Cyclone-2	Plesetsk	Cosmos-2421	Russia
18.06.2006		Zenit-3SL	Odyssey	GALAXY-16	USA
13.04.2006		Zenit-3SL	Odyssey	JCSAT-9	Japan
16.02.2006		Zenit-3SL	Odyssey	EchoStar-X	USA
08.11.2005		Zenit-3SL	Odyssey	Inmarsat 4-F2	England
24.08.2005		Dnepr	Baikonur	OICETS, INDEX	Japan
23.06.2005		Zenit-3SL	Odyssey	Intelsat Americas-8	USA
26.04.2005		Zenit-3SL	Odyssey	Spaceway-F1	USA
01.03.2005		Zenit-3SL	Odyssey	XM Radio-3	USA
24.12.2004		Cyclone-3	Plesetsk	Sich-1M, Micron-1 (KS5MF2)	Ukraine
29.06.2004		Zenit-3SL	Odyssey	Telstar 18	USA
29.06.2004		Dnepr	Baikonur	DEMETER, SaudiComSAT-1, SaudiComSAT-2, SaudiSAT-2, LatinSAT-C, LatinSAT-D, AMSAT-Echo, UniSAT-3	France, Saudi Arabia, USA, Argentina, Italy
10.06.2004		Zenit-2	Baikonur	Cosmos-2406	Russia
28.05.2004		Cyclone-2	Plesetsk	Cosmos-2407	Russia
04.05.2004		Zenit-3SL	Odyssey	DirecTV-7S	USA
11.01.2004		Zenit-3SL	Odyssey	Telstar 14/ Estrela do Sul 1	Brazil
01.10.2003		Zenit-3SL	Odyssey	Galaxy-13	USA
08.08.2003		Zenit-3SL	Odyssey	Echostar-IX	USA
10.06.2003		Zenit-3SL	Odyssey	Thuraya-2	United Arab Emirates
20.12.2002		Dnepr	Baikonur	LatinSat-A, LatinSat-B, UniSat-2, SaudiSat-1C, Rubin-2, TrailBlazer	Argentina, Italy, Saudi Arabia, Germany, Ukraine/USA
15.06.2002		Zenit-3SL	Odyssey	Galaxy IIIC	USA
28.12.2001		Cyclone-3	Plesetsk	Cosmos-2384, 2385, 2386, Gonec-D1 10, 11, 12	Russia
21.12.2001		Cyclone-2	Plesetsk	Cosmos-2383	Russia
10.12.2001		Zenit-2	Baikonur	Meteor 3M, Kompas, Reflektor, Tubsat, Badr-R	Russia, Maroc, Pakistan
31.07.2001		Cyclone-3	Plesetsk	Koronas-F	Russia
09.05.2001		Zenit-3SL	Odyssey	XM RADIO-1	USA
19.03.2001		Zenit-3SL	Odyssey	XM RADIO-2	USA
27.12.2000	F	Cyclone-3	Plesetsk	6 satellites Strela-3	Russia
21.10.2000		Zenit-3SL	Odyssey	Thuraya	United Arab

					Emirates
26.09.2000		Dnepr	Baikonur	MegSat-1, UniSat, SaudiSat-1A and 1B, TiungSat-1	Italy, Saudi Arabia, Malaysia
25.09.2000		Zenit-2	Baikonur	Cosmos-2372	Russia
29.07.2000		Zenit-3SL	Odyssey	PANAMSAT	USA
12.03.2000	F	Zenit-3SL	Odyssey	ICO F1	USA
03.02.2000		Zenit-2	Baikonur	Cosmos-2369	Russia
26.12.1999		Cyclone-2	Plesetsk	Cosmos-2367	Russia
10.10.1999		Zenit-3SL	Odyssey	DIRECTV 1-R	USA
17.07.1999		Zenit-2	Baikonur	Okean-O	Russia
21.04.1999		Dnepr	Baikonur	UOSat-12	England
28.03.1999		Zenit-3SL	Odyssey	DEMOSAT	-
09.09.1998	F	Zenit-2	Baikonur	Globalstar 7, 8, 9, 10, 11, 12, 13, 16, 17, 18, 20, 21	USA
10.07.1998		Zenit-2	Baikonur	Resurs-01 N4, Westrac, Techsat 1B, TMSat, Safir2, FASat-Beta	Russia, Australia, Germany, Israel, Thailand, Chile
15.06.1998		Cyclone-3	Plesetsk	Cosmos-2352, 2353, 2354, 2355, 2356, 2357	Russia
09.12.1997		Cyclone-2	Plesetsk	Cosmos-2347	Russia
20.05.1997	F	Zenit-2	Baikonur	Tselina-2	Russia
14.02.1997		Cyclone-3	Plesetsk	Gonec-D4, D5, D6, Cosmos-2337, 2338, 2339	Russia
11.12.1996		Cyclone-2	Plesetsk	Cosmos-2335	Russia
04.09.1996		Zenit-2	Baikonur	Cosmos-2333	Russia
19.02.1996		Cyclone-3	Plesetsk	Gonec-D1, D2, D3, Cosmos-2328, 2329, 2330	Russia
20.12.1995		Cyclone-2	Plesetsk	Cosmos-2326	Russia
31.10.1995		Zenit-2	Baikonur	Cosmos-2322	Russia
31.08.1995		Cyclone-3	Plesetsk	Sich-1, Fasat-Alpha	Ukraine, Chile
08.06.1995		Cyclone-2	Plesetsk	Cosmos-2313	Russia
26.12.1994		Cyclone-3	Plesetsk	Cosmos-2299, 2300, 2301, 2302, 2303, 2304	Russia
29.11.1994		Cyclone-3	Plesetsk	Geo-IK-1	Russia
24.11.1994		Zenit-2	Baikonur	Cosmos-2297	Russia
04.11.1994		Zenit-2	Baikonur	Resurs-01-3	Russia
02.11.1994		Cyclone-2	Plesetsk	Cosmos-2293	Russia
11.10.1994		Cyclone-3	Plesetsk	Okean-4	Russia
26.08.1994		Zenit-2	Baikonur	Cosmos-2290	Russia
25.05.1994	F	Cyclone-3	Plesetsk	Tselina-D	Russia
23.04.1994		Zenit-2	Baikonur	Cosmos-2278	Russia
02.03.1994		Cyclone-3	Plesetsk	Koronas-I	Russia
12.02.1994		Cyclone-3	Plesetsk	Cosmos-2268, 2269, 2270, 227, 2272, 2273	Russia
25.01.1994		Cyclone-3	Plesetsk	Meteor-3-06	Russia
17.09.1993		Cyclone-2	Plesetsk	Cosmos-2264	Russia
16.09.1993		Zenit-2	Baikonur	Cosmos-2263	Russia
31.08.1993		Cyclone-3	Plesetsk	Meteor-2-21	Russia

07.07.1993		Cyclone-2	Plesetsk	Cosmos-2258	Russia
24.06.1993		Cyclone-3	Plesetsk	Cosmos-2252, 2253, 2254, 2255, 2256, 2257	Russia
11.05.1993		Cyclone-3	Plesetsk	Cosmos-2245, 2246, 2247, 2248, 2249, 2250	Russia
28.04.1993		Cyclone-2	Plesetsk	Cosmos-2244	Russia
16.04.1993		Cyclone-3	Plesetsk	Cosmos-2242	Russia
30.03.1993		Cyclone-2	Plesetsk	Cosmos-2238	Russia
26.03.1993		Zenit-2	Baikonur	Cosmos-2237	Russia
25.12.1992		Cyclone-3	Plesetsk	Cosmos-2228	Russia
25.12.1992		Zenit-2	Baikonur	Cosmos-2227	Russia
22.12.1992		Cyclone-3	Plesetsk	Cosmos-2226	Russia
24.11.1992		Cyclone-3	Plesetsk	Cosmos-2221	Russia
17.11.1992		Zenit-2	Baikonur	Cosmos-2219	Russia
20.10.1992		Cyclone-3	Plesetsk	Cosmos-2211, 2212, 2213, 2214, 2215, 2216	Russia
13.07.1992		Zenit-2	Baikonur	Cosmos-2196, 2198, 2199, 2200, 2201, 2202	Russia
05.02.1992	F	Zenit-2	Baikonur	Tselina-2	Russia
18.12.1991		Cyclone-3	Plesetsk	Intercosmos-25	Russia
12.11.1991		Cyclone-3	Plesetsk	Cosmos-2165, 2166, 2167, 2168, 2169, 2170	Russia
28.09.1991		Cyclone-3	Plesetsk	Cosmos-2157, 2158, 2159, 2160, 2161, 2162	Russia
30.08.1991	F	Zenit-2	Baikonur	Tselina-2	Russia
15.08.1991		Cyclone-3	Plesetsk	Meteor-3-05	Russia
13.06.1991		Cyclone-3	Plesetsk	Cosmos-2151	Russia
04.06.1991		Cyclone-3	Plesetsk	Okean-3	Russia
16.05.1991		Cyclone-3	Plesetsk	Cosmos-2143, 2144,2145, 2146, 2147, 2148	Russia
24.04.1991		Cyclone-3	Plesetsk	Meteor-3-04	Russia
18.01.1991		Cyclone-2	Plesetsk	Cosmos-2122	Russia

Table 34: "Ukrainian" launches

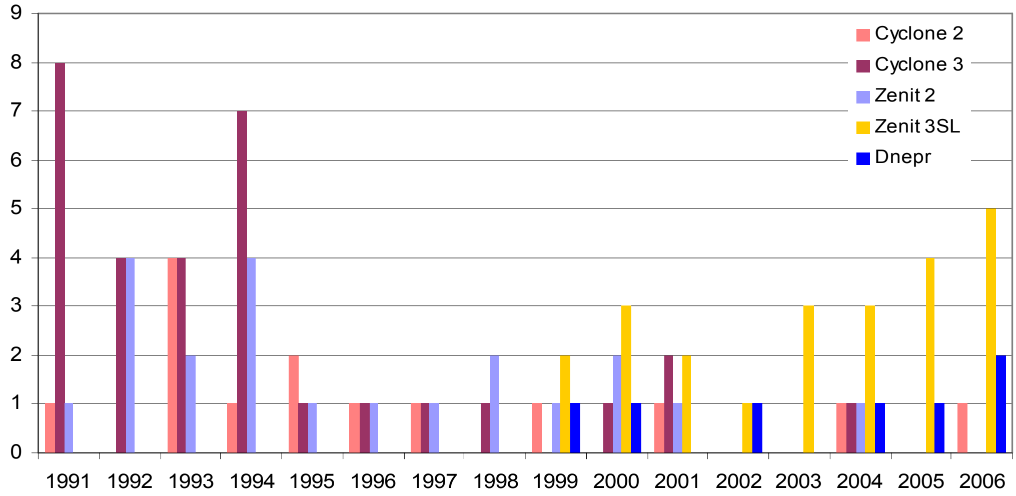


Figure 55: Number of annual launches (including failures) per type of launch vehicle

As presented in Figure 56, since 1991 "Ukrainian" launchers have represented between 3 and 13% of the total number of launches worldwide.

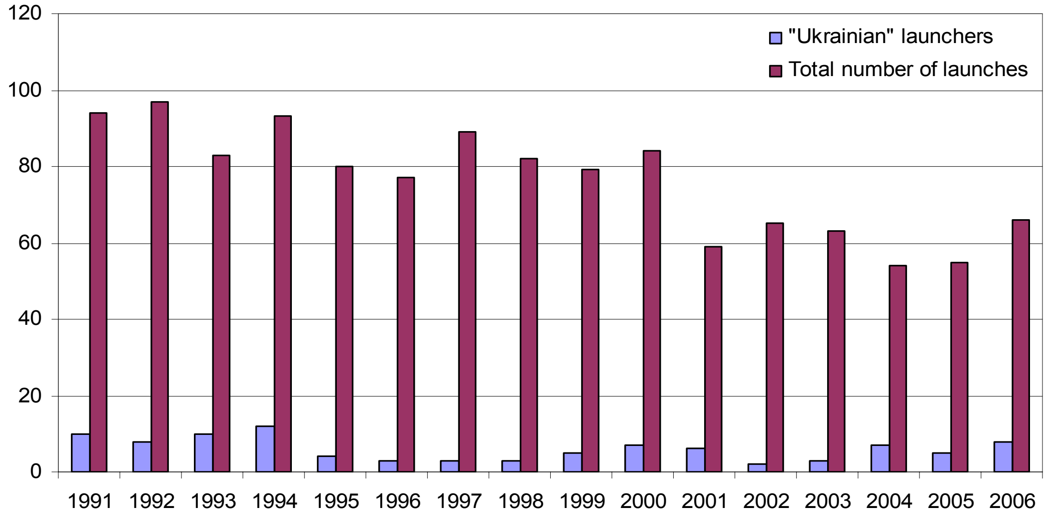


Figure 56: Launches of "Ukrainian" launchers and total number of launches worldwide (including failures)

The various spaceports from which the "Ukrainian" launchers are being launched are summarised in Figure 57. This figure illustrates the dependency of Ukraine on its partners.

Figure 57: Spaceports of the Ukrainian launchers[100]

<u>Spacecraft</u>

- Remote sensing satellites
  - Okean-O (1999)
  - Sich-1 (1995) and Sich-1M (2004)
  - Tselina-2 (series of Russian military satellites - last launch in 2006)
- Future telecommunications satellites
  - Lybid and Lybid-M
- Automatic multi-purpose space platforms
  - AUOS-SM (1994)

The Ukrainian space sector also produces rocket and spacecraft engines, as well as advanced materials and technologies.

<u>Ground facilities</u>
Ukraine has a National Space Facilities Control and Test Centre in Yevpatoriya which includes:
- The Centre of Spacecraft Flight Control
- The Centre for Receiving and Processing Special Data
- The Centre for Space Monitoring
- The Centre for Navigation Field Monitoring
- The Chief Centre for Special Monitoring

1.3.3. The Ukrainian space sector

<u>State-run organisations under the responsibility of the NSAU</u>
NSAU is responsible for about 30 organisations which represent most of the Ukrainian space sector. In 2006, those companies employed more than 40,000 people.[101] They are divided into:
- Design offices, scientific research and design institutes
- Industrial companies
- Specialised centres and enterprises

One should keep in mind that those organisations do not have only space-related activities. In the

[100] Map Collection, Perry-Castañeda Library, University of Texas
[101] Source Yuzhnoye

following tables, only relevant activities are listed for each of them.
Most of the space sector is located in three cities: Dnipropetrovs'k, Kiev and Kharkiv. The key players are the design office, Yuzhnoye, and the industrial company, Yuzhmash, located in Dnipropetrovs'k. Most of the other organisations act as subcontractors of those two companies.

NSAU Design offices, scientific research and design institutes

Dnipropetrovs'k	
M. Yangel Yuzhnoye State Design Office (SDO Yuzhnoye)	Design and development of space systems, launch vehicles and spacecraft
State Dniprovsky Design Institute (SDDI)	
Ukrainian Engineering Technology Research Institute, Public Company (UrkETRI)	• Composite materials • Methods of non-destructive inspections • Galvanic-chemical and coating technologies • Welding equipment • Hermetic
Kiev	
Arsenal Central Design Office, State Company (CDO Arsenal)	Optoelectronic equipment
Kharkiv	
Instrument-making, Research Technological Institute, State Company (IMRTI)	• Electronic devices • Materials • Mechanisation and automation of rocketry producing
Radio Measurement Research Institute, Public Company (RMRI)	• Command-measuring and informational systems for spacecraft • Satellite navigation and geodesic system customer equipment • Telemetry information reception and transmission facilities
Soyuz Research and Design Institute, State Company (Soyuz RII)	• Complex distributed communication systems and information control systems • Digital primary and secondary communication systems

The structure of the Yuzhnoye design office presented on Figure 58 demonstrates the broad scope of activities of the company, which employs about 5000 people. Yuzhnoye products extend from the design of components to spacecraft design, whether launchers or satellites, and includes both space and ground segments.

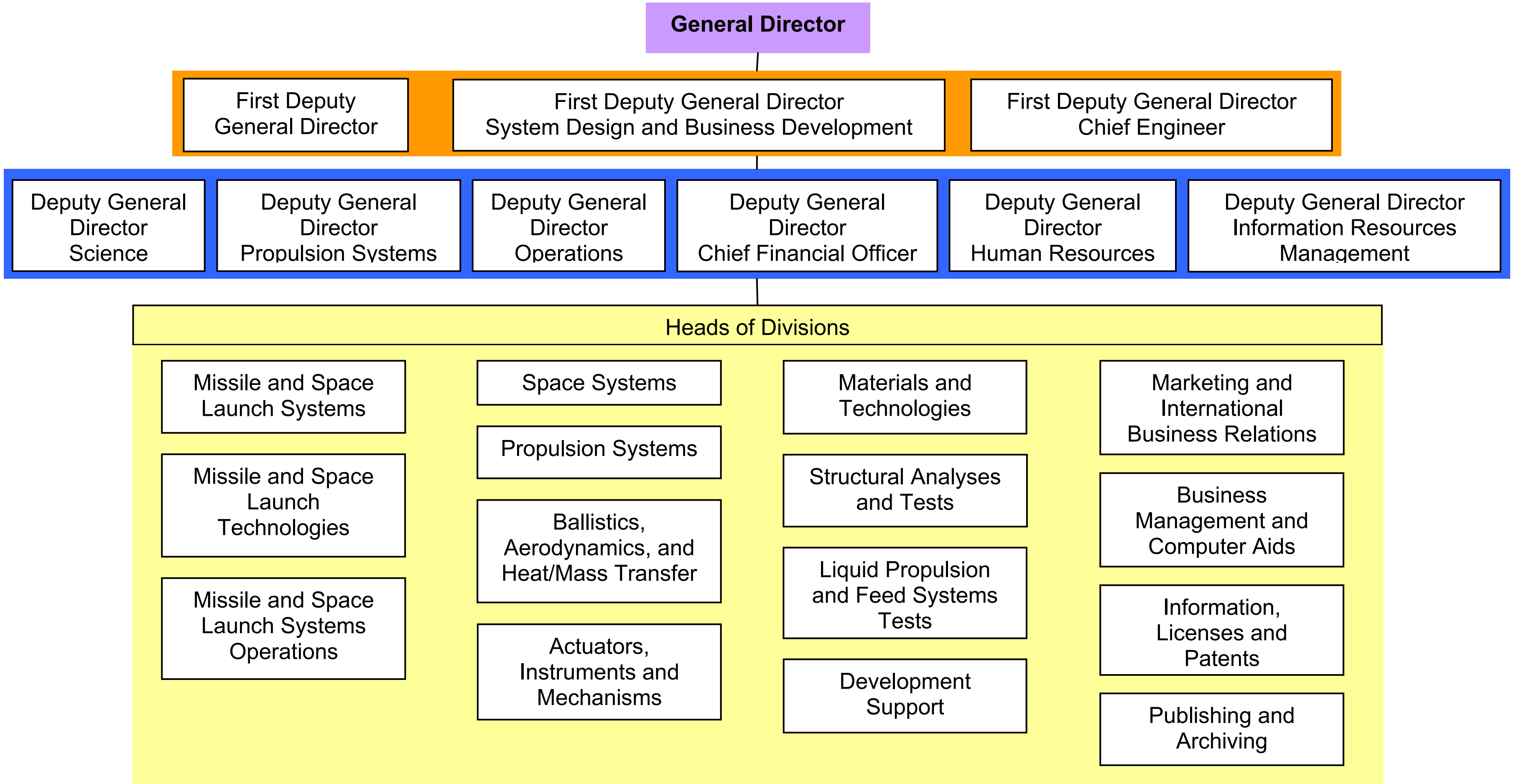


Figure 58: Structure of Yuzhnoye Design Office

NSAU industrial companies

Dnipropetrovs'k	
O. Makarov Yuzhny Machine-Building Plant, Production Association, State Company (PA Yuzhmash)	Manufacturing of space systems, launch vehicles and spacecraft
Pavlograd Chemical Plant, Research and Production Association, State Company	Solid fuel engines
Nikopol Pipe Plant, State Company	Precision pipes
Kharkiv	
Kommunar Association, State Research and Production Company	Control systems
Khartron Public Company	Control systems
Kharkiv Electronic Equipment Plant, State Company	Control and power supply equipment Telemetry Automatic guidance equipment
Kiev	
Arsenal Plant, State Plant	Navigation systems, orientation and aiming systems for spacecraft and launch vehicles
Kiyvprylad Production Association, State Company (PA Kiyvprylad)	Spacecraft control equipment
Kiev Radio Plant, Public Company	Spacecraft equipment
PCB – Radio Plant, Public Company	Spacecraft equipment
Kurs Research and Production Complex, Public Company	Spacecraft components including docking equipment for the ISS
Elmiz Public Company	Radio electronic equipment for "Kurs" spacecraft docking
Chernihiv	
Chernihiv Radio Equipment Plant, Public Company (ChezaRa)	Telemetry equipment for space systems

NSAU specialised centres and enterprises

Yevpatoriya - Crimea	
National Space Facilities Control and Test Centre - Centre of Spacecraft Flight Control - Centre for Receiving and Processing Special Data - Centre for Space Monitoring - Centre for Navigation Field Monitoring - Chief Centre for Special Monitoring	▪ Spacecraft flight control ▪ Reception, collection, processing, storage and transfer of information from spacecraft ▪ Space monitoring
Dnipropetrovs'k	
National Youth Aerospace Education Centre	
DniproCosmos State Company	Introduction of aerospace technologies and services in satellite communication, navigation and Earth remote sensing areas Development and technical maintenance of satellite communication transmitting stations, satellite television and broadcasting networks, topographic, geodesic, cartographic operations and cadastral surveys
Space Equipment Standardization Centre	Standardisation
Kiev	
UkrCosmos State Company	Development and utilisation of satellite information split network Dispatching of transport means through satellite technologies Mobile satellite communications
Pryroda State Research and Production	• Ordering, processing, storing and

Centre	distributing Earth remote sensing information • Applications of remote sensing in nature management and environment monitoring • Geological mapping • Development of digital subject maps on the basis of GIS/EO technologies
International Space Law Centre (ISLC)	Legal support to space activities
Kharkiv	
NANU-NASU Kalmykov Earth Radio Physical Sensing Centre	• Earth remote sensing radar systems • EO data processing
State Research and Engineering Centre for Space Technique Certification	Certification

NSAU has general customer representation offices in Dnipropetrovs'k, Kiev, Kharkiv and Chernihiv that control production quality. It also has the responsibility for the Aerospace Society of Ukraine and Space-Inform Informational and Analytical Centre.

NSAU-NASU Joint Institutes

Dnipropetrovs'k	
NASU-NSAU Technical Mechanics Institute (TMI)	Dynamics of launch vehicle systems Interaction between solid bodies and radiation and ionised environment
Kiev	
NASU-NSAU Space Research Institute (SRI)	Basic and applied research • Space weather • Plasma physics
Lviv	
Lviv Centre of NASU-NSAU Space Research Institute	Basic and applied research • Plasma physics

National Academy of Sciences of Ukraine

The main institutes with space-related activities belong to the section of physical-technical and mathematical sciences of the Academy:

- Division of physics and astronomy
  - Main astronomical observatory
  - Crimea astrophysical observatory
  - Institute of radio astronomy
  - Institute of magnetism
  - Institute of applied optics
  - Institute for low temperatures physics and engineering
  - Institute of radio-physics and electronics
  - Institute of ionosphere
  - Institute for condensed matter physics
  - Centre of radio physical Earth sensing
- Division of atomic physics and energy
  - Institute of plasma physics
  - Institute of atomic research
  - Institute of applied physics
  - Institute of electro-physics and radiation technologies
- Division of technical and physical aspects of material science, Paton welding institute
- Division of Earth sciences: Institute of geological sciences

Universities

The main universities involved in space activities are:

- Ivan Franko National University of Lviv, Astronomical Observatory
- Kharkiv V. Karazin National University, Department of Space Radio Physics

- Tavrical National University, Department of Astronomy and Methodology of Physics
- National Technical University of Ukraine "Kiev Polytechnic Institute", Faculty of aviation and space systems
- Dnipropetrovs'k State University
- Kiev State University of Shevchenko
- National Aerospace University of Zhukovskij, Kharkiv

1.3.4. International Joint Ventures

Following the Russian example, the Ukrainian space enterprises have created joint ventures with foreign partners to commercialise their products, especially in the field of launchers to provide launch services.

Launch Services

- Sea Launch - Zenit 3SL

Sea Launch was created in 1993 as a joint venture between five partners to commercialise Zenit-3SL launch services from a platform in the Pacific Ocean. As described in Table 35, Yuzhnoye and Yuzhmash are mainly responsible for the two first stages of the launcher.

Company	Country	Responsibilities
Boeing	USA	Payload fairing, spacecraft integration and mission operations
Aker Kvaerner	Norway	Launch platform and command ship
Energia	Russia	Block DM-SL upper stage (Zenit-3SL upper stage), launch vehicle integration and mission operations
Yuzhnoye / Yuzhmash	Ukraine	First two Zenit-3SL stages, launch vehicle integration support and mission operations

Table 35: Sea Launch partners and their responsibilities

The two Ukrainian companies Yuzhnoye and Yuzhmash hold together 15% of the JV shares, as detailed in Figure 59.

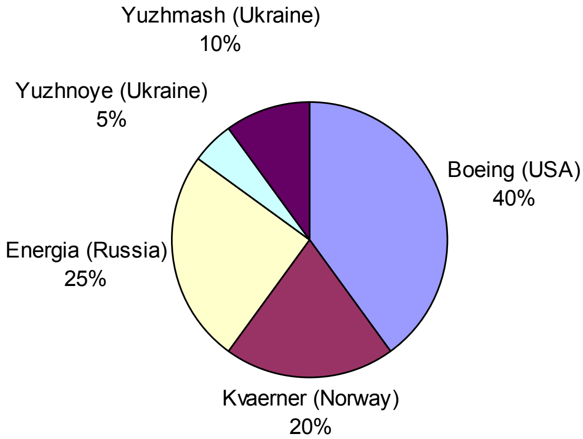
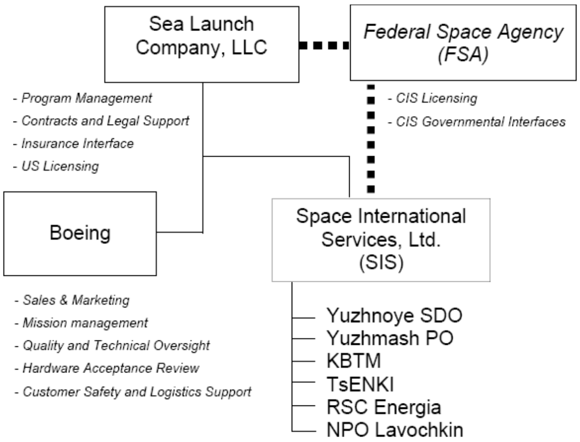


Figure 59: Shares of Sea Launch partners

- Land Launch – Zenit 3SLB[102]

In 2003, the Sea Launch partners decided to commercialise a new version of the Zenit 3SL launcher, the Zenit 3SLB, from Baikonour and created the Land Launch system. Land Launch is marketed by the Sea Launch Company with a subcontracting arrangement with Space International Services as shown in Figure 59. The Sea Launch Company provides contracting and management functions for the Land Launch system, while the Space International Services (SIS) provides all launch system components, mission integration and launch operations from Russia, Ukraine and Kazakhstan. SIS is a Moscow-based joint venture between Ukrainian and Russian partners listed in Figure 60. The first launch is planned for 2007.

[102] http://www.sea-launch.com/land-launch/index.html



FSA: Russian Space Agency

Figure 60: Land Launch organisation[103]

- Kosmotras – Dnepr

Kosmotras was created in 1997 to commercialise launches of ICBMs SS-18 reconverted into commercial launch vehicles called Dnepr from Baikonour. The company ISC Kosmotras is located in Moscow and is equally owned between the Russian and Ukrainian partners listed in Table 36.

Company	Country	Share
Askond Rosobschemash DBSM DBTM TsNIIMASH	Russia	50%
Khartron Yuzhmash Yuzhnoye NSAU	Ukraine	50%

Table 36: Kosmotras partners

- Alcantara Cyclone Space – Cyclone

Alcantara Cyclone Space is a joint venture established between the Brazilian Space Agency and NSAU to commercialise Cyclone 4 launch services from Alcantara in Brazil. It is based on the "Agreement between Ukraine and the Federal Republic of Brazil on use of Cyclone-4 Launch Vehicle at the Alcantara Launching Centre", signed in October 2003. The JV statute came into force in Ukraine in late 2005 and was officially published in Brazil on September 4 2006.
The responsibilities of each partner are detailed in Table 37. The shares of the JV are equally distributed between Ukraine and Brazil.

Country	**Responsibility**	**Share**
Ukraine	Development of a new Cyclone 4 launch vehicle with an upgraded third stage Construction of special ground infrastructure of the launch centre	50%
Brazil	Establishment of the launch centre general infrastructure	50%

Table 37: Responsibilities and shares of the Alcantara Cyclone Space partners

<u>Telecommunications</u>
Ukraine also participates in a joint venture with Italian partners in the field of telecommunications.

[103] Land Launch User's Guide, Boeing, http://www.boeing.com/special/sea-launch/customers_webpage/ll-users-guide/pdfs/1-Introduction.pdf

- ELSACOM Ukraine

ELSACOM Ukraine was established in 1996 to provide satellite communications services in Ukraine and its region. The partners, listed in Table 38, are Italian and Ukrainian. ELSACOM is a Finmeccanica company, partner of Globalstar, that provides fixed and mobile satellite communications services.

ELSACOM	Italy
SIMEST	
Ukrtelecom	Ukraine
Yuzhmash	
Yuzhnoye	

Table 38: ELSACOM Ukraine partners

1.4. Legal framework

1.4.1. National space legislation

Ukrainian space activities are governed by numerous laws, presidential decrees and resolutions of the Cabinet of Ministers.
The main regulatory legal acts relevant to space activities in Ukraine are:

February 1992	Decree of the President "On the Establishment of the National Space Agency of Ukraine"
November 1996	Law of Ukraine "On Space Activities"
July 1997	Decree of the President "On provision about the National Space Agency of Ukraine"
March 2000	Law of Ukraine "On State Support of Space Activities"
October 2002	Law of Ukraine on the National Space Programme of Ukraine 2003-2007
June 2005	Decree of the President "On Space Industry Development"

1.4.2. International treaties and arrangements

Ukraine ratified the main international treaties governing space activities, as detailed in Table 39.

Outer Space Treaty	R
Rescue Agreement	R
Liability Convention	R
Registration Convention	R
Moon Agreement	-
Nuclear Tests Ban	R
ITU	R

R: Ratified -: Not ratified

Table 39: Ratification of the United Nations Treaties by Ukraine

Furthermore, Ukraine is partner of the Missile Technology Control Regime (MTCR) since 1998 and is a participating state of the Wassenaar Agreement.

1.4.3. Export control

The main export control bodies in Ukraine are the Committee for Policy on Military Cooperation and Export Control under the responsibility of the National Security and Defence Council and the State Service for Export Control in the Ministry of Economy.

2. National Policies

2.1. Rationales for space activities

The space industry remains one of the key industries of the Ukrainian economy. The main rationale for space activities in Ukraine is the maintenance and further development of their scientific, technical and industrial expertise and capabilities. The space sector also contributes to the national economic well-being and to national prestige (Ukraine is known worldwide for its launchers). Besides, it remains an important field in the relations between Russia and Ukraine.
Using space to the benefit of Ukrainian citizens is one of the goals stated in the two last National Space Programmes, however more could be achieved in that direction.

2.2. National priorities in the space field

As the main source of funding for the sector, launchers and their commercialisation through international joint ventures remain the top priority. But despite limited funding, Ukraine has an ambitious space programme with a much broader scope. As detailed in 1.2.2., the Third Programme included scientific research, development and manufacturing of space systems, as well as applications projects in Earth observation, telecommunications and navigation. International cooperation is also a priority in the field.

2.3. Foreign policy objectives

Even if the country remains divided between pro-Russians and supporters of closer relations with the USA and/or Europe, since the Orange Revolution, Ukraine has leaned towards the West, and European integration has become a key priority.
The integration into, and ultimately the membership of, the European Union and in NATO appear today as important goals for the country.

2.4. Existing international cooperation

2.4.1. International organisations

Ukraine is a member of the main space-related international organisations, as detailed in Table 40.

ITSO / Intelsat	-
Intersputnik	X
Intercosmos	- (participated as part of the USSR)
IMSO / Inmarsat	X
Eutelsat	X
Eumetsat	-
GEOSS	X

Table 40: Membership of Ukraine in space-related international organisations

2.4.2. Bilateral Cooperation Agreements

Ukraine has signed a number of cooperation framework agreements on the exploitation of space for peaceful purposes.
At governmental level, Ukraine signed agreements with China in December 1995, the USA in May 1996, Russia in August 1996, Kazakhstan in October 1997, Turkey in December 2001, Israel in

January 2001 and India in June 2005 (Ukraine provided assistance to India in the seventies for the launch of their satellites Ariabhata and Bhaskara within the Intercosmos programme).
At agency level, the NSAU has signed agreements with the Hungarian Space Office in May 1994, the National Commission for Space Activities of Argentina in October 2001, the Chilean Space Agency in April 2002, the Spanish National Institute for Aerospace Technology in July 2003 and the Korean Ministry of Science and Technologies in December 2006.
In February 2006, the heads of the Ukrainian and Russian space agencies signed an agreement on Russian-Ukrainian cooperation in the exploration and utilisation of space for 2007-2011.
Moreover, China and Ukraine signed in February 2006 a protocol on a Cooperation Programme for 2006-2010, which initially included joint projects in four fields: satellites, rockets, rocket components and space science. The details of the agreement were agreed upon during the session of the Sino-Ukrainian Joint Commission on Space Cooperation in June 2006. Three or four joint projects with no exchange of funds between the partners are today envisioned.
There are also several agreements related to the launch services joint ventures between Ukrainian and American partners and a new Framework Cooperation agreement with the US is currently under review in the US Department of State.
Finally, CNES and NSAU are currently preparing a cooperation agreement on launchers technologies as a follow-up of the INTAS/CNES/NSAU experience.

2.4.3. Cooperation

Ukraine currently participates in several international projects with various countries.
The main scientific projects are undertaken in cooperation with Russia:

- Spectr-radioastron (2008?)
- Coronas F (2008?)
- 6 ISS experiments

The main commercial projects realised with foreign partners or for foreign clients are:

- Russia
  - Sich satellites
  - Dnepr
  - Sea Launch - Land Launch
- USA: Sea Launch - Land Launch
- Brazil: Cyclone 4 in Alcantara
- Italy: Vega upper stage engine
- Egypt: Egyptsat

3. Relationship with Europe and contribution to European space activities

3.1. European Member States

3.1.1. INTAS/CNES/NSAU

On October 19 2005, CNES, INTAS and NSAU signed a protocol for a joint call for research project proposals on space technologies. The scope of the call encompassed basic and applied research. The total budget was 1.2 million euros, 500,000 euros from INTAS, 500,000 euros from CNES and 200,000 euros from NSAU. Eleven proposals were selected for future funding, seven of which included Ukrainian teams.

3.1.2. VARIANT

The VARIANT instrument on-board Sich-1M that aimed at measuring current density in ionospheric and magnetospheric plasmas was the result of an international cooperation between Ukrainian, Russian, Polish, French and British partners.

3.2. European Union

3.2.1. The Partnership and Cooperation Agreement

Ukraine-EU relations are based on the Partnership and Cooperation Agreement (PCA) that entered into force in 1998 (for an initial period of ten years).
The PCA comprises an article dedicated to space:
Article 65 - Space
"Bearing in mind the respective competences of the Community, its Member States and the European Space Agency the Parties shall promote, where appropriate, long term co-operation in the areas of civil space research, development and commercial applications. The Parties will pay particular attention to initiatives making full use of the complementarity of their respective space activities."

Joint Working Group
A Ukraine-EU Joint ad-hoc Working Group on Space Research and Peaceful Uses of Outer Space was established in March 2003, under the EU-Ukraine PCA Sub-committee on Science and Technology, Research and Development, Education, Culture and Public Health, to investigate means of closer cooperation in the field. So far, limited results have been achieved.

3.2.2. EU Technical Assistance

TACIS
TACIS is a programme of technical assistance of the EU established in 1991 aimed at Eastern Europe, South Caucasus and Central Asia. The programme's objective has been to support the transition of the countries of those regions towards market economies and democratic societies.

One of the initiatives under TACIS is Bistro ("fast" in Russian). The Bistro Programme provided support to small-scale projects in Ukraine in three areas:

- Support for institutional, legal and administrative reform
- Support to the private sector and assistance for economic development
- Support in addressing the social consequences of transition

The projects' duration did not exceed a year and their budgets were kept below 200 thousand euros. Three Bistro projects were implemented with NSAU between 2001 and 2006. During the first project, general recommendations concerning space technology commercialisation were developed. More specific recommendations for intellectual property rights protection and an implementation plan for a Technology Transfer Centre were made during the second project. Links between leading Ukrainian space companies and their European partners were established and the joint R&D

projects started as a result of the third project.

Since 2007, technical assistance is provided under the new European Neighbourhood and Partnership Instrument (ENPI), replacing the TACIS programme and other programmes.

Twinning project

One of the instruments of the European Neighbourhood Policy is institutional twinning, which supports the harmonisation of Ukrainian legislation and standards with EU ones. The institutional twinning mechanism consists of a direct cooperation between Ukrainian public authorities and any of their counterparts in the EU Member States.

A call proposing a twinning with NSAU was released in February 2007. According to the twinning fiche,[104] the objective of the project is to support:

- the participation of Ukraine to the European Research Area (ERA) and to European space programmes
- the development of its research and technological capabilities in the service of the economy and the society
- the approximation of its legislation and standards to those of EU

3.2.3. Framework Programmes

Ukraine participated in FP6 projects as a third country with an agreement with the EU on Science and Technology. In particular, Yuzhnoye participated in a couple of space-related FP6 projects in cooperation with EADS and Alcatel. The project COMPARE, led by EADS Space Transportation, aimed at providing a standards comparison methodology that was validated with a comparison of selected space industry standards. The project NAVOBS was a support measure to boost the business prospects of GMES and telecom satellites through focused and innovative RTD work involving SMEs.

In order to promote space cooperation between Ukraine and Europe in the framework of the FP6, a workshop was jointly organised in January 2004 in Kiev by ESA, the European Commission, NASU and NSAU.[105]

For the seventh Framework Programme, the status of Ukraine might evolve, which would make easier the participation of Ukrainian teams in projects.

3.3. European Space Agency

3.3.1. INTAS/ESA

ESA and INTAS made joint calls for research project proposals on space technologies. Ukrainian research teams have participated in several of those INTAS/ESA projects.

3.3.2. Cooperation Framework Agreement

A Cooperation Framework Agreement on research and peaceful use of outer space between ESA and the Ukrainian Cabinet of Ministers is under preparation and might be signed by mid-2007. ESA delegations visited Ukraine in June and November 2006. In particular, the cooperation on Vega, Aurora and FLPP were discussed at those occasions.

3.3.3. Vega

Under a contract with Avio, the Yuzhnoye design office is developing an engine for the fourth stage of the future European launcher, Vega. Yuzhnoye is responsible for the development of VG 143 main engine, which is part of the Liquid Propulsion System for the Upper Module of the launcher. This system will generate thrust, control pitch and yaw and perform manoeuvring and de-orbiting of the Upper Module.

[104] "Boosting Ukrainian space cooperation with the European Union", Twinning fiche, EU TACIS Programme, UA06/PCA/OT/05

[105] http://www.nkau.gov.ua/workshop/GI.htm

3.3.4. Proposals

Ukraine is interested in cooperating with ESA on various projects. For instance, in the field of telecommunications, Ukraine proposed providing the ground segment for the Artemis optical link. Ukraine also proposed European cooperation on Ionosat, a cluster of three ionospheric satellites.

3.4. Participation in the joint EU/ESA programmes

3.4.1. Galileo

Ukraine has several operational ground stations that could be used for Galileo in the future.

In December 2005, the EU and Ukraine signed a Framework Cooperation Agreement on Galileo. Ukraine was the third non-EU country after China and Israel to sign such an agreement. Ukraine will participate in the development and management of the Galileo system and receive EU funding. The extension of EGNOS is also mentioned in the Agreement.

Such an agreement offer Ukrainian companies opportunities to participate in new international projects, in particular within the framework of the FP7, and to cooperate with foreign partners.

3.4.2. GMES

One of the two projects common to NSAU and NASU is the development of Geo Ukraine, the Ukrainian segment for GMES.

NSAU and NASU will contribute 10 million hryvnas (about 1.5 million euros) each in order to jointly fund GMES-related R&D projects. Those projects will cover topics like disaster management, Black Sea monitoring, crop monitoring, and atmospheric and environmental load (like pollution) monitoring.

Acronyms

AEKI	Atomic Energy Research Institute
ASTRO+	Advanced Space Technologies to Support Security Operations
BERD	Business Expenditure on R&D
CASTLE	Clusters in Aerospace and Satellite Navigation Technology Applications linked to Entrepreneurial Innovation
CBSA	Czech Board for Space Activities
CCMS	Committee on the Challenges of Modern Society
CEEX	"Research of Excellence" Programme
CENIA	Czech Environmental Information Agency
CNES	Centre National d'Etudes Spatiales
CoCom	Coordinating Committee for Multilateral Export Controls
CORINT	International S&T cooperation and partnership
COSPAR	Committee on Space Research
COST	European Cooperation in the field of Scientific and Technical Research
CRDF	Civilian Research & Development Foundation
CSO	Czech Space Office
CSRC	Czech Space Research Centre
DBSM	Design Bureau of Special Machine-Building
DBTM	Design Bureau of Transport Machinery
DG	Directorate General
DIAS	Digital Upper Atmosphere Server
EC	European Commission
ECS	European Cooperating State
EFRD	European Fund for Regional Development
EGNOS	European Geostationary Navigation Overlay Service
ELINT	Electronic Intelligence
ENPI	European Neighbourhood and Partnership Instrument
EO	Earth Observation
ERA	European Research Area
ERA-STAR	European Research Area - Space Technologies Applications & Research for the Regions and Medium-Sized Countries
ESA	European Space Agency
ESF	European Social Fund
ESINET	European Space Incubators Network
ESO	European Southern Observatory
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EURATOM	European Atomic Energy Community
F	Failure
FLPP	Future Launchers Preparatory Programme
FÖMI	Institute of Geodesy, Cartography and Remote Sensing
FP	Framework Programme
FTT	Higher Education and Research Council
GARDA	Galileo Receiver Development Activity
GDP	Gross Domestic Product

GEMS	Global and Regional Earth-System Monitoring using Satellite and In-Situ Data
GEO	Geostationary Orbit
GEOSS	Global Earth Observing System of Systems
GERD	Gross Expenditure on R&D
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
GNSS	Global Navigation Satellite System
GSA	Galileo Supervisory Authority
GSE	GMES Service Element
GTO	Geostationary Transfer Orbit
H	Height
HLSPG	High Level Space Policy Group
HSB	Hungarian Space Board
HSO	Hungarian Space Office
Hunagi	Hungarian Association for Geo-information
i	Inclination
IAC	International Astronautical Congress
IAF	International Astronautical Federation
ICBM	Inter-continental Ballistic Missile
ICPC	International Cooperation Partner Country
INSPIRE	Infrastructure for Spatial Information in the European Community
INTAS	International Association for the Promotion of Cooperation with Scientists from the New Independent States
ISS	International Space Station
ITSO	International Telecommunications Satellite Organization
ITU	International Telecommunication Union
JBR	Research and Development Units
JV	Joint Venture
KFKI	Central Research Institute for Physics
KTIT	Research and Technological Innovation Council
LBS	Location-Based Services
LEO	Low Earth orbit
MTCR	Missile Technology Control Regime
NASR	National Authority for Scientific Research
NASU	National Academy of Sciences of Ukraine
NATO	North Atlantic Treaty Organisation
NAVOBS	Action to launch New Economic Activities from Satellite Communications, Earth Observation or Geo-localisation
NIS	New Independent State
NKTH	National Office of Research and Technology
NMS	New Member State
NSAU	National Space Agency of Ukraine
OTKA	Hungarian Scientific Research Fund
PAN	Polish Academy of Sciences
PCA	Partnership and Cooperation Agreement
PEARL	Port Environmental Information Collector
PECS	Plan for European Cooperating States

PPP	Public-Private Partnership
PPP	Purchasing Power Parity
PPS	Purchasing Power Standards
PREVIEW	PREVention, Information and Early Warning pre-operational services to support the management of risks
ProDDAGE	Project for the Development and Demonstration of Applications for Galileo and EGNOS
PRODEX	Programme de Développement d'Expériences scientifiques
PSO	Polish Space Office
R&D	Research and Development
RIMS	Ranging and Integrity Monitoring Station
RIN	European Sea Level Observing System
RMKI	Research Institute for Particle and Nuclear Physics
RON	New Romanian Leu
ROSA	Romanian Space Agency
RTD	Research and Technology Development
RTDI	Research, Technological Development and. Innovation
RTN	Turbulent Boundary Layers in Geospace Plasmas
S&T	Science and Technology
SCOM	NATO Science Committee
SCOR	Satellite Centre of Regional Operations
SCORE	Service of Coordinated Operational Emergency & Rescue using EGNOS
SCSR	Scientific Council on Space Research
SICU	State Innovation Company of Ukraine
SIS	Space International Services
SME	Small and Medium Enterprise
SPS	Science for Peace and Security
SRC	Space Research Centre
SSETI ESEO	Student Space Exploration and Technology Initiative - European Student Earth Orbiter
START	Strategic Arms Reduction Treaty
STCU	Science and Technology Centre in Ukraine
SURE	International Space Station: a Unique Research Infrastructure
TTPK	Science and Technology Policy Council
TWISTER	Terrestrial Wireless Infrastructure integrated with Satellite Telecommunications for E-Rural
USA	United States of America
USSR	Union of Soviet Socialist Republics
WTO	World Trade Organisation

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Mr. Balda	TL elektronic
Mr. Sobotka	Frencken Brno
Mrs. Brzoňová	Czechtrade
Mrs. Kopacková	Czech Geological Survey
Mr. Sabourin Mr. Hanák	Economic Mission, French Embassy in Czech Republic

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Prof. Kłos	Space Research Centre
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Mrs. Badurska	Space Research Centre
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Mr. Markachov	Economic Mission, French Embassy in Ukraine
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Mrs. Thieser Mr. Frisch	International affairs, CNES

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