Understanding the European Space Policy

The Reference Book

Prepared in the frame of the C-SPACE project
Funded by the European Commission – FP7

ABOUT C-SPACE PROJECT AND THE ESP REFERENCE BOOK

C-Space (Conditions for Space Policy and related action plan consolidation in Europe) was funded by the European Commission within the 7th Framework Program (FP7), running from March 2010 until September 2011.

C-Space supports the vision of a comprehensive European Space Policy (ESP). By means of a multi-level policy study, the project aims to further enhance the development and implementation of the ESP. It aims to define a comprehensive approach towards establishing new milestones for space in Europe. In order to do so, the study adopts a dual approach: (1) an analysis of the drivers for change within key space sectors in Europe, and (2) a comprehensive space policy vision.

Based on a detailed analysis of current trends in the European space sector, the study presents a number of "high level" concepts to be further developed within the continuing process of European integration, with the objective of fostering a more extensive identity for space in Europe.

A key output was the creation of a Reference Book to be used in support of the decision making process within the EU and as a means of spreading awareness and knowledge among a wider European public.

The Reference Book poses three important questions:

Why is Europe interested in the space domain?

What is the role of the EU in the space domain?

How space is being used in Europe?

The approach is academically rigorous but presented in an accessible form that still reflects the complexities of space as a subject. It highlights critical points and current trends across several areas of space activity. The Reference Book is also designed to offer guidelines to future policymaking, and ends with a chapter dedicated to challenges and opportunities as a contribution to the on-going debate over the direction and shape of European space policy.

The opinions expressed in this document are the only responsibility of the authors and of C-SPACE consortium.

More information about C-SPACE project can be found on the website: www.c-space-eu.org

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ABOUT THE CONSORTIUM

The Foundation for Strategic Research (Fondation pour la recherche stratégique, FRS) is a think tank based in Paris and is the coordinator of C-SPACE project. The FRS is one of the most prominent independent research centres in the field of security and research.FRS researchers involved in C-SPACE project: Xavier Pasco, Gerard Brachet, Lucia Marta and Florence Gaillard-Sborowsky, with the support of Bianca Szalai, intern at the FRS in the summer 2011.

Centre national de la recherche Scientifique (CNRS) is a government funded research organization under the administrative authority of the France's Ministry of research.
CNRS researcher involved: Isabelle Sourbès-Verger

The Romanian Space Agency is an independent public institution, a legal entity fully self-financed. The main mission of ROSA is to promote, coordinate and develop aeronautical, space and security research and application programs and projects in Romania and Europe.
ROSA researchers involved: Pisu Marius-Ioan and Anca Racheru.

The Swedish Defence Research Agency (FOI) is a government agency established to conduct research and development mainly for the Swedish armed forces and civil defence and security authorities.
FOI researchers involved: Mike Winnerstig, Sandra Lindström, Christer Andersson and Maria Oredsson.

The Istituto Affari Internationali (IAI) based in Rome is a non-profit organization whose main objective is to promote the understanding of international politics through studies, research, meetings and publications.
IAI researchers involved: Jean-Pierre Darnis, Anna Clementina Veclani, Michele Nones.

The Royal Aeronautical Society (RAeS) based in London is the learned society for the Aerospace and Aviation community. Through its various boards and committees, it can draw upon considerable experience and expertise in aviation and space matters.
RAeS researcher involved: Prof. Keith Hayward

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Why is Europe interested in the space domain?

Space has a strong political dimension that helps enhance Europe's position as a global actor in several fora.

In recent years there has been an increasing European focus on the space domain. Space systems have proved to be a reliable tool for supporting various European policies, among others those related to security, environment, climate, health, sustainable development, information technology and international affairs. The growing European interest in space activities is highlighted in relation to three main aspects: political and strategic; economical; and societal aspects.

POLITICAL AND STRATEGIC ASPECTS

Space has a strong political dimension that helps enhance Europe's position as a global actor in several fora. Space also contributes significantly to European competitiveness and technological development; this not only has a considerable economic impact, but is also an essential characteristic of an advanced, cutting-edge society. Space provides Europe with additional political weight that can be exploited at national, European and international levels, and on more than one stage.

The following sections will detail the role of space for the EU in the international context, demonstrating how space can be exploited as a tool of diplomacy and foreign policy. Space research and development, besides underpinning European space capabilities, also contributes to the development of a European "identity". Finally, as space makes a massive contribution to European security and interdependence, there are powerful reasons to develop autonomous capabilities across the range of space technologies.

EU in the international context

Space is a powerful tool of diplomacy and foreign policy. The financial, technological, scientific and industrial capacities required to pursue space activities autonomously are potentially so overwhelming that countries, or organizations, able to demonstrate these capacities gain a clear political advantage in bargaining on the international stage. Conducting autonomous space activities implies an ability to pursue policies, partnerships, and cooperation programmes that have considerable political benefits. During international negotiations, an independent space capability is an asset in defence of European interests.

As a space actor, the EU has an increasing presence on the international stage. This is demonstrated by a number of key initiatives:

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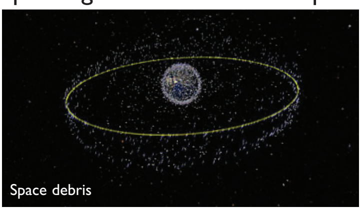
- ***The EU Draft Code of Conduct for outer space activities.*** Concern about the harm caused by intentional or accidental events to orbiting space objects has increased in recent years.

This was underlined by two events which caused damage to space infrastructures and left an impressive amount of orbiting debris the Chinese anti-satellite missile test in January 2007, and the collision between Iridium 33 satellite (US) and Cosmos 2251 satellite (Russia) in February 2009. More recently (June 2011) a piece of space debris narrowly missed the International Space Station (ISS) by a mere 250 m, putting at risk the lives of the 6 astronauts on board, years of scientific experiments and some very expensive infrastructure. An international legal framework governing the use of space already exists, but some standards for good behaviour are still absent.

The European Union – acting for the first time as a lead player in space governance – has proposed a Draft Code of Conduct for Outer Space Activities (Council Conclusions, 17 December 2008).



Space debris

Credit: ESA

The EU Draft CoC affects the whole international community, and represents a comprehensive approach that avoids focusing on the politically sensitive arena of space weapons, involving the sensitive issue of legally binding treaties. By seeking consensual agreement, this initiative has a good chance of success, unlike other international initiatives in this domain, such as the Russian-Chinese treaty proposal to ban space weapons. In 2010, the EU began informal consultations with the international community to promote the Code and to build a consensus. The EU intends to sponsor an international conference (likely at the end of 2011) to invite countries to sign up to the Code.

If the EU succeeds in persuading the main space countries - US, Russia, China, Japan, Canada, and the emerging ones like India, Brazil, and South Korea - the international community would have a potentially effective international regime to ensure a safe space environment.

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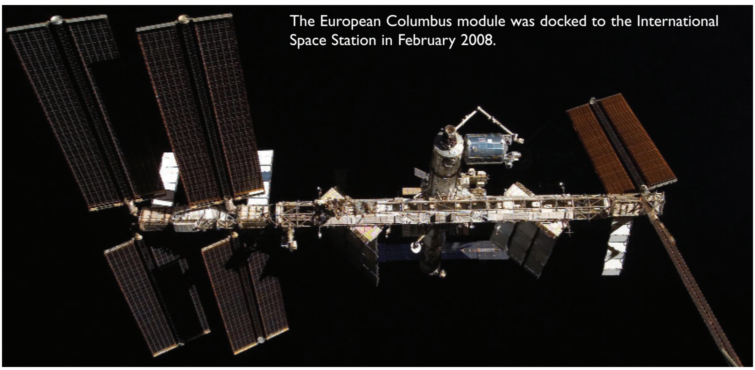
• The EU, as a space actor, is also involved in international partnerships as a concrete implementation of the ESP and as a tool of its external policy. **The EU and African Union have adopted strategic proposals integrating the use space technologies** as a tool to support sustainable development as a contribution to the Millennium Development Goals targets. As a result, the African Union, the African, Caribbean and Pacific Group of States (ACP) plus five Economic Regional Communities in Africa have requested the extension of GMES services to African and ACP countries (Maputo Declaration, October 2006). Work began formally to implement this agreement under the Portuguese Presidency (second semester 2007), with the adoption of an Action Plan (2008-2010). This was followed by a second Action Plan 2011-2013. One of the partnerships envisaged in the Action plan focuses on "science, information society and space". Among other things, the Action Plan "allows a joint analysis of the potential of space science and applications for the better management of natural resources, navigation and safety of transport, for coordinating humanitarian aid operations and for promoting sustainable development – areas of vital importance to Africa"[1].

• Eleven European countries contribute to the **International Space Station** development and exploitation, either on a national basis or through ESA. This includes providing a large number of well prepared and trained astronauts who have worked on the ISS, and a major contribution the ISS structure and support systems. The lat-ter includes the Automated Transfer Vehicle (ATV) cargo ferry (the first of which, the Jules Verne, was launched in 2008); and the scientific module Columbus, a techno-


The European Columbus module was docked to the International Space Station in February 2008.

Credit: NASA

logically advanced laboratory used to conduct scientific experiments on the ISS (more than 500 experiments a year in the field of material sciences, medicine, biology).

• ESA and some European countries participate in the international effort providing free space data on request from a country affected by natural or man-made disasters. Through the **International Charter mechanisms**, ESA and national space agencies, free images are given to authorized users, allowing quick, effective and coordinated responses. This was demonstrated by European responses to the earthquake in Haiti and the tsunami and nuclear crisis in Japan.

Space contributes also to several policies and agreements underpinning the EU's role in international relations. This is demonstrated by several important examples:

The EU development policy seeks to eradicate global poverty through the promotion of sustainable development, enshrined in the Millennium Development Goals (MDG). The EU intervenes in different areas and on various issues including trade and regional integration, environment and the sustainable management of natural resources, infrastructure and transport, water, energy, rural development, territorial planning, agriculture and food security. This also includes governance, human rights, democracy and support for economic and institutional reforms, human development, social cohesion and employment, conflict prevention and fragile states. The instruments used comprise financial aid, development programmes, political dialogue and cooperation, training and research. The EU has bilateral relations with Brazil, China, India, Iraq, Norway, Russia, South Africa, Ukraine and the US in energy issues, whilst trying to create a competitive and sustainable internal energy market. The EU also aims to address a number of challenges such as pollution, security and energy safety, diversification of sources reduction of dependency on fuels imports. In all of these areas, GMES is intended to be a key contributor to implementing development policies and to increase cooperation in these critical policy domains.

The EU also has a leading role on combating the negative effects of climate change at global level. Several European programs, including the flagship EU program GMES and several other ESA scientific programs, will help research in this field over both the short and longer term.

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Space R&D : a sort of "identity driver" facilitating the creation of pan-European teams bringing together different perspectives ans ideas to the benefit of a common European Space Policy

R&D as an identity driver for the European Union

EU's space activities originated in the desire on the part of the EU to develop space systems in support of specific European policies, such as transport and environment, as well as to sustaini the European technological and industrial base (ETIB). For this reason, the Directorate General (DG) Enterprise is responsible for the funding and leadership of the space R&D work program. One of the objectives of the Seventh Framework Program's (FP7) space program is to support the European Space Policy. In the FP6 (2002-2006), a relatively low share of the budget (about 1075 million Euros) was dedicated to «Aeronautics and Space».

In 2007, for the first time, space was allocated its own budget of 1.4 billion Euros, of which 85% was for GMES services, and the remaining 15% for activities in central space areas (space exploration and science, space technologies and space transportation). The FP7 call for proposals generated Europe-wide collaborative response from academia, think tanks, industries, SMEs, end-users and stockholders. In this sense, Space R&D (as other R&D themes) has become a sort of "identity driver", facilitating the creation of pan-European teams, bringing together different perspectives and ideas to the benefit of a common European Space Policy.

Stakeholders share the common vision of the EU as a developed, cutting-edge organization, generating economic growth and societal well-being through innovation, scientific and technological progress. EU support for space R&D is a powerful vehicle to develop a common European vision and identity.

This reflects the long established belief of the European Commission that Europe will emerge as a leading world player sustained by a common vision embracing researchers, industrialists, governments and societies across Europe. Such a vision requires that research and policy move together hand-in-hand. As Europe seeks to assert itself on the world stage and play its part in defining the future of the planet, this must be supported by participation in key global scientific challenges such as climate change, biodiversity and the protection of natural resources. This must be backed by cutting edge research, as much as by diplomacy. At the same time, research aims at the achievement of independence in critical technologies

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and the creation of innovative applications. For example, the International Space Station (ISS) and the European automated transfer vehicles (ATVs) are used to develop the microgravity research including radiation protection, virology and crew psychology.

European ATV

The Johannes Kepler mission was the second flight of the European ATV. The space freighter re-supplying and servicing the ISS was attached four months to the ISS. The mission exceeded all the mission objectives and thoughts are now directed at the next ATV flight early next year.

Crédit :CNES/ESA/ill./DUCROS David 2011

Security and independence

Following the launch of the European Security and Defence Policy (ESDP) in 1999, Europe is involved as an integrated entity in conflict prevention and crisis management. Space was soon identified to play a key role for the security of the European citizens. Space-based assets can contribute to CDSP (Common Security and Defence Policy, as it is called in the Lisbon Treaty) operations in various ways before, during and after a crisis.

The **European Security Strategy** (ESS) adopted in 2003, set out the principles for European Union's (EU) external actions. These include: prevention (act before crisis comprehensive approach (no purely military threat or action), and multilateralism (partnerships and cooperation are the key to success).

Example

Before a crisis: Providing information about the overall political, environmental, social and economic situation, namely information in situations linked to humanitarian and rescue tasks, early warning, or support to the EU and third countries in combating terrorism.

E.g. locating a terrorist training camp in Uganda/Somalia in the preplanning phase

E.g. intelligence support during the planning phase of a CSDP operation (civil or military)

During a crisis: Support to deployed forces with terrain mapping, cartography and information about the geographical environment (border surveillance, types of deployment, local resources, population, meteorological forecasting, oceanography, etc.) and information about the capabilities of the hostile forces. In the case of 'threat detection' space technologies such as positioning, navigation, observation, communications and intelligence are used to communicate with personnel on the ground, especially in the absence of infrastructure and classical communication services.

After a crisis: Damage assessment. Support to reconstruction policies.

E.g. Haiti

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operational and technological independence are crucial

ESA, EC and EDA are concerned to meet the challenges posed by technology dependence

The contribution of space to security and independence is assured through the EU's flagships programmes, the various satellite-based sensors for intelligence, space situational awareness and early warning systems.

The Global Monitoring for Environment and Security (GMES) EU flagship programme, that uses satellites originally to monitor environmental risks, has also been attributed a security function. GMES serves, therefore, for the prevention and response to crisis related to natural and technological risks in Europe, humanitarian aid and cooperation, conflict prevention including monitoring of compliance with treaties and surveillance of borders.

Galileo[2], the second European flagship programme, is a dual use radio navigation and positioning system. with applications aimed at contributing to humanitarian search and rescue services and critical transport regulations. This programme will guarantee Europe's strategic independence in the field of navigation, which has relevant applications for both civilian and military activities.

Satellite based sensors for image intelligence (IMINT) and signal intelligence (SIGINT) can provide the basis for creating a common operation picture. While such cooperation would be welcome at the European level, these kinds of assets remain today purely national. Space Situational Awareness (SSA) is a concept that strengthens the security of space infrastructure by monitoring all satellites in orbit and the increasing number of space debris. As civil and military applications are increasingly relying on space infrastructure,

SSA program to detect space hazards

Credit: ESA - P. Carril

Europe has recently started to evaluate national SSA capabilities for possible integration within the European framework. Feasibility studies are on-going in ESA, EDA (European Defence Agency) and EC framework.

Europe does not currently possess a system for long-range warning of ballistic missile attacks. Such systems today are envisioned in the framework of NATO in cooperation with the USA. Europe by itself does not have a similar programmatic objectives. However, early demonstrators in space have been developed (French satellite SPIRALE) to validate R&D orientations.

Besides, operational and technological independence are crucial: currently, Europe needs to import 60% of electronic components for the development of a satellite from the US. Despite the fact that US are a strategic ally, ESA, EC and EDA are concerned to meet the challenges posed by technology dependence. Thus, reducing European dependence on outsiders is a major element of the European Space Policy. Enhancing European space competence contributes to increasing the attractiveness of European space goods and services and the wider socio-economic return from space technology. Moreover, operational independence is seen as very important and the two flagship programmes, Galileo and GMES, besides providing a technological edge, also aim at giving Europe freedom in its security missions.

ECONOMIC ASPECTS

If compared with other industrial sectors in Europe, space manufacturing is not a major force in national economies. Indeed, even within the aerospace industry, space represents around 10% of total European output. In 2009 this amounted to 8.8 billion Euros and directly employing of about 31360[3] people. Even more striking is the comparison with a classic sector like automobile industry with 12 million jobs and an annual turnover of about 850 million Euros in Europe. However, space has important qualitative impact on national and European economy, including technological spin-off and generating comprehensive socio-economic benefits through space operations and applications.

The space sector, while affected to some extent by the cyclical nature of the telecommunications business, as weathered the recent world economic crisis. This difference can be largely explained by the strong role played by domestic institutions in the European space market (about 50% institutional customers, compared to private costumers) and by the political and strategic high value attached to space.

Industrial performance

Manufacturing

Over half (59%) of total European space sales were to institutional customers, with ESA responsible for 66% of this revenue. Satellite applications revenue grew steadily over the last decade, compared to other market segments. Over the last ten years, European manufacturers captured 28% of the market for satellites, rising to 50% in 2009. Two thirds of all satellite sales were for telecommunications applications. However, this market was subject to cyclical variations, reflecting primarily changes in the demand for GEO telecommunication satellites and associated launch services. On the other hand, revenue from the European institutional market has grown steadily.

The six largest ESA members, France (13,020 employees), Germany (5,065), Italy (5,100), UK (3,190), Spain (1,970) and Belgium (1,120), dominate employment in the European space industry, representing 90% of the total. Unsurprisingly, the workforce is highly skilled with a higher than average level of graduates (53%). As a whole 77% of space industry employees have a technical qualification. The space industry also has a higher productivity than aerospace generally and markedly so compared to the defence sector, and aerospace typically has one of the highest productivity levels in the manufacturing sector.

The space sector is research intensive, with the costs of R&D shared evenly between industry and institutions. In the case of satellites and ground systems, the proportion of industry R&D funding is between 40% and 50%. Around 10% of industry unconsolidated revenue is R&D, including some 3.3% of self-funded R&D. This compares with 5% and 2.6% for the US[4].

European space manufacturing is not especially profitable: over the last decade, returns rarely exceeded 3%. Sub systems suppliers tend to be more profitable than space primes, typically in the 5-6% region.

Services

Satellite operation is more profitable. Overall, the European satellite operator sector employs over 4 000 people directly with a turnover exceeding 3 billion Euros, with some 1.5 billion Euros traded outside of the EU.Value added activity in this sector is over twice that of manufacturing. The primary market is in telecommunications. The four main world players include several European based companies, such as Inmarsat, Eutelsat and SES. Eutelsat had sales of 1.8 billion Euros in 2009, up by 11% in comparison to the previous year, with an average growth of 5%.

Market potential

The prospects for Europe in accessible markets, primarily for commercial satellites and European institutional requirements are promising, comprising an estimated 41% share of the satellite sector and 45% of launch services. However, European space sales will be affected either negatively or positively by, inter alia, trends in the US industry, particularly the extent to which US manufacturers become more aggressive in the world commercial market and the effects of new entrants. The prospects for European institutional markets will be affected markedly by any expansion of European military and security demand. But in general, based on existing commitments, revenues from the European institutional market should grow over the 2009-13 period to an average of 1.9 billion Euros annually compared to about 700 million Euros per annum over the last decade.

Wider socio-economic impact

Employment

The space industry has a wider impact on the EU economy than simply the activity and jobs in those companies directly part of the industry. Both upstream and downstream space companies source goods and services from companies outside the space industry thereby generating activity in the rest of the EU economy. These industries themselves will in turn source goods and services from suppliers and so on.This has a number of multiplier effects.

The most obvious of these effects is on employment. For every 10 jobs directly supported by the EU space industry, another 20 in total are supported indirectly in the supply chain and from the induced spending of those directly or indirectly employed by the EU space industry.This employment multiplier is higher than most other industries reflecting the very high productivity of those employed in the space industry.

Accordingly, direct employment in the space industry in 2009 was about 33,000, with a further 69,000 jobs supported indirectly by space activity, producing a total of approximately 102,000.

Technology transfer: spin-off and spill-over

A space spin-off can be defined as something that has been learned or changed during "space activities", which is then used or transferred to other contexts creating further economic value. ESA supports organizations interested in transferring space technology into other industries through funding for feasibility studies, market analyses and prototyping. Support for start-up companies is available through business incubators as well as the "incentive" (or seed funding) available from the ESA Technology Transfer Programme Office (TTPO). In 2009, ESA data showed that space technology had been transferred into lifestyle (19%) and software solutions (19%), closely followed by environment (14%) and health (10%).

The benefits of spin-offs can be separated into two categories: tangible and intangible. Tangible benefits that can be analysed include revenue growth, cost reduction or avoidance, increase of efficiency and productivity, time saving, increased regulatory compliance, health and safety. Some intangible benefits are an improved service or image, enhanced customer satisfaction, or a higher level of well-being. A recent study[5] found that a number of life sciences related spin-offs are under-exploited, and that there would be huge benefit on a European level of having a well-targeted spin-off strategy at the start of a space programme involving wider participation from other industrial representatives.

In general, the EU space industry has a major impact on Europe's scientific and technological standing. This includes encouragement for the European science and technology base, and the wider effects of space technology on the wider economy – "spill-over".

R&D investment enhances the productivity performance of the firm or sector that undertakes it. But not all of the returns to R&D spending are 'private' – i.e., captured by the firm or sector that makes the investment. Some of the technological advances and innovations derived from R&D

"spill over" into other firms and sectors, boosting their productivity. This may occur through knowledge sharing or imita-tion as new techniques and products are passed onto the next stage of the production process, or as workers move from one company to another.

Academic studies suggest that the "spill-over" benefits of space R&D can be very large. Using data for 25 European economies plus the US and Canada over a period of 20 years, Oxford Economics found that R&D investment in the aerospace sector generally generates a social return of about 70%, that is for every 100 million Euros invested in R&D leads to an increase in GDP of 70 million Euros in the long term. These data should be viewed as a conservative estimate, as they take no account of long term effects on society as a whole of space research or of the economic returns from space downstream applications.

The benefits of R&D investment by one sector will spill over into the wider economy in a number of ways. In this context, space plays a major role in elevating the EU's S&T capabilities. Space pushes the frontiers of knowledge; making these breakthroughs in understanding of our natural environment also has more immediate impact on the way we live and prosper on Earth.

Space and exploration in particular sits at the centre of several key technological streams, stretching the state-of-the-art in a number of separate but interrelated disciplines. Space technology is on the cutting edge of "knowledge-based economy" driving future economic competitiveness and proving the tools for resolving other pressing terrestrial problems.

SOCIETAL ASPECTS

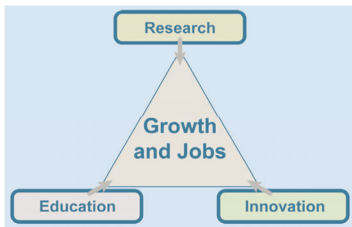
As it is defined in the European Commission communication from the 4th of April 2011 "Towards a space strategy for the European Union that benefits its citizens", space activities and applications respond to plenty societal needs. In this chapter of the Reference book, three main points will be considered: the two aspects of the societal needs where space could play a significant role (knowledge society and social needs as citizens' well-being) and how space could be considerated as a cultural asset.

How space contributes to the information and knowledge society

In Europe, a distinction is made between Knowledge and Information Societies. The difference between these two concepts is based on what they entail from political and ideological points of view. Information Society gives primacy to the content of work, focusing on ICT technologies as the central point, while Knowledge Society emphasizes the social and human dimensions.
The European Union defines the Information Society "as keeping in touch anywhere and anytime", and is the focus of a common specific policy. Building a stronger Information Society is a central issue in the European political agenda. In December 1999, in preparation for the Lisbon Council, the European Commission launched the eEurope initiative - an information society for all- to bring its benefits to all Europeans. Following this initiative, the Information Society was at the heart of the ambitious targets set by the European Union at the Lisbon European Council 23 and 24 March 2000; at the same time a Directorate General (DG) Information Society was created within the European Commission. Since then, three actions plans relating to building a European Information Society have been implemented: eEurope 2002, eEurope 2005 and eEurope 2010. Within the 6th Framework program a budget line representing nearly a fifth of the total R&D budget was dedicated to Information Society Technologies. The IST theme identified R&D activity in four technological areas, one of which was dedicated to "communications and computing infrastructures", including satellite based communications.

Building a European Information Society is considered by the EU to be part of the broader concept of the Knowledge Society as a vital step in creating a Europe of knowledge.

The knowledge dimension is viewed by the European Union as a cross-cutting axis, which involves education, research and innovation



known as the knowledge triangle.
It is not as a specific policy in itself, but rather a fundamental underlying principle. In the FP7, and with space included as a separate budget line, the EU confirmed space as

Key EU objectives for Knowledge[6]	Space activities related
Enabling wide access to Europe's education resources	Telecommunications : Providing access to educational resources and offering e-education
Increasing efficiency of professional training and lifelong learning	Remote Sensing: images and derived products can advance other disciplines and contribute to the structuring of professional training in different fields Telecommunications: By facilitating affordable communications to a majority of European citizens and connecting those that live in less-developed areas without terrestrial cable or wireless links that provide internet access, space offers training and educational opportunities without the need for travel (e.g. e-learning)
Bolstering European cooperative arrangements and sharing best practices	Models of space European cooperation which could be applied to others domains
Promoting the advancement of scientific research, knowledge and innovation, maintaining leadership in basic research and developing partnerships to proliferate knowledge	-Spin-offs from the space sector to other sectors -Supporting European science policy through space-related research -Developing knowledge through scientific and technological challenges -Advancing technological innovation -Models of partnerships and cooperation which could be applied to others domains (e.g. Hubble Space Telescope, International Space Station) Remote Sensing: Knowledge of the entire earth and of various interactions of the Earth's system, allowing observation of large-scale phenomena with a high level of accuracy, monitoring and detection of changes, providing information that can advance other areas of science including physical geography, geology, geophysics, meteorology, oceanography, climatology, global environmental changes, biochemical cycles, natural resources, fundamental physics, material sciences, biotechnology, etc. and studying deep space to provide new knowledge about the Universe Telecommunications: Facilitating exchanges among scientists as well as civil society Data Relay Satellite to guarantee continued and real-time communication Testing operations for advanced telecommunication through deep space Science and Exploration: Advancing research concerning the origin of the universe, life on Earth, astronomy, astrophysics, the observation of exoplanets, cosmology and fundamental physics, solar and heliospheric physics and Solar exploration, gravity and microgravity research, understanding solar-terrestrial relations and their impact on technological systems and human lives It provides also a unique opportunity for synergies among scientific fields
Strengthening the links among education, business, research and innovation	Space-related projects contribute to promoting scientific progress and excellence as well as the development of a European Space Policy Space-based science and research drives new technological developments, advanced knowledge and innovation Space exploration contribute to make the European trans-disciplinary research more competitive

Space technologies:

facilitate access to information

enable technological developments in other fields

one of the key building-blocks of the knowledge based society.
Space telecommunications are an essential tool in the establishment and development of long-distance telecommunications and the global information infrastructure providing wide-area coverage, high speed data transmission and connectivity. Space is therefore a critical element in a European ICT strategy.
In summary space technologies:

- Facilitate access to information for the general public and institutional or governmental bodies.
- Facilitate access to information for Europe
- Enable technological developments in other fields.

Societal needs and space answers

The EC communication "Towards a space strategy for the European Union that benefits its citizens" (4th April 2011) identified environment, health, combating climate change, public and civil security, humanitarian and development aid, and transport as societal needs. Moreover, societal needs may be envisaged more generally and could also encompass areas such as agriculture and maritime activities.

Space contribution to meeting societal needs can be summarized with reference to Maslow's hierarchy of human needs, as represented in the following figure:

Self-Actualization needs
(Fulfillment)
European space policy and activities as supports and symbol of the European Union identity

Self Esteem needs
(Achievement, status, reputation)
Space related responses: space activities engage the interest of the citizens, stimulate scientific careers, symbolize a high level of technologies, independence, power etc. contribute to a high developed society (triangle of knowledge, ICT, etc.)

Belongingness needs
(Relationship, work group)
Space related responses: telecommunications as supports of relationship and of development of synergies and cross-cutting activities etc.

Safety needs
(Protection, security)
Space related responses: Disaster management, Border control, Intelligence, Crisis support, Geo-intelligence, Data processing, 3D imaging for planning and conducting operations, Proliferation and disarmament treaty compliance, Defense and civil security communications etc.

Biological needs
Basic life needs (Air, food, drink)
Space related responses: Agriculture, Environmental Management, Hydrology etc.

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How is space influencing culture

Space plays an important role in various aspects of society and human life; these can be summarised in relation to three main cultural avenues:

Space as cultural heritage

Outer space is considered as a common heritage of humanity. Moreover, taken in its broadest sense, space is a powerful lever to raise fundamental questions about the universe, how to explore and understand it, and how this adventure changes human habits by introducing a different representation of the world. This appears as a collective heritage comprising cultural references influenced by the notion of discovery, with perhaps unexpected long-term effects on human history and society. The exploration and use of outer space, and much of the technology, infrastructure and outer space media products, are part of this important cultural heritage.

Space as cultural tool

By providing global telecommunication services independent of geographical conditions and terrestrial infrastructures, and by linking people through broadcasting thousands of TV channels in different countries, space activities are a unique means of promoting and developing cross-cultural exchanges.

Space as cultural asset

By stimulating the curiosity and dreams of writers, painters, movie makers, scientists and philosophers, outer space mobilizes the collective imagination. This is particularly true for young people who will lead new discovery efforts about the universe. Space is in itself a cultural asset.

Space :

a common heritage of humanity

an unique means of promoting and developing cross-cultural exchanges

mobilizes the collective imagination

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What is the role of the EU in the space domain?

"In the areas of research, technological development and space, the Union shall have competence to carry out activities, in particular to define and implement programmes; however, the exercise of that competence shall not result in Member States being prevented from exercising theirs."

Since mid-1980's the competences of the European Union have been continuously broadening. If initially the focus was on R&D competency as detailed in implementation of the Single European Act (1st of July 1987), and a number of treaties such as the Maastricht Treaty (1st of November 1993), the Treaty of Amsterdam (1st of May 1999) and the Treaty of Nice (1st of February 2003), space and space-related activities have started receiving increasing attention.

The Treaty of Amsterdam, for instance, emphasised commitment by the EU in the area of environmental protection, thus highlighting a potential connection to space through the services offered by remote sensing satellites. Furthermore, the Treaty of Amsterdam also suggested the establishment of an "area of freedom, security and justice", in which space systems could play an important role by providing early warning and crisis monitoring. In this context, the GMES initiative was launched to monitor environmental risks.

The Treaty of Nice facilitated the consolidation of the EU's Common Security and Defence Policy (CSDP), and also served as the basis for the ESA-EU agreement on security and exchange of classified information, which added an extra security dimension to the GMES programme.

Established in 1998, Galileo was the second flagship programme, following a request from the Council to establish a European radio navigation and positioning system. Similarly, the EU started building other space competences as a result of a number of space-related projects proposed by other ministries such as transport and environment.

The Lisbon Treaty – the Treaty on the Functioning of the European Union (TFEU) – Art. 4(3), lies at the heart of the new EU space competence. Space is mentioned explicitly for the first time: "in the areas of research, technological development and space, the Union shall have competence to carry out activities, in particular to define and implement programmes; however, the exercise of that competence shall not result in Member States being prevented from exercising theirs." Furthermore, in article 189, a European space policy obtained a constitutional basis; not only to promote scientific and technical progress, but also to encourage industrial competitiveness and the inclusion of space in all EU policies where appropriate. Finally, article 189

space This project is funded by the European Commission SEVENTH FRAMEWORK PROGRAMME REA RESEARCH EXECUTIVE AGENCY

opened the door to establishing deeper collaboration with ESA, subject to negotiating a format acceptable to both organisations.

EXISTING STRENGTHS AT THE ROOT OF THE EUROPEAN SPACE POLICY

The space sector represents a successful example of substantive European integration and cooperation. Historically, the development of space technologies dates back to the mid of the 20th century following two paths: science and research on the one side, defence applications on the other. While some European countries, such as Germany and Italy, originally focused on science and exploration applications, the military dimension of space was a vital stimulus to post 1945 space developments. This was most evident clearly in the case of rocket technology, originating in the WW2 German V2 rocket programme, and subsequent American, Soviet, French and British missile programmes, and later by the Chinese, the Israelis and others, that also formed the basis for launch vehicles. Over the decades the civil and military duality of space technology complemented each other: today dual use (civil and military) space assets are of special interest to meet simultaneously different and complex needs.

From the early stage of space scientific and technological developments, European national space communities came together in order to shape common efforts, collaborative programmes and institutions. Clearly, the complexity of space science and the need to support it with significant investments represented a strong driver to pool national competencies and resources. This reality underpinned the space founding fathers' vision for Europe. Two physicists, the Italian Edoardo Amaldi and the French Pierre Auger, shared the ambition of fostering scientific cooperation among European space faring nations, as a contribution to enhancing peace and stability.

Space was synonymous with a "new frontier", a domain to be explored, a dream able to bring people with peaceful goals together. Sentiments such as these are why European space should not be considered as a simple scientific and technological exercise. It has always been strongly linked to a political vision. The development of pan-European space institutions in the early sixties, (1964), namely

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ESA

the key player in Europe for space activities

the European Launch Development Organisation (ELDO) and the European Space Research Organisation (ESRO), paved the way for the creation of the European Space Agency (ESA) just a decade later (1975) - a success story in terms of scientific and technical cooperation in Europe.

ESA programmes

ESA is the key player in Europe for space activities. Since its creation, the intergovernmental agency has shaped and developed initiatives in every space sector. These include satellites development (ERS-1, ERS-2, Envisat, etc.), launchers (the Ariane family and Vega), human flight and exploration (International Space Station, Columbus, Marco Polo, ATV, etc.).

ESA is a successful model in terms of coordination of national space policies, activities, and resources. The fact that the leading European space countries assign an important part of their space budgets to ESA programmes is a clear indication of the level of trust in, and the successes of this institution. In many cases, ESA has helped shape national space agencies and offices, creating a requirement for extended coordination and dialogue between governments and the agency.

Furthermore, ESA has acquired extremely valuable know-how in terms of research and development (R&D) programme management. A key feature was the adoption of the "juste retour" rule, the guiding principle of the agency's industrial policy which distributes work shares to national industries in proportion to national financial contributions, ensuring the satisfaction of Member States' (MS) interests.

As far as programmes are concerned, ESA is the backbone of

SOHO: The Solar & Heliospheric Observatory studied the internal structure of the Sun, the solar wind and the terrestrial magnetosphere

Credit: ESA

European space scientific and research development. Indeed, over the decades, ESA fostered innovative new technologies and space science. Key examples are ESA's extensive studies on the Sun (Proba_2, Soho), the solar system (i.e. Venus Express, Rosetta, Mars Express, Cassini-Huygens, etc.), astrophysics (Plank, INTEGRAL, Hubble, etc.) and fundamental physics (LISA Pathfinder).

More generally, space technology investment has been structured around providing central services for European citizens, a development that has been reflected in ESA's increasing commitment to space-based applications and services. Significantly, ESA has shown its ability to use its R&D management expertise in a new range of services development. This was first seen in telecommunications and meteorology followed in due course by positioning and EO.

For these reasons, space technological development has come to rank high in the EU agenda. The European Commission (EC) has developed a comprehensive approach in order to foster services dedicated to citizens, emphasising investments based on a user-oriented approach.

European space programmes

Since 2003, the EC has been increasingly dealing with space (Green Paper on European Space Policy, White Paper on a Space action plan, ESA-EC Framework Agreement, European Space Policy, etc.). At the same time, the EC has launched two ambitious "flagship" space programmes, in order to foster the development of space-based services for European citizens: Galileo and GMES.

Galileo is the European navigation and positioning programme, a response to the well-known American GPS. The launch of Galileo responds to the will to develop an autonomous and reliable navigation and positioning system, having in mind that the GPS is controlled by the US Department of Defence. Galileo, directly funded by the EU, after major difficulties in its development and deployment phase, will become partially operational from 2014 based on a constellation of 18 satellites. The remaining 12 satellites should complete the system by 2020.

GMES aims to establish a European capacity for EO, by pooling European and national (existing and planned) assets, at the service of EU policies and European citizens' needs. GMES

EC has launched two ambitious "flagship" space programmes in order to foster the development of space-based services for European citizens: Galileo and GMES.

services are being developed based on six main thematic areas: Land, Atmosphere, Marine, Emergency response, Security, and Climate change. As of today, GMES entered its Initial Operations phase (2011-2013) providing some (pre-operational) services, while others are still to be consolidated. GMES has also an important infrastructural element being developed by ESA: the Sentinel satellites will provide capabilities to shape a variety of services in the different thematic areas.

Galileo and GMES illustrate a key trend: space has become crucial in the EU agenda, and the EC is pushing for technological and services development with dedicated budgets.

These two flagships programmes seem to pave the way for future space programmes funded and managed by the EU, demonstrating its growing political and coordination role in the space domain, as established by the Lisbon Treaty (articles 4.3 and 189). But it must not be forgotten that space in Europe is still largely shaped by national policies, often combined in cooperative initiatives. Innovative forms of governance for these programmes are key to their effective development and sustainability.

ELEMENTS CONTRIBUTING TO THE EUROPEAN SPACE « ENGINE »

Member states' programmes

Member States retain significant capabilities for space research and develop independently space technologies and programmes. This derives from the historical evolution of space technology which required public funding and strong political support. At the same time, space played an important role in the European integration process. However, these two themes are convergent as space activity is a highly integrated sector at the European level. This duality can be viewed as a balanced model, where there is major investment in space at both at the ESA and at the MS levels. This is now complemented by the recent growth of the EU as a space actor adding a European political dimension. Nevertheless, in some cases, competition between national and European programmes may arise, but in general terms, national programmes deal with research or sovereign technologies (especially for defence needs), while ESA and EU programmes deal with more ambitious initiatives directly serving European interests.

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Space technology has always contributed to defence capabilities. This is the case for France, where launching, telecommunications and observation capabilities were elements of the national strategic nuclear deterrent. More recently, as the post-cold war international scenario widened the scope for national military forces to be deployed abroad, reinforcing the need for a global technological outreach for security and defence, other EU MS have invested in space-based EO and telecommunications capabilities.

Several trends can be observed in MS space programmes. The French space programme is clearly the most comprehensive in Europe, as it was created as a part of an autonomous national capability for nuclear dissuasion. The other European nuclear country, the UK, rapidly abandoned an autonomous approach, preferring cooperation with the US. Currently, France still maintains a strong national space programme for both defence and civil requirements. The two other biggest ESA contributors, Germany and Italy, are also developing national military and civil space capabilities. Italy experimented in the 1960s with off shore launching (the Malindi base in Kenya) and started its own satellite programme ("San Marco Programme"). Germany has invested in human flight capabilities and satellites. Today, both countries are investing in a new generation of satellites for EO, such as COSMO-SkyMed and TerraSAR-X/TanDEM-X respectively, as well as in satellite communications.

Credit: DLR

Other MS like Sweden or Spain have also some national programmes in place, such Svea (Swedish surveillance satellite) and SEOSAT-SEOSAR/Paz (Spanish dual use satellites system), while others, as Belgium and the Netherlands, mostly vehicle their investments into ESA programmes or intergovernmental initiatives.

Cooperation programs

There are several current bilateral or multilateral cooperative programmes under way amongst European countries independently of ESA.
The MUltinational Space-based Imaging System for Surveillance, Reconnaissance and Observation (MUSIS) can

be regarded as the biggest intergovernmental programme in Europe. Contributing countries are France, Italy, Belgium, Germany, Greece, and Spain. MUSIS aims to share data and images from the next generation of European military or dual use satellites for EO, such as the replacements for the French Helios II, the Italian CosmoSkyMed and the German SAR Lupe. Cooperation will centre on an interoperable user ground segment (UGS) working to agreed rules and quotas. In 2009 MUSIS was transferred to the European Defence Agency (EDA) as a collaborative project which is open to other EDA MS. Indeed, in 2010 Poland and Sweden expressed an interest in taking part in the programme. Precursors of such enlarged programme were the bilateral agreements between Italy and France and between France and Germany.

The Optical and Radar Federated Earth Observation (ORFEO), launched in 2001 by Italy and France, was the initial answer to the need, which emerged from a series of studies on future user requirements for an optical and radar metric resolution observation system to detect, recognize and identify specific targets. The Italian COSMO-SkyMed provides the radar component (SAR) of the ORFEO architecture, while the French Pleiades provides the optical component. Similarly, Germany and France agreed to share images from SAR Lupe and Helios II respectively, while Belgium and Spain have been involved in the development of Helios II, each with a 2.5% share. In the field of satellite communications, the Access on THeatres and European Nations for Allied forces - French Italian Dual Use Satellite (ATHENA-FIDUS) is a French-Italian cooperative project to develop a dual use broadband satellite to be launched in 2013. It will be used by French, Belgian and Italian armed forces as well as French and Italian civil protection services.

Credit: Thales Alenia Space artist's conception

How space is being used in Europe?

HOW IS EUROPE TAKING ADVANTAGE FROM SPACE ?

The priority areas that could particularly benefit from the use of space in Europe have been identified as being climate change, security, innovation and exploration. The major space services and related activities linked to these priorities, as well as their end users are presented in the following sections.

Space services and end-users

Space applications and related services represent a key benefit for everyday life in Europe. In the societal field, they contribute to the well-being of citizens both directly and indirectly.

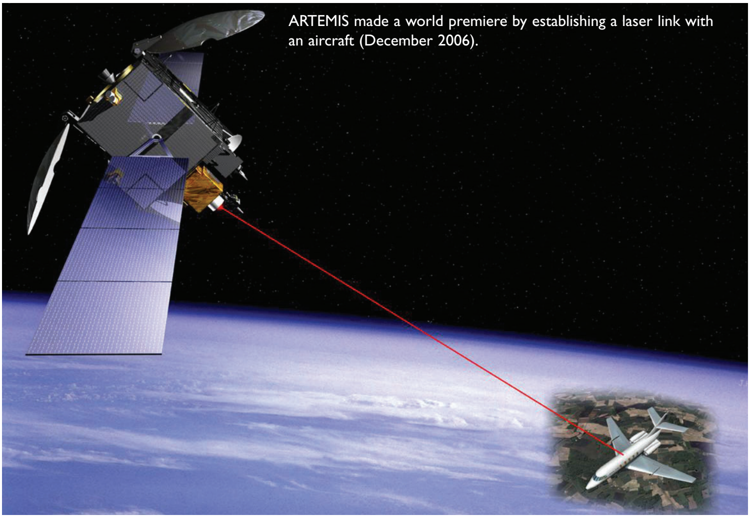
On the one hand, the general public is now accustomed to the utility of in-car satellite navigation systems for travelling or for tracking a stolen vehicle; for EO providing the daily weather forecast; for satellite communications for TV broadcasts and the telephone. On the other hand, space services are vital to the security and protection of the citizens thanks to innovative solutions such as estimating of seismic hazards or avalanches and other natural or manmade disasters. These very basic examples clearly illustrate the importance of space services in people's lives.

It is usual to divide satellites into three categories, based on their applications: telecommunications (satcom), EO and navigation/positioning. The first space-based services available to the public have their foundation in satcom and EO. These two applications were developed during the 1960s and the 1970s respectively, within a public funded framework and often through international cooperation. Governments and governmental agencies (national or international) undertook initiatives aimed at creating new technologies for the benefit of national industries and citizens, while enhancing a country's international profile, its

Satellite communications

Satellite communications are one of the major commercially viable space-based services. They provide a wide range of options including digital video broadcasting (DVB), satellite news collection, wideband multimedia applications, specialized services for home, and global mobile personal communications by satellite. New areas such as telemedicine and air traffic management also benefit from digital satellite technologies, especially in remote areas. At European level, in 2009, telecommunications were the most profitable satellite applications with 1.940 billion Euros of sales (Lionnet and Perrier, 2010).

The major European players of the satellite communications market are EUTELSAT, Inmarsat and SES.



ARTEMIS made a world premiere by establishing a laser link with an aircraft (December 2006).

Credit: ESA

national security, and the national scientific base. This initial public investment and control of space-based systems, was the only feasible way to develop space-based applications, as the costs of researching, developing, launching and operating such systems were beyond the possibilities of the private sector. Private investment was also deterred by the high risk of technical failure. By the end of the 1990s, some public-owned companies and intergovernmental organizations were privatized, as the satcom and EO markets were progressively opened to competition, albeit to very different extents and rapidity. While the satcom market became quickly profitable and competitive, but with the exception of meteorology, the EO market remained limited and less dynamic, with the exception of meteorology.

GMES

The GMES programme has been established in 1998 as an EU flagship programme providing a wide range of services, such as, forecast, geographic information and emergency management support.

Earth Observation

Earth Observation satellites can cover and provide information of the planet across time and space. The data gathered can be used for activities such as meteorology, mapping of territories, climate change and environment (i.e. floods monitoring, land use, desertification, vegetation coverage, etc.), strategic planning (i.e. crisis management, search and rescue, damage assessment, etc.), operational activities (i.e. maritime surveillance, border and coastal control, etc.), management of natural resources (water, timber, marine resources, etc.). The first services delivered in the field of Earth Observation (EO) included meteorology and resource monitoring. To date, the European EO market sales have reached 938 million Euros.

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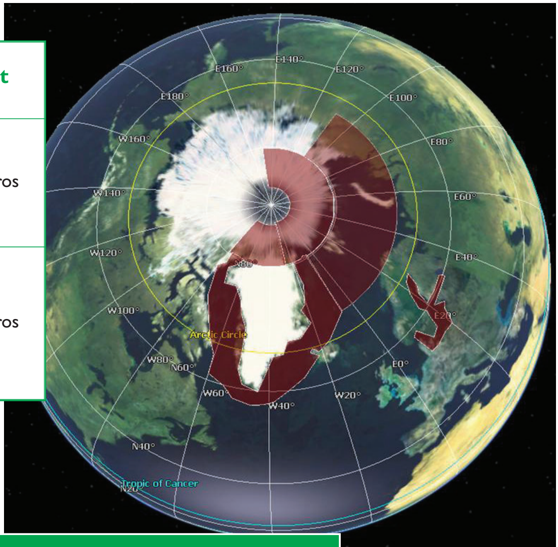
EU R&D Projects	Focus	Budget
SAFER	Rapid mapping, geographic reference, disaster extent, damage assessment, early warning	40M Euros
G-MOSAIC	Situation awareness, damage assessment, crisis indicators assessment, routes surveillance	15M Euros



Credit: ESA

Meteorology

Europe has long recognised the importance of having free access to meteorological data, for this purposes the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) was established in 1986. EUMETSAT aims to deliver weather and climate-related satellite data, images and products. Along with meteorological monitoring, the development of environmental services is another direction covered by EUMETSAT, with particular focus on oceans, atmosphere, land and biosphere, as well as natural disasters.

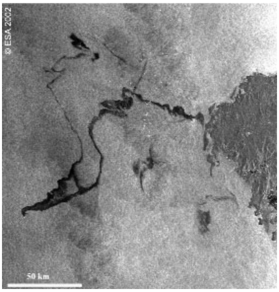
Earth resources monitoring

Europe has been playing an important role in the domain of Earth resources monitoring mainly via two major initiatives SPOT (Satellite Pour l'Observation de la Terre) and the European Remote Sensing (ERS) satellites.

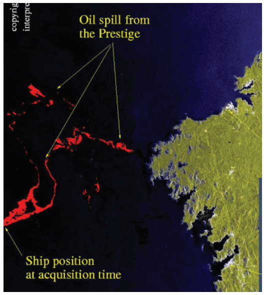
SPOT is one of the most successful EO programmes in Europe used for improving the knowledge and management of Earth resources, but also to commercialize EO satellites data and images.

ERS satellites included ERS-1 and ERS-2 both used extensively for gathering data about Earth's land surfaces, oceans, polar caps and also for monitoring natural disasters. Data from these satellites is available free of charge.

Example
EO was used to monitor the marine pollution caused by the wreck of the oil tanker “Prestige” off the coasts of Spain and France in November 2002



Credit : CNES, Envisat satellite



In terms of projects related to global environmental monitoring both ESA and the EC have sponsored a large number of initiatives through various funded programmes - the major areas covered include atmosphere, land, and water. The main categories under which each project is carried out is summarized in the following table.

Themes	Focus
Agriculture	Crop monitoring, sustainable development
Atmosphere	European air quality, UV radiation monitoring
Biodiversity	Habitats monitoring
ECV/climate change	Climate variability monitoring, ice monitoring, CO2
Emergency	Earthquakes prediction, flooding forecasting, damage assessment, landslides
EO data	Data exploitation and integration
Land	Forest cover, forest cover changes and biomass monitoring
Marine	Detection of harmful algae blooms and forecasting, pollution detection
Maritime surveillance	Vessels tracking and borders surveillance
REDD	Carbon accounting, forest monitoring
Regional networks	European networks, EU-Africa networks
Renewable energy	Renewable energy sources promotion
Sea ice	Ice mapping and monitoring
Water	Water resource monitoring and forecasting

Navigation and positioning has benefited everyday life through the use of the US GPS signal. Originally developed for military use, the availability of this technology for civilian use has fostered a large family of applications using geo-localization capabilities.

In addition, modern applications are increasingly based on a mix of technologies. For example, precise navigation requires meteorological data, positioning and telecommunication capabilities.

Various value-added services have also reached the market related mainly to the processing and interpretation of satellite data and images. Some of the players include: GAF – Germany, SERTIT-France.


Galileo, the European satellite positioning and navigation programme was established by the EU and ESA in 2002.

Credit: ESA/J.Huart

Space has thus become more "demand oriented", pushing the EC to adopt a user-driven approach in its programmes, involving final end- users even during the definition and implementation phases. Nevertheless, it is important to consider that key technological space developments have been fostered by scientific, exploration or defence demands. Space has always been about the translation of public policy choices, which then facilitated commercial spin-offs for civilian markets. But while the increasing importance of civil markets is a reality, public investment remains a fundamental source of funding for space technology. In the contemporary space business the "end-user" and the "public policy" approaches must be seen as the two sides of the same coin. The "end-user" approach translates the will to develop a specific demand, while "public policy" provides the technology and services for very specific markets. But the "public policy" approach is still needed to shape and develop concepts and application to fully meet and to encourage "end-user" demand.

Other applications: science, exploration, security and defence

Space exploration and space science

Space exploration is the most emblematic area of space activity and by proxy of space technology. But space exploration also has a powerful scientific role, and the results provided by space missions may contribute to the solution of unanswered scientific questions about the Earth or the universe.

Either as a result of robotic or human intervention, space exploration is a political, economic or scientific objective for both the established and emerging space powers. To date European space exploration programmes have been largely used for scientific purposes with limited political concerns. In the future, however, this could change as Europe needs to align with other space powers that are linking space exploration and 'high politics'. Moreover, challenges related to climate change or internal security, in which Europe aims to play a major role, are increasingly important elements in future space exploration.

Europe is at the forefront of space-based scientific research, as it supports a large number of projects in potentially breakthrough areas. Space science is a strategic asset that could contribute to European technological independence while strengthening a European cultural identity. Space is a unique dimension in which to expand human knowledge. Recognizing that single European nations could not independently achieve much success, ESA has catalysed European cooperation in this sector by pooling the best scientists and resources from MS. For science and exploration, space technological developments are driven by a very specific demand: public policies aimed at pure research. While this was especially important in the early days of space exploration, the approach is still valid today, as "user" for space exploration and science is a significant but tiny community, a very specific "market", exclusively publicly funded. An example would be research carried out in microgravity that revealed important findings for life and physical sciences.

Microgravity research in Europe

ESA started an ambitious long-term programme in the field of microgravity research: ELIPS (European Programme of Life and Physical Sciences).

Examples of microgravity experiments

Natural gas storage

Experiments carried out by CEA and the University of Bordeaux based on the Alice instruments on board of the MIR station revealed potential applications to the extraction and storage of natural gas.

Plasticity of neural system

Microgravity research on the central neural system allowed French scientists to reveal new mechanisms involved in the plasticity of the neural system.

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SEVENTH FRAMEWORK PROGRAMME REA RESEARCH EXECUTIVE AGENCY

Furthermore, Europe operates many scientific satellites and interplanetary probes to the solar system; of these high energy astronomy and the Hubble telescope have revealed impressive results. The later becoming a public outreach tool for the promotion of space exploration and space science as a result of the sheer beauty and impact of the images returned.

Credit: ESA

In terms of space exploration Europe has participated in a large number of missions such as Mars Express, Venus Express, Rosetta, SOHO or Huygens probe, with an outlook to other ambitious future missions like Bepi Colombo, ExoMars and the James Webb Space Telescope.

A number of scientific missions, in the field of Earth sciences, to which Europe contributed, are directed at gravity field determination, atmospheric research, sun-earth interaction, the dynamics of ionosphere and implications for radio propagation. Furthermore, innovative European research in the field of physics and life sciences is also carried out on board of the International Space Station (ISS) in the European laboratory or in the Russian module.

Credit: NASA, ESA, Hubble Heritage

Micro and mini satellites have been gaining importance in recent years in Europe. The British company Surrey Satellite Technology (now part of Astrium) launched the first commercial microsat (UoSAT-5).

Security and defence

The benefit of space for security in Europe is derived mainly from the three services imagery, communication and positioning. There are three broad groups of users: intelligence organisations, military forces and civilian crisis managers. While the exploration of space and the use of space for strictly civilian, non-crisis related services has been the responsibility of the multinational European Space Agency (ESA) and, where possible, commercial entities such as SES Astra, space for security has lacked European coordination and has been developed nationally.

The major European space power in the field of security is France, closely followed by the United Kingdom. This is probably due to the fact that France and the UK also are the two western European nuclear weapon powers as well as regularly operating militarily outside the European region. To make a nuclear deterrent plausible, a nation needs not only the nuclear weapons but also a system for targeting and command and control for the weapons. France and the UK were therefore early developers of military satellite communications in Europe. UK developed its Skynet program with its first launch in 1969, and France developed the Syracuse system, first launched in the early 1980s.

With the end of the Cold War two things happened: first, the focus of military operations moved from the defence of continental Europe against an attack from the Cold War adversaries toward out of area crisis management operations; and second, developments in information technology both introduced computers and digital information into more military systems and raised the demand for information within both military and civilian crisis management operations and between a theatre of operations, e.g. Congo or Tchad , and Europe This led to an increased interest in dedicated satellite communications capacity on the part of more national authorities. A result of this was the launch of national communication satellites by Italy (SICRAL), Spain (Xtar-EUR, Spainsat) and Germany (COMSATBw). European states also follow the US trend in buying commercially available bandwidth, either to augment their nationally owned bandwidth or as a substitute for owning a national communications satellite system.

In parallel to the development of satellite communication, Europe has developed imaging satellites. The first European imaging satellite was the optical French/Belgian/Swedish SPOT 1 launched in 1986. SPOT 1 has been followed by four other SPOT satellites with increasingly higher performance. Imagery products from the SPOT series are used by both military and civilian European users. However, from an institutional perspective SPOT must be viewed as a government owned commercial system.

The first dedicated space-based national intelligence system using satellite imaging in Europe was the French Hélios 1, with its first launch in 1995. This was followed by the Hélios 2, first launched in 2004. As more European countries are now involved in crisis management operations some distance from Europe, the use of satellites for both strategic and tactical intelligence has increased. The French Hélios 1 is now to some extent an international collaboration between France, Spain and Italy, while Hélios 2 is a collaborative exercise involving France, Spain, Italy, Belgium, Germany and Greece.

As more European countries are now involved in crisis management operations some distance from Europe, the use of satellites for both strategic and tactical intelligence has increased

The United Kingdom has chosen not to take part in the European collaboration on satellite systems for intelligence needs, but instead has developed a dedicated satellite for tactical use called TopSat. The TopSat demonstrator was launched in 2005 and designed to produce high resolution images (2.5 meters) with a somewhat reduced coverage in comparison with traditional Earth observation satellites. However, such a satellite is fairly inexpensive, and the images can be downloaded in the field, making TopSat a possible resource for battlefield commanders and on scene commanders in crisis management operations, rather than a major resource for national intelligence organisations.

To complement the optical imaging satellites, a number of radar satellites are being developed by European countries. Radar satellites use synthetic aperture radar (SAR) to create an image from the radar signals. This can be done day or night and through cloud cover. The images are more difficult to interpret than optical images and also are less detailed. The current systems are the German SAR-Lupe and TerraSAR-X and the Italian Cosmo-SkyMED. The SAR-Lupe system consists of five satellites launched between 2006 and 2008. TerraSAR-X consists of two satellites launched 2007 and 2010. Cosmos-SkyMED consists of four satellites launched between 2007 and 2010. With the exception of SAR-Lupe, all these European military or dual-use imaging systems use polar orbits. This gives a worldwide coverage with a revisiting time in the order of days.

From a European Union and

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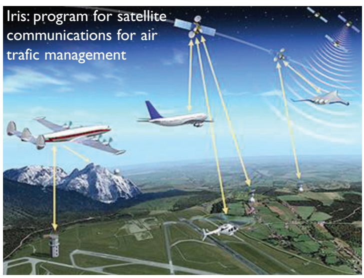
CSDP-perspective, although the satellites are controlled by various member states, there is now a comprehensive European imaging satellite capability. The Swedish ground station in Kiruna, close to the Arctic Circle, is already used for both tracking and control of these satellites, and downloading of the images. The closeness to the North Pole means that the Kiruna station can download images from satellites on many more occasions per day than ground stations in Spain or Italy. For similar reasons France uses a ground station on the island of Kerguelen in the southern Indian Ocean.


Kiruna ground station

Credit : ESA

Even though all of the imaging systems in Europe are national and the EU as a union does not have any satellite capability of its own, the EU does have an imagery analysis resource in the form of the European Union Satellite Centre, EUSC, at Torrejon in Spain. The EUSC is an important part of the EU crisis management operations as it supports the EU missions with intelligence derived from imagery bought on a commercial basis. About 15% of the images used come from European sources and the rest come mainly from US sources.

The third space service in extensive use by European nations is satellite navigation/positioning. The usefulness of satellite navigation for military operations was demonstrated by the US during operation Desert Storm in 1991, and today almost all military platforms use satellite navigation in one form or another. Besides the obvious use as a means for navigation, it is also used by most European air forces to guide bombs to their targets. Europe currently has to rely on the signal from the US GPS-system as the European GALILEO system is not yet operational. Moreover, as the GALILEO is a civilian system, there is a debate over to what extent it could be used for mili-


Iris: program for satellite communications for air trafic management

Credit : ESA

Even though all of the imaging systems in Europe are national and the EU as a union does not have any satellite capability of its own, the EU does have an imagery analysis resource in the form of the European Union Satellite Centre

This project is funded by the European Commission

tary purposes. Besides the more direct uses of space described above, there are also a number of service that can be regarded as being enhanced or enabled by space systems. One example is weather forecasts that benefit from various weather satellites. Another area is mapping where space systems are essential for the creation of 3D-maps used in command and control systems.

THE PLAYERS AND THEIR ORGANIZATION

The European institutions

Following the Lisbon Treaty, with reference to article 4 and article 189, ESP has become an area of shared competencies among several stakeholders: on one hand there is the triangle comprising the European Union, the Member States and the European Space Agency, and on the other hand, within the EU, there is the triangle composed of the European Council, the European Parliament and the European Commission.

Since 1st December 2009 when the Lisbon treaty entered into force, the European Union has a legal competence to address the full range of space policy related issues

Since 1st December 2009 when the Lisbon treaty entered into force, the European Union has a legal competence to address the full range of space policy related issues, whether related to human space flight, exploration, launchers, application satellites or international cooperation. Space-related decisions are governed by normal legislative procedure, which gives the European Commission the initiative in proposing legislation, but shared responsibility for authorisation between the European Parliament and with the Council, where qualified majority rule is applicable.

However, the principle of subsidiarity also applies: the EU can only act if it is in position to do it more efficiently than the Member States. This principle was reinforced by the Lisbon Treaty that envisioned "an early warning procedure" allowing the national Parliaments to control the application of subsidiarity.

Under the Lisbon Treaty, the EU is now responsible for the formulation and implementation of European Space Policy, legitimised through the Parliament and the Council processes. In theory, from an intergovernmental-nature organized primarily through ESA, European Space Policy has become a transnational policy supported by a political entity composed of 500 million citizens. Until this point, the EU only had an indirect competence for space, its main programmes the responsibility of common general competences such as

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telecommunications, environment, common foreign and security policy, transportation, and research. Most notably, Galileo was funded as part of the common transportation policy while GMES was defined by R&D goals associated with the development of a common environmental policy. However, despite these changes at a European level, the EU still shares its competence in designing the ESP with the Member States. The existence of a more coherent EU competence does not prevent Member States from exercising their own space-related polices (Article 4&3 of the Lisbon Treaty). Indeed, MS tend to have a different interpretation of the Lisbon Treaty; and a juridical debate is continuing to determine if the EU competence is "parallel", "shared" or "complementary" to national competence.

As a result, Member States retain their full competence with operational, more than purely normative, capacities (including common initiatives, R&D, exploration and use of space, etc.). But in addition, the Lisbon Treaty assigned new capabilities to the EU in the field of European military space programmes.

The EU can act in two ways: (1) Art.189 provides ample room to allow the EU developing dual-use programmes as long as the proportion of military developments remains at a controlled level as in the case of Galileo and GMES. In this hypothesis, they will benefit from some flexibility as far the interpretation of EU's domain of competence is concerned, as stated by art. 352. More notably, Art. 40 of the EU Treaty and the declaration N°41 of the Intergovernmental Conference, limit the flexibility in the application of the EU competences under CFSP/CSDP rules, and may prevent a dual-use programme from being developed based on Art. 189 (2) the EU may also intervene in the field of security and defence related programmes under the CSDP framework. In this context, the role of the EU will have almost to be defined on a case by case basis. In the case of military or dual-use space, Member States may accept that a direct access to the data for the EU, even up to the designing of the tasking or of the data policy between the Member States. In the contrary, the EU may also want to be given a coordination role only, and leave the control of the system to the national authorities even if the EU contributes to its financing.

The main EU institutions and agencies active in the ESP and

EU still shares its competence in designing the ESP with the Member States

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their role are described below[7].

The European Commission (EC)

The European Commission (EC) is the executive body of the EU in charge of community policy. The EC represents the common European interest and has a crucial role in the European lawmaking process, as it proposes legislative acts to the European Parliament and the Council of Ministers. The Commission together with the Member States has agreed a shared vision for research and how the European Research Area might develop by 2020. Space is one of the major themes in the R&D area. Moreover, the EC aims to reinforce its role as a key player in the space arena by contributing to key themes, such as exploration via international partnerships, security at pan-European level, mobile and broadband communications, and improved efficiency of air-traffic management.

Space issues are addressed by several DG or Units established within EC; there is a dedicated Unit for European space policy matters – Unit H1 Space Policy and Coordination, which is established within the DG Enterprise and Industry, and which is responsible for organising the High Level Space Policy Group's meetings.

The Council of the European Union

The Council of the EU is the intergovernmental institution of the Union, it represents the member states and is the main decision making body. The Council of the EU, jointly with the European Parliament, is co-legislator at the EU level and approves the EU budget. Moreover, the Council is responsible for developing the Common Foreign and Security Policy (CFSP) and the Common Defence and Security Policy (CSDP). The Council coordinates also the cooperation among MS in criminal and justice matters.

Two formations of the Council are regularly and particularly involved in space: the Competitiveness Council (principally involved in overseeing space policy and the development of GMES) and Transport, Telecommunication and Energy Council (mainly involved in monitoring Galileo issues). Moreover, the Council is directly responsible for the satellite Centre in Torrejon (EUSC), and for the drafting and negotiation of the EU proposal for a Code of Conduct on Outer Space Activities.

The European Parliament (EP)

The European Parliament is the only European institution directly elected by European citizens. It is organized in political parties and has a range of specialized thematic committees and subcommittees. In its legislative function, the European Parliament participates in the co-decision procedure together with the Council. With regard to the budgetary function, the Union's budget is established by the European Parliament and the Council on the basis of a European Commission's proposal. Since the adoption of the Lisbon Treaty, the European Parliament has had important new powers regarding EU legislation, the EU budget and international agreements.

Within the EP, two Committees deal with space policy: the Subcommittee on Security and Defence (SEDE) and the Committee on Industry, Technology and Research (ITRE). Space-relevant legislation is the responsibility of the latter Committee, while SEDE deals with the security and defence aspects of space. The EP also provides the financial resources, which were necessary for the continuation of the Galileo programme. Within EP, an Intergroup on Sky and Space has been established to discuss specific matters to these two fields.

The EP adopted also several resolutions concerning space (see list of main institutional documents in Appendix).

The European Space Agency (ESA)

The European Space Agency (ESA) is an intergovernmental organization of 18 member states, two of which are not in the EU, which seeks to coordinate and develop the space capabilities of its members. Romania will be the 19th member state of ESA once the accession agreement is ratified during 2011. "By coordinating the financial and intellectual resources of its members, it can undertake programs and activities far beyond the scope of any single European country. […] Its mission is to shape the development of Europe's space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world"[8].

"ESA's purpose shall be to provide for, and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems:

- By elaborating and implementing a long-term European space policy, by recommending space objectives to the Member States, and by concerting the policies of the Member States with respect to other national and international organizations and institutions;

- By elaborating and implementing activities and programs in the space field;

- By coordinating the European space programme and national programmes, and by integrating the latter progressively and as completely as possible into the European space program, in particular as regards the development of applications satellites;

- By elaborating and implementing the industrial policy appropriate to its program and by recommending a coherent industrial policy to the Member States”[9].

These four institutions and agencies are the main players in the ESP process, although there also a large number of other stakeholders with an interest, influencing directly or indirectly the ESP. These can be implementing agencies (like the European Defence Agency or the GNSS Supervisory Authority), or current or potential end users (like FRONTEX, European Maritime Safety Agency, Council CSDP related bodies, EC DGs) or finally contributors to the development generally of the ESP (European Space Policy Institute or European Economic and Social Council).

However, the four main actors described above form the backbone of the ESP and the so-called “institutional triangles”. Recent developments (introduction of the flagship programs, the Lisbon Treaty, and budget constraints) have forced the EU to search a new institutional balance among the players in order to maximise efficiency, viability, and long term financing for programs while keeping in mind the general goals of ESP (space at the service for the EU policies and its citizens, industrial and technological development, economic growth and innovation).

Recent developments have forced the EU to search a new institutional balance among the players in order to maximise efficiency, viability, and long term financing for programs

The new institutional architecture is at the core of the current debate, and will be further explored in this reference book under the chapter “challenges and opportunities”.

The industry

The space value chain extends

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from the "upstream" manufacturing sector, though satellite operators to further "downstream" into a range of space applications and services. Indeed, the value of the downstream segment vastly outweighs the value of the manufacturing element.

European Space Industry Structure

The European space industry is highly concentrated, with a high degree of vertical integration in the manufacturing supply chain. While some manufacturers are expanding their satellite services business, this tends to be in niche, specialised areas. Industrial concentration reflects the wider consolidation trends in the European aerospace industry as well as the "critical mass" requirement of space prime contractors and major suppliers globally. Four multinational companies (EADS-Astrium, Thales-Alenia Space (TAS), Finmeccanica, and Safran) are responsible for more than 70% of the total European space employment. This has helped to maintain Europe's position relative to its major competitors, with four companies in the world space industry top 10 and 14 in the top 50.

Vertical integration is driven by the highly specialised nature of the space business, high capital requirements, costly testing facilities and low volumes. There is also a strong pressure to retain control over critical component supply to ensure quality and reputation with customers and space insurers. As a result, SMEs represent less than 5% of European space manufacturing employment. The US for example can sustain a greater number of smaller players supplying a larger number of primes and space systems integrators. This, for example, would justify capital investment in test facilities and clean rooms and generate some economies of scale denied to European companies. Nevertheless, there are European views considering that increasing significantly the volume of European space production would, perhaps, support a larger number of space suppliers.

New entrants in the space sector have been aided by the application of ESA geo-return policies and by political support for "national champions". However, the former has also helped to trigger a number of mergers and acquisitions, as larger companies have sought to increase their share of European institutional funding.

SMEs have been recognized as

SMEs : key actors for the competitiveness of a sector

'key actors for the competitiveness of a sector' and their participation and fair access is strongly encouraged in the space R&D area via various financial instruments, such as the creation of start-up satellite-enabled services or co-participation in European research programmes. Despite the relative size of the SME sector, it is qualitatively important. The space supplier chain is effectively an intense innovation net work, with strong links to academia and research agencies. They are a key part of the knowledge transfer chain and a substantial contributor to the high level of competitiveness in the sector. Their inherent flexibility means that they can adjust quickly to take account of emerging technologies and to develop products for new markets.

There are also important links between European academia and industry in the aerospace sector generally. However, these are especially close and direct in the space sector. This ranges from basic research associated with the design and development of space hardware, as well as detailed work on scientific payloads and the interpretation of data. In this sense, academia is a major customer of the industry's most advanced products. In a number of notable cases, such as Surrey Satellites, an academic grouping led to the creation of SSTL as a spin-off company.

Although often constrained by national political interests, aerospace generally has globalised supply chains and ownership. This is significantly less evident in the space sector. While the major European firms are multinational in operation, there are varying degrees of intra-firm rationalisation of functions. Trans-continental ownership of space companies is also very much the exception. There is a trade in space goods, but this too is affected by political issues, notably by the application of the US International Trade in Armaments Regulation (ITAR) to the space sector. This has led to European initiatives designed to reduce dependence on US sourced components.

However, there are signs that commercial interests may be driving European space companies to invest in the US, or to seek US partners to enable access to US government markets. TAS is partnering with Ball and Boeing to develop the next generation of Iridium satellites. Astrium is also reportedly considering a US acquisition. The TAS-US joint venture will enable

Iridium to bid for US Defence Department business. Boeing will be responsible for the ground segment and Ball will handle satellite assembly, integration and testing. While making good business sense, the partnership approach is likely to reduce the overall industrial value of a large satellite production run to the Europeans. Some 40% of the manufacturing work will be done in the US. The competitive position of European firms also been affected by the impact of US technology transfer regulations.

Political constraints on inward investment in the space sector, especially in the US have at least ensured that the European space sector has a more evident European cohesion. In the wider de fence and aerospace industry the development of extensive investment in the US, especially by the UK, can act as a divisive force in terms of developing a European defence and technology base. In the space sector, with some limited exceptions – again related to the UK's determination to retain a freedom to choose launch vehicle options and to rely on US sources for key strategic space services – European space policy is more immediately able to address a European space industrial context without distraction or the temptation of a US option.

Overall, the European space industry has achieved an impressive standing in the world industry with a high degree of technological quality and accessible market penetration. This position is, however, vulnerable to increasing global competition and the continuing pervasiveness of political factors shaping the market.

European Space Services

European launch services are marketed and operated by Arianespace, which has captured a large share of the accessible world market. EADS-Astrium Space Transportation is the prime contractor for the Ariane, with Safran-Snecma leading propulsion systems development and production. There are some 40 other European suppliers involved, with a

Arianespace is the market leader

The vast bulk of space services are in the telecommunications sector

The European Earth Observation (EO) industry is still relatively undeveloped compared to the US

number (25) highly dependent on Ariane business (more than 50% of turnover). The Italian company Avio is prime contractor for the smaller Vega launcher. Arianespace now also operates the Russian-built Soyuz rocket.

Arianespace has captured more than one-half of the commercial launches and is now the market leader, able to claim a price premium for reliability and flexibility of provision. However, the launcher services industry is heavily affected by political interests and non-market factors.

The European satellite-operating sector has over 11 companies, some of which are subsidiaries of space manufacturers such as EADS Astrium Services and Telespazio (Finmeccanica). The four main world players include several European based companies, such as Inmarsat, Eutelsat and SES. The development of space services by the manufacturing primes is motivated by an interest in accessing higher value elements of the space market. It also reinforces the importance of a strong linkage between upstream and downstream aspects of the space business.

The vast bulk of space services are in the telecommunications sector. With the exception of the comparatively low value meteorological services market, the European Earth Observation (EO) industry is still relatively undeveloped compared to the US. This has been due in part to the fragmented nature of the sector. This has hampered competitiveness in higher value Earth markets such as Homeland Security. However, some rationalisation has occurred as upstream companies acquire an interest in EO with increased opportunities to deliver integrated services and to exploit economies of scale.

Developments in EO and some aspects of the space-based telecommunications business are highly sensitive to the effects of public policy on data dissemination and the perceived value of space-based platforms.

National space agencies

National Space Agencies play a crucial role in the space domain by funding space programmes and coordinating national space activities in the implementation the ESP. They also take part in the decision making process of ESA. National Space Agencies also contribute to the EUMETSAT budget and develop national space programs, often in cooperation with other countries on the basis of bilateral and multilat-

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eral agreements. However, not all European Member States have set up national space agencies (A list of countries and their corresponding space agencies and contacts is included in Annex).

Austria

In Austria, the national funding agency for industrial research and development is the Austrian Research Promotion Agency (FFG). The Aeronautics and Space Agency (ALR) is established within FFG. ALR implements the national aerospace policy and represents Austria on international aerospace committees.

Austria considers the representation in the European Space Agency (ESA) and the Airbus Intergovernmental Committee as strategically important in strengthening the international standing of Austrian industry, business and science. The ALR also encourages Austrian researchers and supports their participation in international and bilateral aerospace partnerships and within international networks.

Belgium

In Belgium the Federal Science Policy Office is responsible for planning and coordinator of space activities by developing the national space policy.

The mission of the Federal Science Policy Office is to prepare, execute and evaluate science policy and its extensions. In particular, the implementation of scientific and technical resources in support space is the responsibility of the Directorates-General Research & Space and Coordination & Information.

Czech Republic

In the Czech Republic, the national body coordinating the space activities is the Czech Space Office, a non-profit association created in 2003.

The main mission of the Czech Space Office is to support Czech researchers in international space collaboration, to represent Czech Republic in ESA and other European / international space related institutions.

Denmark

In Denmark, the body coordinating the space activities at national level is the National Space Institute formed in 2007 by merging of the Department of Informatics and Mathematical Modelling from the Technical University of Denmark with the former Danish National Space Centre, which was an independent government research institute until 2007. The recent merger has brought together most of the space related activities in Denmark.

The National Space Institute offers education in space, research, industrial development and collaboration and consultancy for the public sector.

France

France is the leading European nation in space activities. In 2009 it had the largest national civilian spending of 1.8 billion Euros of which 1.1 billion Euros are funded by the French national space agency (CNES). France is the biggest contributor to ESA budget and the third contributor to EUMETSAT with about 36 million Euros (about 15% of EUMETSAT overall budget).

CNES operates with a double governmental mandate: under the Ministry of Research, for civil space activities, and under the Ministry of Defence for military related activities.

The agency's strategic planning focuses on three main objectives: developing downstream services for users, leading multinational space programs without duplicating ESA programs and improving the space industry competitiveness.

Germany

Germany tries to position itself as the space technological leader in Europe, by taking a leading role in both EU and ESA space technology development programs. German budget for civilian space activities was about 925 million Euros in 2009. Germany is the second contributor to the ESA budget and the first contributor to EUMETSAT with about 49 million Euros (about 20% of the EUMETSAT's budget). However, Germany also has an extensive national space programme, developing important technologies and capabilities, risking overlapping with European or multilateral programs.

German Space Agency (DLR) participates actively in European R&D research projects.

Hungary

Since 1992, the main coordinating body of space activities in Hungary has been the Hungarian Space Office (HSO), which manages, co-ordinates and represents Hungarian space activities in international organisations. At the end of 2005 the Hungarian Space Office was integrated into the body of the Ministry of Informatics and Communications, then into the Ministry of Environment and Water, while keeping its name, image and independence in external relations.

Italy

The Italian Space Agency (ASI) receives funding from the Ministry of Research and

Universities, and from the Ministry of Defence for contributions to dual use projects (notably CosmoSky-Med program and Athena-Fidus). In 2009 the Italian budget for civilian space activities was about 700 million Euros, 300 million of which were spent on national programs. Italy participates actively in ESA projects: in 2009 it was the third largest contributor to ESA. Italy is also the fourth largest contributor to EUMETSAT with about 29 million Euros (12% of EUMETSAT budget). In addition, the Italian government funds 60% of the development of the future small-launcher VEGA (an ESA program).

Italy has also developed important bilateral (especially with France) and multilateral programs with other European countries, contributing to the harmonization and common expression of European space requirements (especially in dual use EO and communication programs).

The Netherlands

The Netherlands Space Office (NSO) acts as the Dutch agency for space affairs. The main mission of NSO is to develop and implement the Dutch space programme.

NSO has been established in 2008 by an agreement between the Ministry of Economic Affairs, Ministry of Education, Culture and Science, Ministry of Transport, Public Works and Water Management and the Netherlands Organization for Scientific Research (NWO), NSO reporting to the Steering Committee of these ministries.

The NSO represents the Dutch space community within international space organizations like ESA, NASA and JAXA and raises awareness on spaceflight science, usage and exploration to teachers, students and the general public.

Norway

The Norwegian Space Centre (NSC) coordinates space activities in Norway, and is a government agency under the Ministry of Trade and Industry.

NSC promotes the development, co-ordination and evaluation of national space activities as well as supporting Norwegian interests in ESA.

Romania

The Romanian Space Agency (ROSA) is responsible for the coordination of space activities.

ROSA is an independent public institution – a legal entity fully self-financed, organized by Government Decision no.

923/1995 and defined by Law no. 500/2002. The main mission of ROSA is to promote, coordinate and develop aeronautical, space and security research and applications programs/projects in Romania and to represent the government in relevant international cooperation organisations such as relations with ESA and to act as the head of delegation for the United Nations Committee on the Peaceful Uses of Outer Space. ROSA carries out its own research and development projects.

ROSA is the contract authority for aeronautical, space and security projects within the National Programme 'Research for Excellence' 2006-2008. ROSA is involved in defining the national space and security strategy and programme. ROSA organizes on a regular basis, workshops, seminars and annual national conferences on space and aeronautics to highlight the progress of the programme.

Spain

In Spain, INTA is the Public Research Organization specializing in aerospace research and technology development. Among its main functions are: the acquisition, maintenance and continuous improvement of technologies that can be applied to the aerospace field; performing all types of tests to check, approve and certify materials, components, equipment items, subsystems and systems that have an aerospace application. It also provides technical assessment and services to official bodies and agencies, as well as to industrial or technological companies. INTA also acts as a technological centre for the Ministry of Defence.

Sweden

The Swedish National Space Board (SNSB) is the agency acting as the coordinating body for space activities in Sweden. It is a central governmental agency under the Ministry of Enterprise, Energy and Communications. The SNSB is responsible for national and international activities relating to space and remote sensing, primarily research and development.

The SNSB's primary mission is to distribute government grants for space research, technology development and remote sensing activities, to initiate research and development in space and remote sensing areas and to act as the Swedish contact for international co-operation.

Basic research is financed via the Ministry of Education and

Research. The SNSB functions as a research council for Swedish research using equipment in space or at high altitudes in the atmosphere.

Switzerland

The Swiss Space Office (SSO) is the national coordinator of space activities in Switzerland.

The SSO implements Swiss space policy. It acts under the SER (State Secretariat for Education and Research) and the Space Affairs division. The SSO conducts research in the field of Space Sciences, Satellite Navigation and Communication, Earth Observation, Human Spaceflight and Microgravity, Launchers, Space Industry / Technology.

UK

The United Kingdom has recently replaced the coordination body on space activities (British National Space Centre) with a National Space Agency (April 2010). This decision should have a very positive impact on UK visibility in multinational space programmes, an increased participation in ESA/EU programmes and a consequent increase investment return to UK space companies. The UK has increased its participation to ESA budget. In 2009, UK was the fourth largest contributor and the second largest contributor to EUMETSAT (about 16%). Its overall national space spending on civilian activities was about 49 million Euros. The UK might possibly expand future British space agency area of responsibilities in the military sphere, on the model of Italy and France.

ENSURING SUFFICIENT RESOURCES FOR A SOUND EUROPEAN SPACE POLICY

The EC budget

The EC allocates a budget to research and development projects via specific Framework Programmes (FP). In the context of space activities the 6th and 7th Framework Programmes are relevant.

The Sixth Framework Programme (FP6, 2002-2006) allocated a budget of about 1 billion Euros to Aeronautics and Space over five years, with space R&D focusing on design and development of GMES applications; research on services related to Galileo; and advanced research on interfaces between space and ground segments in

Example: SAFER
Services and Applications for Emergency Response
EC/FP7 project – GMES programme
Total Budget: 40M Euros; FP7 grant: 27M Euros.

the field of communications.
Under the Seventh Framework Programme (FP7, 2007-2013) space was allocated a separate budget line of about 1.4 billion Euros over 7 years. The main focus was GMES (land, marine, emergency, atmosphere, and security) with a major investment in its space components and operational services, strengthening space foundations and services. But there was also an allocation to technology development in the fields of space technologies, space exploration, space transportation, space science, up-stream research and data exploitation.

Under the Seventh Framework Programme (FP7, 2007-2013) space was allocated a separate budget line of about 1.4 billion Euros over 7 years. The main focus was GMES

The EC funds GMES through the R&D FP7, with a budget of 1.2 billion Euros, plus 107 million Euros since 2011 in the frame of the GMES Programme (Regulation 911/2010). The development of observation infrastructure is funded by ESA (for the space component for an amount or around 1.6 billion Euros, plus 103 million Euros for development of services) and by the European Environment Agency (for the ground segment and in situ sensors), while Member States contribute directly also with national satellites missions.

The following table details the allocation of the provisional 9 million Euros budget for GMES Regulation related developments from 2011 to 2013:

Project category	**Focus**	**Budget**
GMES emergency management services – Mapping	Rapid mapping, reference maps	2.3M Euros
GMES emergency management services – Early Warning Systems	Early warning	0.4M Euros
Pan-EU Land Cover monitoring service	Space data processing, automatic extraction, five high resolution layers: artificial surfaces, forest areas, agricultural areas, wetlands and water bodies.	2.7M Euros
Space component	service	3.6M Euros

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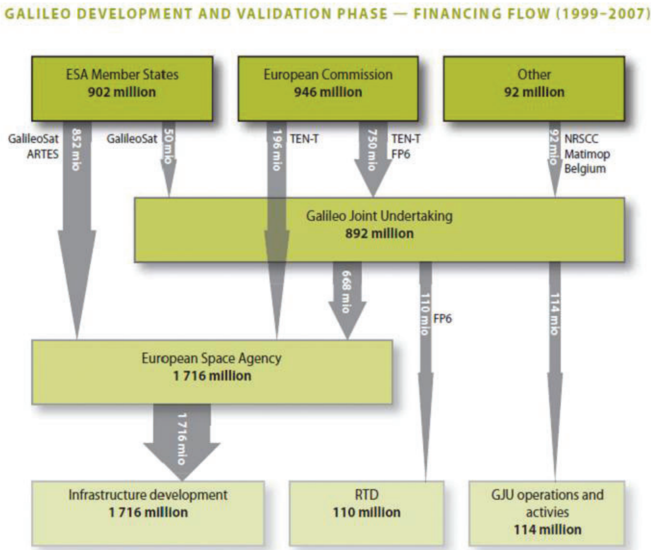
In respect of Galileo, following the withdrawal of the private sector from the PPP initiative due to the high risks linked to the program, the EU decided fully to fund this flagship program.

In the current Multi-year Funding Framework (MFF) an amount of about 3.4 billion Euros is allocated to the Galileo programme, covering its development and deployment, plus the operation of EGNOS. This figure, however, represents 10% of its overall cost: in fact, the implementation of Galileo is largely the responsibility of the European Space Agency.

The following schema summarizes the entities and the amount of resources made available for the program's development and validation phase.

Financing a large space project in the EU
The example of Galileo



Source: Court of Auditors, report 7/2009.

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Evaluation of the implementation of the current financing system has produced some lessons and forced the EC to demand new financial architectures.

Evaluation of the implementation of the current financing system has produced some lessons about, among others, managing large scale programs such as GMES and Galileo. The likelihood of cost-overruns, complexity, unclear governance and the mismatch between long term development and the duration of a single MFF, forced the EC to demand new financial architectures.

Looking ahead, the EC has just released the Multi-year Funding Framework (MFF) 2014-2020 (29th of June 2011), in which it details how the European budget will be invested in "Europe's brains"[10], thus increasing the amount allocated to education, training, research, innovation and SME development.

With reference to the GMES program, the Commission proposed to place funding outside the MFF after 2013, again due to cost overruns and to the fact that as of 2014, the GMES project will move from development/initial operation to full operation. As a result, post 2013 funding will have to reflect this transition, shifting from mainly research-based funding to operational financing.

The Commission recognizes that "large scale projects of interest to the EU tend to be disproportionately expensive for the small EU budget" and that the "general objective is to set up a budgetary framework that secures unpredictable long term funding […] minimizing the uncertainties linked to the periodic renewal of the MFF"[11].

This reasoning applies also to other non-space related projects (like ITER). However, Galileo program is an exception: fully owned by the EC, it will be funded within the new MFF (7 billion Euros).

ESA budget

The activities carried out by the European Space Agency can be funded either by mandatory or by optional contributions from the agency's member governments. In the case of the mandatory programmes, those carried out under the General and the Science Programme budgets, all Member States contribute on a scale based on their Gross Domestic Product (GDP). The mandatory programmes include ESA's basic activities such as studies on future projects, technology research, shared technical investments, information systems and training programmes.

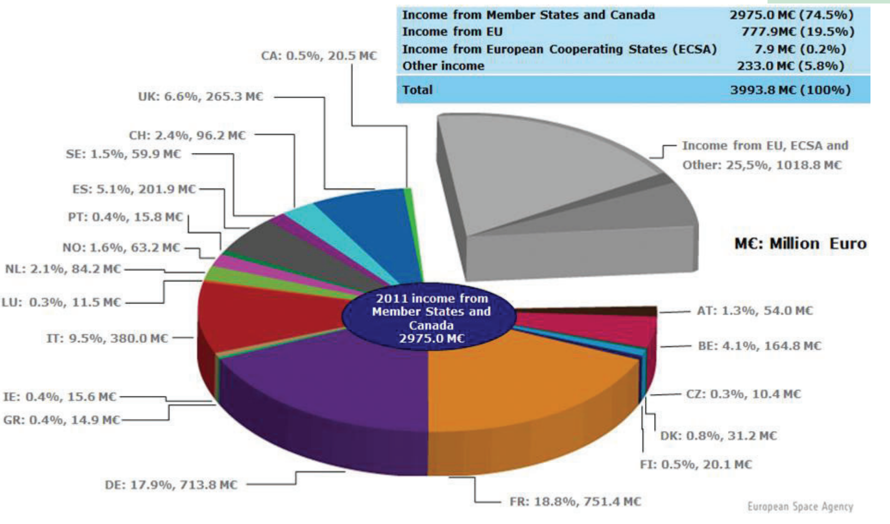
With regard to optional programmes, each nation selects the programmes it perceives most likely to produce contracts for its national industry from ESA, deciding freely on their level of involvement. Optional programmes include Earth observation, telecommunications, satellite navigation and space transportation. The International Space Station and microgravity research are also financed by optional contributions.

In addition to member governments' contributions, ESA also receives payments from the European Commission for programs such as Galileo and GMES managed by ESA but sponsored, in whole or in part, by the commission.

The ESA budget plan is agreed by all member states during the ESA conference. The budget plan is decided for several years ahead, usually for 3–4 years. While this plan can be later amended, it provides the main guideline for ESA for future work. The last major conference took place in 2008 and set the budget for the years up to 2012. However, in January 2011, ESA's budget was reviewed leading to an increase over the 2010 figure. The total budget of ESA was almost 4 billion Euros for 2011, nearly 7 per cent higher than planned in 2010.

As far as financing of individual space programmes is concerned, ESA applies a geographical distri-

The following figure details each national contribution for 2011 ESA budget

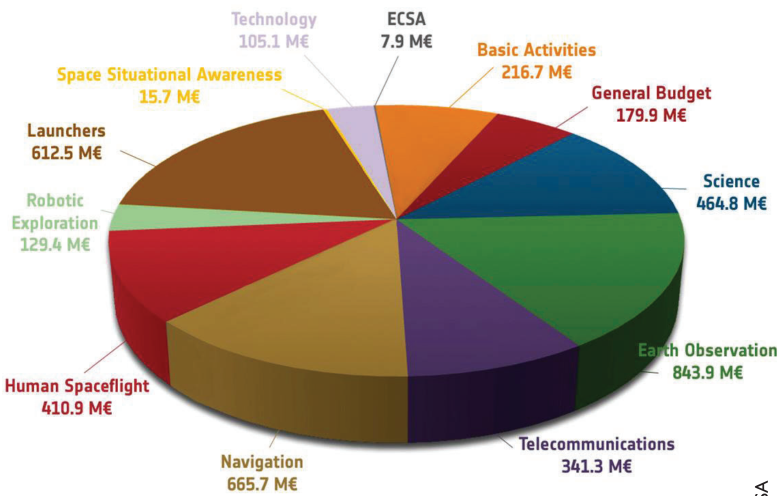


Source: ESA

bution or fair return principle. This means that a country's contribution is paid back in the form of contracts for work to be done domestically. This principle has helped to sustain interest in space on the part of the smaller European countries and to attract large investments by European space faring nations.
France and Germany are the largest contributors, and have both increased their funding to ESA in 2011 over 2010. Several countries, including Spain, have also increased their ESA payments, despite the current financial crisis.

The agency's budget priorities for 2011 remain the applications programs, which are believed to have near-term commercial value, and science. Earth observation accounts for 21 per cent of ESA's total budget in 2011, up from 19 per cent in 2010. This is mainly due to the fact that GMES and other satellite missions enter their high capital spending phases. Navigation, which is mainly Galileo, is ESA's second-largest funding area, accounting for 16.7 per cent of the total budget planned for 2011. Launch vehicles have moved down to the

The following chart presents the 2011 ESA budget distribution among the different activities



Source: ESA

third position in 2011 and are expected to account for 15.3 per cent of the budget. Various launches are expected to take place in 2011 from Europe's Kourou spaceport, in French Guiana, such as Vega, the Italian small-satellite rocket.
For 2011, considerable investment is also made in the area of science, ESA's fourth-largest spending area, accounting for 11.6 per cent of the budget.

In comparison with other space powers the ESA budget is still relatively small. In 2011, NASA funding for space is nearly five times than ESA, despite a recent cut in space spending by the US government.

Despite the severe economic situation facing several European countries, the outlook for future ESA funding is still positive. European institutional needs and the desire to maintain European competitiveness in the commercial market will require continued investment in various key areas such as Launch vehicles, where the preparation of the Next Generation Launcher (NGL) will be instrumental in maintaining guaranteed future access to space for Europe.

Technology development is another area where ESA budget will need to be strengthened in the future. In particular funding will be required for the High Thrust Engine and Cryogenic Upper Stage Technologies, and the Intermediate eXperimental Vehicle (IXV), which will represent a major step in the mastering of re-entry technologies by Europe. Moreover, the extension of the operations of the ISS until 2020 and beyond will require the development of new capabilities, including a versatile tug for payload transfer with return capability and a new Crew Space Transportation System.

National budgets - national support for European space

The largest share of European space funding comes from national budgets, a large proportion of which is related to national or multilateral military or security related space activities.

Although European space activity is dominated by a small number of large players, led by France, Germany, Italy and the UK, almost all of the EU members have a space budget. France remains the largest single national player with the world's fourth largest national space spend (1.92 billion Euros). Germany (1.17 billion Euros), Italy (0.68 billion Euros) and the UK (0.34 billion Euros) were sixth, seventh

The largest share of European space funding comes from national budgets, a large proportion of which is related to national or multilateral military or security related space activities.

Support from national governments remains critical in developing European space assets

and ninth respectively[12].

GDP allocations perhaps give a more accurate picture of comparative spending on space. The **United States** devoted the biggest share of its GDP to public space expenditure at 0.31% (30.5 billion Euros). The **Russian Federation** was second with 0.20%, whereas China was third with 0.122%. France was fourth at 0.1%. Most European countries ranged between 0.05% and 0.01%. Significantly, quite a few small European countries like Belgium (0.05%) and Luxembourg (0.03%) did relatively well. As another relative measure the institutional shows that the US spent approximately 105 Euros per capita on space, with France second with around 29 Euros and Luxembourg third at 24 Euros per head. Most European states spent around 14 Euros per capita. Again, the good performance of smaller European states was noteworthy.

France has reinforced its national commitment to space by including support for launch vehicles and satellites in its 2011 national economy recovery package. The 500 million Euros programme is in the form of a bond issue.

The recent **German** national space plan also confirms a general commitment to maintain Germany's space industry, but no details were given for enhanced spending to deliver its objectives. 2011 budget for national efforts is not rising as much as Germany's contributions to the 18-nation European Space Agency (ESA), but is nonetheless rising. German commitments to EUMETSAT's new generation of satellites (713.8 million Euros), has also been used to advance German national industrial interests.

Italy has also a 10-year strategic plan, which also defines space as a strategic national sector, and defined as an important contributor to economic development. Thus, ASI's own 10-year, 7 billion Euros development plan looks set to survive the current budget debate largely intact. Earlier, Italian government support has underpinned the development of the Vega small launch vehicle.

In the UK, its modest space budget of about 339 million Euros per year, of which some 85 per cent goes to ESA has been enhanced by a further investment in a new International Space Innovation Centre, to be co-located in Harwell with a newly created ESA centre. The centre, with a development budget of 45.3 mil-

lion Euros will be co-financed by local and regional government organizations. The UK Ministry of Defence is also buying dedicated military satellites communications capacity from Paradigm through a private finance initiative.
Support from national governments remains critical in developing European space assets. While funding from ESA, EU and other European institutional funding has grown in significance, without the continued support of national governments, the future of European space would be highly problematic. So far space budgets are weathering the effects of the recent financial crisis, but there is increasing pressure to cut public funding. Even if this does not lead immediately to reduce commitments to space, it may increase demands for national return on national investment in international programmes and reduce political support for ambitious new space initiatives.

On the other hand, financial stringency may increase interest in collaborative ventures especially in security-related space programmes, although these are more likely to be government-to-government initiatives than European institutional activity.

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Challenges and opportunities

Cooperation, funding and interoperability can both bring valuable benefits, but also pose serious threats to the development of the sector

The recognition and full utilisation of space in Europe depends largely on succeeding to identify a number of potential challenges and opportunities. *Cooperation, funding and interoperability* are some of the major themes that can both bring valuable benefits, but also pose serious threats to the development of the sector and success of the various space programmes. The following sections look at identifying the most significant thematic and cross-cutting challenges and propose, wherever possible, potential solutions.

THEMATIC CHALLENGES

European Challenges

Few space market entrance options for Europe

The European institutional space market is smaller than Europe's major competitors. If the European budget is 1, then China is 1.3, India 2.1, Russia 8.8 and the US 9.7. This alone is not sufficient to sustain the current level of the European space industry. Most of the global market is closed to outside competitors and is unlikely to change in the near future.

Launchers

Currently, there are not enough institutional launches to sustain the launcher sector in Europe. Moreover, considerable funding will be needed for the replacement of the current generation of launchers by the 2020s, if Europe is to maintain its ability to launch independently all sizes of satellites and to maintain its competitiveness in the global market.

ESTIB Structural Aspects

A stronger, more integrated European-wide consensus, or vision about the direction of future space investments, would be an important step forward in maintaining the competitiveness of the ESTIB. The specific and often unique characteristics of the space economy also shape the structure and performance of the ESTIB. In particular, these underpin the "critical mass" requirement of space prime contractors and major suppliers as well as creating barriers to entry that encourage vertical integrated industrial enterprises. While the EC should be rightly concerned to prevent the abuse of market position by dominant primes and systems integrators, the simple fact of vertical integration is not of itself evidence of such abuse. The overriding concern for public agencies is to ensure that the ESTIB is not handicapped in the face of external competition by an over-rigor-

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ous application of competition rules. The Commission should be encouraged to accept that space is a special case, with characteristics that distinguish it from other sectors where open markets are generally beneficial. Policy should reflect the realities of the space economy, where international competition is largely determined by non-commercial factors. Similarly, policies designed to encourage SME participation in the space sector, while perhaps desirable for wider socio-political reasons – may have limited value in improving the competitiveness of the European space industry. Increasing significantly the volume of European space production could support a larger number of space suppliers by improving the business case for investment in the space sector.

Europe is not technologically independent

Currently, an average of 60% of European satellite electronics components are imported from the US, as these are not manufactured in Europe due to the lack of 'commensurate institutional support', or the lack of volume production to justify investment in specialised facilities. This situation leaves Europe vulnerable to external controls, such as ITAR. This has been achieved to a degree, but further developing ITAR-free systems would enable free access to world markets and offer Europe a competitive technological edge.

Data access and timelines need improvements

In a number of operational scenarios the rapid set-up of the systems and generally the 'freshness' of information are critical success factors. End-users have noted that real-time imagery is often not available to support operations in fast moving crises. It is vital that access to data is done in a fast and easy manner, and systems are set up in an efficient and timely manner, in particular in the case of disasters or military joint operations.

Satellites communications shortfalls

Fully secure satellite communication links and interoperable communication systems are not yet a reality. The integration of com-

Example

Situation:
In the Haiti disaster, field missions of Relex or ECHO had to utilize satcom provided by an NGO (Telecom Sans Frontieres) in order to send videos of the situation to Brussels.

Solution:
A European programme in satellite communication area (ESA, EU or joint programme) should be created or commercial services or national assets should be used.

The Commission should be encouraged to accept that space is a special case, with characteristics that distinguish it from other sectors where open markets are generally beneficial.

munications and intelligence systems would bring considerable value to the crisis management missions. Lack of bandwidth slows communication. Bandwidth is increasingly expensive and it is difficult to obtain a satisfactory capacity.

The EU cannot yet fully rely on in-house assets for global satellite communications.

The vast bulk of space-based services are in the telecommunications sector. Profitability is relatively high, in part due to the limited nature of competition in a number of the space-based telecommunications markets. However, there is often direct competition from terrestrial service providers. It is essential that space-based platforms be treated equally in the development of public policy towards the provision of telecommunications services. Developments in EO and the space-based services business are also highly sensitive to the effects of public policy on data dissemination and the perceived value of space-based platforms. EU policy choices in this area will have a major impact on the emerging EO business. There is a sharp dilemma here: Free access to data would encourage new enterprises and help to pump prime wider market awareness of the potential offered by integrated EO services; but this could undermine the business model for existing EO providers and EO satellite owners.

International challenges

Space competence has a strong symbolic value on the international scene. Since the beginning of the space conquest, the presence in outer space has been seen as a proof of technological excellence, of economic performance and high level of knowledge. As a whole, to be a member of the Space club is still considered as a tool of power and influence coming in different patterns according to the historical context and the distinctive features of each national policy. The main usual drivers of any space policy are defined according to national interest priorities, affirmation of sovereignty and search for leadership. Although Europe suffers from an uncompleted political construction leading to find other motivation to develop its own space policy, the European space competence is recognized worldwide. In fact the European ability is undeniable in the field of science and exploration as well as applications like telecommunication or Earth observation. In the same vein, new programs like Galileo and GMES contribute to draw the picture of an ambitious player concerned with the innovative and dual approach of global issues.

Europe's place in the international arena

The preeminent position of Europe, both on the international market and in the cooperation domain, also shows that the European model is largely successful even if it is specific.

In 2011, with about 60% of the commercial launches market won by Arianespace and more than 40% of the commercial space market hold by European firms, the European space industry gives concrete expression to the reliability and quality of European space technologies. This position is all the more noticeable since the level of national and regional investment is long far from the US one.

In parallel, the total of cooperative agreements with foreign partners signed by European Member States and ESA confirms this global recognition of the European skills (see map). This number needs probably to be minored taking into account some possible duplication of agreements led by different Member States with some foreign proactive partner. However, Europe is mastering an impressive position. This largest cooperation is a good index of the dynamism of the European space policy abroad. To some extent it is also the success of a unique policy based since its origins on internal strong cooperative principles.

So, at first sight, the specific constraints of the European space policy have driven to a satisfactory cost versus profit ratio.

This situation is the result of a long term tradition enhanced by a common willingness as described in the European space policy and managed by the High Level Space Group since 2007. The international space policy of Europe has been identified to respond to global challenges according to the main principles driving the European ambition in that field. To sum up these priorities, one could list the development of applications to meet the needs of European citizens, to ensure regional and global security including natural risks, to preserve the industrial and technological base fostering innovation and to contribute to the knowledge based society project as well as securing independent access to new and critical assets. Based on these global items quite

This largest cooperation is a good index of the dynamism of the European space policy abroad

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At a time when the balance between traditional and emerging space nations is evolving, the future European position has to be seriously considered

open, cooperation may be set on the basis of mutual benefit in respect of political, programmatic and budgetary considerations. De facto, unlike the other members of the space club, the lack of a direct link from national political interest and space policy allows broader opportunities and openness.

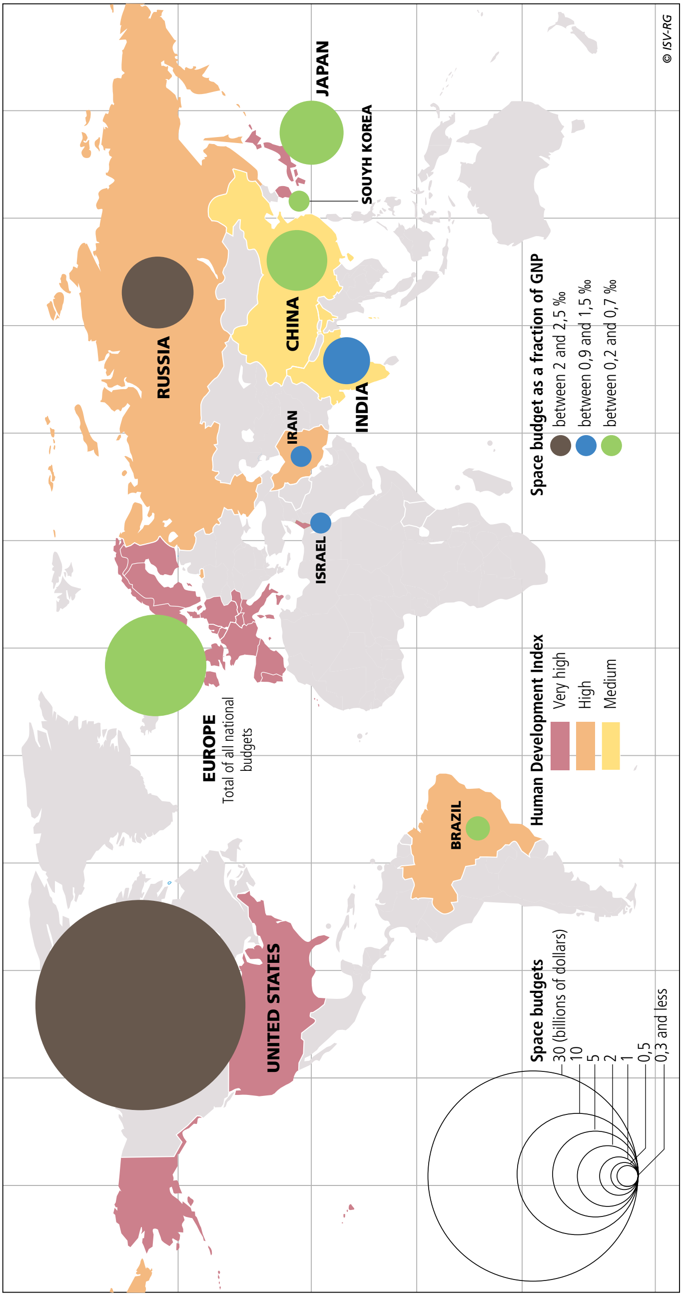
Nevertheless, compared to the other space powers, these unique characteristics of European space entail some weaknesses, too. The deficiency of a common military space policy refers to the limits of the common Security and Defense Policy. Moreover, the absence of European autonomy in human spaceflight has more to see with the disconnection to any form of national identity. A part of their symbolic aspects, the political inadequacies of European space strategy have serious budgetary consequences compared to the other space faring nations' global incomes. This point is especially sensitive as it concerns public investment in the space industry for the research as well as the development issues.

Possible evolutions of the cooperation framework in the next future

At a time when the balance between traditional and emerging space nations is evolving, the future European position has to be seriously considered. It is difficult to establish a ranking of the different space powers, excepted for the outstanding United States, but one has to notice that big changes are taking place and that Europe has to adapt in order to keep its place.

To be brief, since the 90's, the United States are the only space super power due to their very high annual budget, the command of a large scale of high technology systems and the complete integration of space tools as a crucial element of national security. All these elements contribute to reinforce the gap between the US and the others and so to confirm their preeminence as the First space nation. Even the recent decision made by President Obama to cancel the Constellation Program has been adopted with the concern to restart the technological innovation and an ambitious spirit of new conquests. Combined with the continuation of the support of a huge space industry mastering the last high technologies and

Space budgets around the world in 2011



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holding the control of technological transfers, the US spacesector keeps out of reach of its competitors. In this context, Europe has to develop its own niche and priorities to keep the position of a plain partner in the cooperation with the US and to maintain the independence on its technological basis to satisfy its own needs and to be recognized as a supplier in the international market.

Considering Russia, the situation is evolving significantly from the last ten years. From now on, the strategic value of space is fully recognized. The political level has made it clear that modernization is the aim of the current and next years as the only way to build a new economy relying on the knowledge society as other developed countries did it. In this respect, satellites of telecommunication, Earth observation, and navigation have to play a direct role by compensating the lack of ground infrastructure but also an indirect one by improving high technology research as well as facilitating the development of information technology processes. The industrial backwardness of some part of the Russian industry is a strong incentive to cooperation with foreign partners in order to fill the current gap in application domains. It may be seen as an opportunity for the European space industry as long as a mutual benefit may be identified. If not, the overture made by Russia to new countries such as India or in longer term South Korea or Brazil to jointly develop new programs could lead to the reinforcement of potential challengers in the international market.

Among the space nations, China is supposed to strongly improve its capabilities in the coming years. Geopolitical as well as internal incentives are evoked by many experts to give the image of a very ambitious space policy. This ambition may be overestimated due to an extrapolation of the impressive growth of the Chinese economy without taking into consideration the real concurrence in terms of public investment of the space sector with other high technological value domains such as biotechnology or nanotechnology. However, there is no doubt that space systems give a strong support to a better global and more balanced management of its huge territory and that space competence symbolically contribute to the image of modernity. For all these reasons, it is essential to consider space cooperation issue as a possible way to enlarge European influence on a new

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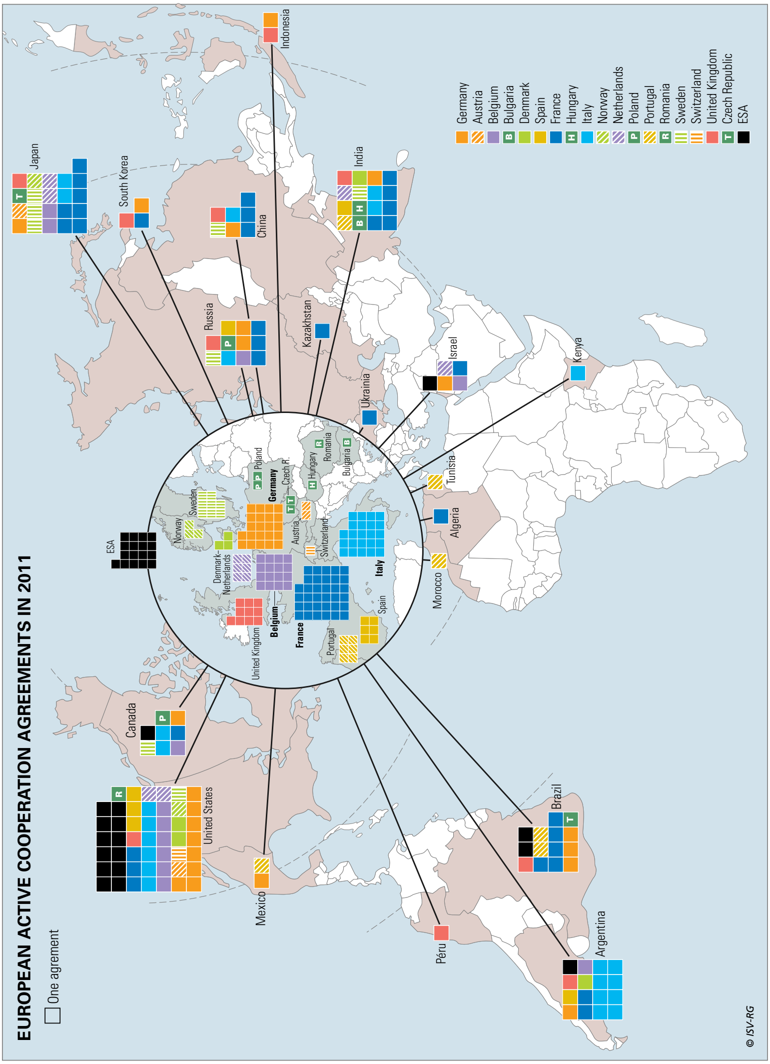

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Credit: The Council of the European Union

Commission Vice-President Gunter VERHEUGEN (right) and Mr Jean-Jacques DORDAIN, Director General of ESA present the European Union flag which was flown aboard the International Space Station during the Delta Soyuz mission, in April 2004. The flag is signed by the astronauts.

demanding huge market even if national interests may slow down technological developments on critical aspects. To go with Chinese needs is both sensitive and essential.

Even if the United States, Russia and China focus main attention, they do not represent the unique opportunities of partnership. For instance, Japan and India represent successful examples of long term partnership with Europe. It is not the aim of this reference book to give a comprehensive description of different kinds of cooperation with all the potential partners. Some new opportunities in the global framework of a confirmed space country and a growing one include the development of agreements with Brazil or South Korea, as well as with Arabic countries. This schema of relation between a senior and junior partner may be seen as opening a new step in the space cooperation of Europe perfectly fitted to its key foreign policy principles: multilateralism, engagement with emerging powers and support of social and economic development.

This rapid overview of the cooperation issues demonstrates that Europe has the potential to remain a key player in the development of global partnership. However, its future efficiency is dependent on the improvement of the European space governance i.e. the coordination between the Member states national policies, the European Space Agency project management and the European Union political implication. According to the analysis made by the partners of Europe, the current model of inter-agencies cooperative agreements is seen as quite satisfactory. Nevertheless, this agency level is far from sufficient in regard to global negotiations in an international forum, be it the International Union of Telecommunications (ITU) for the attribution of rare resources like frequencies and location on geostationary orbit, the UN Conference for Disarmament about the "code of conduct" and the debris issues or the climate negotiations and the possible verification process. At this point, it is the responsibility of the European Union to promote a coherent and united position.

CROSS-CUTTING CHALLENGES

Governance and funding

Until the Lisbon Treaty, the EU institutional setting was divided into three pillars with respective domains of competence. Space was no exception. In order to foster cooperation and coordination among the different EU institutions, the Lisbon treaty abolished (at least on the paper) the three-pillar structure. The Treaty also clearly recognized a European competence in the space domain.

The respective roles of the EU institutions (Commission, Council, Parliament) have been both clarified and reinforced in the space domain in civilian and, to a lesser extent, military areas. The EU, which has political and juridical legitimacy, must define the orientation of a European Space Policy. It has the means –through the Space Council in cooperation with ESA, which in return has been recognised has having the technical competence to oversee the development of space programs. The Council and the Parliament may reinforce this position in time through a multi-year engagement for European space policy that could take the form of a European Space programme adopted. Once the overall direction of policy is decided, the policy would then have to be structured and supported by budgetary allocations. The resources available would depend on the structure of the Multi-year Funding Framework (2007/2013 and 2014/2020) and on national subscriptions to the ESA programmes (the next Council of Ministers being planned for the end of 2012). In this respect, the EU finds it very

Once the overall direction of policy is decided, the policy would then have to be structured and supported by budgetary allocations.

difficult, if not impossible to engage in commitments beyond the MFF horizon. Combined with the lack of coordination regarding the budget scheduling, this will make it very difficult to create and sustain a genuine ESP, especially where large, complex and expensive programmes or long term international cooperation is involved. This aspect remains one of the weakest aspects of the ESP. This has been noted in the latest official documents related to MFF 2014/2020, stating that the EU budget is not organized to manage large long-term programmes such as ITER or GMES.

The financing of space programmes will remain a combination of EU and intergovernmental contributions, whatever the respective evolution of the institutions in this area. In turn, this will heavily influence the evolution of the institutional balance affecting the EU space programme. In initial programmatic phases, the EU, and more particularly the Commission should act in general as the owner of the EU space programmes. Responsibilities and rights attached to this ownership could then be delegated to a relevant organization (which could take different forms - public, private, existing or new entities); while the European space industry would act as prime contractor. Direct management by the EU could then be employed only in the case of strategic programmes with specific ownership responsibilities.

ESA-EC perspective

The new relationship between the EU and ESA as the "executive" arm of European space policy has created a new dynamic. The transition to the new regime, while increasing the sector's political salience, has left a number of unresolved issues between ESA and EU practices that are creating difficulties for the European space industry. Some of the legal challenges related to the ESA-EU cooperation were revealed by the two flagship programmes Galileo and GMES, namely the mismatch of the EC funding instruments and the space programme cycle organised under the ESA framework. Particularly, the concept of juste retour at the heart of ESA industry policy is at odds with the uncompromising rules of open competition enshrined in EU legislation.

For this reason, the EU-ESA Framework Agreement clearly provides in its Article 5.3 that «any financial contribution made by one Party in accordance with a specific arrangement shall be governed by the financial provisions applicable to that Party. Under no circumstances shall the European community be bound to apply the rule of 'geographical distribution' contained in the ESA Convention».

Several alternative arrangements can be envisioned for future ESA-EU relationship models. The nature of such arrangements is at the heart of the European debate between the EU, ESA and the MS. At the heart of them all the role and the position of ESA in the European institutional landscape, with heavy political, legal, financial, and industrial consequences associated with the choice.

EU-MS perspective

The Lisbon Treaty enlarges the perimeter of the EU competences in the field of space. However, this situation can create some tensions as not all MS wish seeing the EU involved in all space related areas. For example, the space launcher sector is typically an intergovernmental programme strictly linked to national political, industrial and strategic issues that have been managed historically by a small group of countries. While a purely legal interpretation of the Lisbon Treaty establishes the perimeter of EU competences in space, defining the substance of an EU space competence will require a stronger political investment both from the EU institutions and from the MS.

Indeed, EU-MS relation is of particular importance from the space governance perspective. The GMES program, for example, is made up of European "Sentinels" and national space capabilities. The Governance and data policy of GMES, or for that matter, of a future SSA program, is still under debate. The outcome will reflect the necessity of keeping certain information flow under national control, set against the desire to develop a common European data policy for space.

In addition, in the field of security and crisis management, several political differences and diverging interests can be noted between EU Member States. Some of them, the more "Europeanists", traditionally represented by France, strongly support the EU developing its own capability to act alone. Whereas others, more inclined to maintaining a strong transatlantic link, represented by the United Kingdom and Member States from central and Eastern Europe, tend to emphasize a NATO dimension. A third vision has been put forward by

Several alternative arrangements can be envisioned for future ESA-EU relationship models.

The nature of such arrangements is at the heart of the European debate between the EU, ESA and the MS

GALILEO and GMES remain specific institutional challenges for Europe in a civil–military perspective.

Germany and the Scandinavian countries, which prefer to see Europe retain a more civilian orientation to space activities. These different political views play an important role in the use of existing space applications and will influence the development of new ones. The evolution of GMES and Galileo, both dual-use programmes has reflected this diversity of approaches, with ambiguous results.

Civil-military perspective

The biggest challenge for European use of space for security and safety is arguably the "complexity" problem – policy makers being overwhelmed by the sheer difficulty of large scale, long term programmes. Advanced, high performance space systems are complicated and expensive. There is a drive towards "dual use system", i.e. common systems for military and civilian users. Moreover, no European nation will the long run be able financially to develop independently all of the space capabilities it wants and needs. Some form of bi- or multilateral cooperation, especially for smaller countries that want access to space services, is usually essential.

These are both designated "flagship programs" and civilian in nature, but for many practical purposes, have military implications

A third layer of complexity is added by the European Union as a user in its own right. The Union could be seen as a "national user" in competition with the member states when it comes to the use of scarce space assets. Navigating this system, and creating the institutional structures that allow Europe to reap the benefits of space for all levels without unnecessary duplication of capabilities, and thus costs, while guaranteeing the national integrity under an accepted set of rules for prioritizing between various users needs and demands, are challenges that will need careful consideration.

GALILEO and GMES remain specific institutional challenges for Europe in a civil–military perspective. These are both designated "flagship programs" and civilian in nature, but for many practical purposes, have military implications. The challenge regarding GALILEO is quite straight forward. Since the use of satellite navigation systems like GALILEO do not require an end user to interact with the space segment, the challenge boils down to who will be given the power to decrypt the most accurate GALILEO signals.

In the case of GMES the challenge is more complicated. GMES is supposed to supply value added services to users in the

EU by using data from various sensors, including space-based equipment. However, the users will not necessarily access the sensors themselves, or even see the data supplied from specific platforms. In order to integrate GMES into a European architecture for security, there are consequently two challenges to address:

- Under what circumstance can a "security user" gain access to a specific sensor in the GMES system?

- What GMES services for security purposes can be developed using the same structure as other GMES services?

A challenge of a more practical nature, but nevertheless a challenge, is how to support the EUSC with images? As long as the EUSC is forced to buy all of its required images on a commercial basis, there is no linkage between European space assets and the use of space for CSDP missions. That also means that any investment in R&D for space technology, or EU support of the European space industry involved in the development and manufacture of imaging satellites, will not directly result in more or better data for EUSC use, and will not directly be translated into a better support for CSDP operations.

Public-private perspective

Public initiatives have always played a key role in the history of European space. Developing space technology requires substantial investment, while showing concrete economic returns is invariably a difficult and problematic exercise. Furthermore, the nature of such returns can be direct or indirect. The development of meteorology and telecommunications shows that the commercial value became apparent only after a period of public subsidies that resulted in a mature and readily exploitable service. In the case of navigation, it is very difficult to estimate direct returns, therefore making it impossible for private companies to develop a proper business plan with the certainty that their investments will be repaid.

The US GPS example clearly indicates that an infrastructure, first developed with public money for defence needs, and then made available for free to the civil downstream market can lead to the emergence of high value services. This approach fostered a wide range of activities and benefits, from hardware development to services provision. These ventures could not have be

The role of public authorities in launching, consolidating and maintaining a variety of technological capabilities is fundamental

The policy requirement is to find the right balance between generic developments in technological programmes and specific developments in application programmes.

launched as conventional "capital risk" operations. In general, this approach is largely adopted in the US, where the government and the Department of Defence in particular, subsidize space through defence activities.

The role of public authorities in launching, consolidating and maintaining a variety of technological capabilities is fundamental in exploiting space for commercial and social benefit. Different models of funding for space technologies have been tried in Europe, but they proved unsuccessful and were abandoned in favor of the public funding model. There is room for alternative models, but not in the research and technology demonstration phases of large and complex programmes. Private companies and commercial funding models are, however, increasingly involved in space through contracting, providing approaches offering better value for money to end users, particularly in the public sector.

The public-private partnership (PPP), a model of funding that become more common in Europe (UK, Germany, Italy) shares the costs of developing a system, transferring the risk of expensive and highly technological infrastructure to private contractors – usually a consortium. To date this has been mainly applied to satcom systems (both for defence and civil needs), a sector where private companies have gained extensive expertise and a market where profits are likely. It allows for a variety of forms of cooperation between commercial entities and public authorities to fund, develop, manage, renew and maintain space assets.

For instance, the German TerraSAR-X mission is carried out by the German Federal Ministry of Education, the German space agency (DLR) and Astrium GmbH. The total cost of manufacturing and launching the satellite, as well as operation and running the ground segment, has been shared among all the actors. In addition, a wholly-owned subsidiary of Astrium, Infoterra, was purposely created to commercialize EO data and services.

One of the options for reducing public investment while maximizing existing and future space infrastructure, could be the use of "hosted payloads" or "piggyback payloads" which would allow governments to exploit commercial satellites to accommodate, for instance, their own sensors, UHF- and Ka-band payloads. At the same time, this may

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also represent an additional source of profit for satellite operators.

Technology Policy

There is a technology-led argument for maintaining European competitiveness that would also underpin wider European economic and strategic capabilities. In particular, there is a need for technology risk mitigation in advance of major projects. This requires earlier and increased investment in technology acquisition, supported by technology demonstration. Yet, without major programmes, there is less incentive to invest and a limited focus for effort.

The policy requirement is to find the right balance between generic developments in technological programmes and specific developments in application programmes. European space competitiveness requires a strong collective approach to R&T planning and investment. Enhancing European space competence would not only increase the attractiveness of European space goods and services, it would also increase the wider socio-economic returns from space technology.

Technological capability is the foundation stone of competitiveness in the space sector. This is a long-term issue, requiring investment with little prospect of an early return. It is often best directed at generic concepts, which should be readily available for a wide range of applications. These factors, combined with the very high cost of bringing novel application to the market, deter private investment. Hence the continued importance of institutional funding. In a recent communication, the EC has recognised this reality, as well as identifying generic technologies such as advanced materials and nanotechnology and the importance of research to anticipate "breakthrough" technologies.

Most important, there is a need for a clear "Space Champion" in the Commission, which would develop and oversee a Space industrial "policy", reflecting commercial requirements and the creation of an integrated technology demonstration programme, filling the gaps in generic technologies and programmes that in the US is often covered by DoD programmes.

Improving the sharing of data and results

Both Galileo and GMES have specifically defined data policy frameworks. For Galileo, different level of services will be provided

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with various user categories. As such data policy issues are settled by the nature of the programme (broadcasting a signal) and by the defined public/commercial services. The only undecided data policy related issue for Galileo is the question of 'civilian and military' use In the case of GMES, the EU regulation no. 911/2010, of the European Parliament and the Council on the European Earth monitoring programme (GMES) and its initial operations (2011 to 2013) set out the relevant data policy principles.

- 'GMES data should maintain coherence with Member States' spatial reference data and support the development of the infrastructure for spatial information in the Union set by the 'Directive 2007/2/EC of the European Parliament and of the Council of the 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE). GMES should also complete the Shared Environmental Information System (SEIS) and Union activities in the field of emergency response.'

- 'GMES information should fully and openly accessible without prejudice to relevant security restrictions or to the data policies of Member States and other organisations contributing to data and information to GMES. This is necessary to promote the use and sharing of Earth observation data and information in accordance with the principles of SEIS, INSPIRE and GEOSS. Full and open access to data should also take into account existing commercial data provision and should promote stronger Earth observation markets in Europe, in particular in downstream sectors to increase growth and employment

Data policy and governance go hand in hand, and clear governance principles should set the basis for an effective 'data policy'. In Europe, a key policy issue will be the extent to which the EU follows the US model of making data freely available. Data services provided by space systems often have a partial public good aspect, in that the use of the data by one customer does not preclude its use by another. Access to the highest quality of data can however be restricted. Whatever the future decisions, this debate generates questions about the extent of the free access to data, as this will have to be compatible with viable economic perspectives for future operators.

Ensuring a sustainable funding

As already mentioned, the relatively short experience of the European Commission and ESA in the field of European large-scale programs has provided already some lessons learned. One of them, concerns the difficulty in financing flagship programs with the current funding system, meaning with important EC budgets allocated every 7 years and in part externalized to ESA.

This issue has been clearly confirmed by the EC in its proposition for the Multi-year Funding Framework (MFF 2014-2020), where the EC asks for the definition of a new funding architecture. In the mean while, the EC proposes that for the next 7 years GMES remains out of the EU budget and merely suggests an amount of resources (over 800 million Euros) to be allocated on a volunteer basis by Member states. Galileo, instead, remains within the EU budget, despite the overrun costs and delays that were already registered.

The sustainable and long term financing of large-scale programs is therefore a key challenge.

In a perspective exercise, it is possible to imagine two situations along a line of possibilities:

- one extreme consist in achieving a completely self-sustainable sector, funded with commercial revenues;

- at the other extreme, a completely public-funded sector.

In the first case, it is possible to imagine that space activities would be purely financed by commercial revenues, which should be enough to maintain operations and also to fund future replacement of satellites that have achieved their end of life (normally after about 10 years), in order to guarantee the continuity of the services.

This hypothesis could be realistic if we consider some mature sectors, like telecommunications, which have already proved their high level of commercialization and even new potentialities. Nevertheless, other sectors, like EO and navigation, still need to prove the existence of a strong commercial market. EO has already started to develop commercial applications (as Astrium services, or E-Geos are doing), but for the meanwhile industries and operators are still far away from a self-sustainable situation.

It is possible to imagine two situations : funding with commercial revenues or a completely public-funded sector

With regard to GMES, while MS would continue to commercialize images obtained with their space national assets, the EC wishes to adopt a free-data approach in the implementation of GMES future data policy. The EC should therefore wander how to ensure the replacement of Sentinels, if they do not produce any commercial income. Concerning Navigation and Positioning, the existence of GPS as a free service undermines the possibilities of mass commercialization of next Galileo services, despite the improved performances. Finally, the launcher sector is a precise example of the peculiar features of the space domain, since it cannot survive with only commercial funding. In a very competitive landscape, the commercial sector would not ensure Ariane's survive, which is subjected to international pressure. In fact, a quick look to other competitors would immediately show that the policy adopted in the US (according to which all institutional launches are performed with American launchers) and the Asiatic low production costs do not allow the EU to be competitive at the international level, thus undermining self-sustainability.

At the other extreme, it is possible to imagine space programmes that can continue to be funded completely by the public sector. In this hypothesis, a further step consists in defining the composition of such public funding: would it be made of purely EU resources, part of which would be externalised to ESA? Would ESA, as an external organization, participate to the funding, thanks to national space agencies contributions, in exchange of a certain degree of geographic distribution of work? Would European programs take the form of optional programs or would the participation of all ESA MS be required? Which implications on the industrial policy and on the capacity to attract investments?

Obviously, this second option is linked strictly to the future institutional architecture in Europe and in particular to the future relationship between ESA and the EU.

In the middle of these two extreme solutions, a hybrid approach can be adopted: part of future space programs could continue to be funded by the public sector (still need to define how EU and ESA would contribute), and a part funded by commercial revenues. Here again, this will depend on the sector we are considering (tele-

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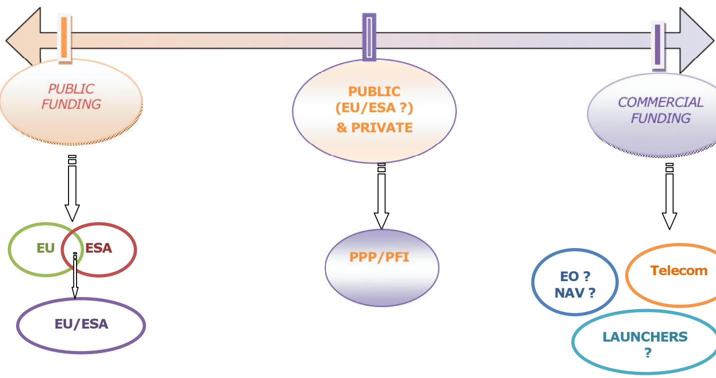
coms, EO, etc.). To this regard, the use of different forms of Public-Private Partnerships or Private-Financing Initiatives still need to prove its validity (in operational, industrial, and economic terms) but seem to be for the time being an interesting solution at national level, at least for telecoms. Lessons learned from the case of the PPP failure in the Galileo programme can provide, indeed, a basis for future thinking in the EU.

In any case, the entry into force of the Lisbon Treaty obliges the EU to develop a European Space Program, which can be implemented truly only if the EU allocates for it a dedicated amount of resources in a programmatic way. Whatever the new form of financing (with of without ESA or the private sector), it cannot exclude a direct participation of the EU, likely under the form of a specific budget line in the next MFF. Only in this way the EU will be considered a credible space actor and will be able to put in place the ambitions that are stated in its Treaties.

Under this hypothesis, the EU should think about the industrial policy to be adopted in order to keep a good balance between free competition and need to attract MS resources, and also about the duration and structure of the MFF.

	Public	Public/private	Private
EU	Need to find new financial mechanism / Part of the EU financing externalized to ESA?	PPP / PFI (lessons learned from national experiences and Galileo) Some sectors could be self-sustainable	The EU does not implement a real ESP. Private actors will not finance all sectors.
ESA	Need to keep just retour principle/ Optional programs?	PPP/ PFI (lessons learned from national experiences and Galileo) Some sectors could be self-sustainable.	ESA continues to fund some programs. Private actors will not finance all sectors.
EU/ESA	Which distribution of funding? Which industrial policy?	Which distribution of funding? / which industrial policy? Some sectors could be self-sustainable.	ESA continues to fund some programs. The EU does not implement a real ESP Private actors will not finance all sectors.



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Appendix

SOCIETAL NEEDS AND SPACE

The following table presents societal needs to which space activities could offer responses to, by the intermediary of Earth observation, telecommunications and navigation and localization satellites.

Areas of social needs	Space-based related responses and services
Agriculture and forestry	• Land productive capacity assessment • Forest resources inventory • irrigation planning support • Thematic maps of croplands, inventories • Vegetation monitoring • Estimation of acreages • Stand density monitoring • Weather damage assessment • Biomass estimation • monitoring of underground water extraction • drought monitoring and assessment • hail or frost damage location and assessment • crops conditions reports • danger analysis based on the vegetation conditions • fire detection and monitoring • fire severity analysis • reforestation success analysis
Environmental management	• Digital terrain models • land use and cover maps, changes detection and analysis • spill detections and monitoring • flood surveillance and monitoring • wind and solar plant location assessment • Burnt area mapping • Detection and monitoring of earthquakes, volcanoes, floods • terrain displacement monitoring • Land and land processes, such as soil moisture, land surface temperature, fire monitoring, etc • Weather forecasting • Climate change monitoring • Composition of the atmosphere • Sea levels monitoring • Sea surface temperature monitoring • Natural land use information • Habitat surveys • Water bodies/wet areas mapping • Water bodies pollution • watershed planning and water quality • Desert aerosol large-scale mapping • Pollutant concentration maps • Monitoring of water temperature and algae eutrophization • Measurements of coastline variations • Quarries and landfills variation monitoring
Maritime activities support	• Ship detection and tracking • Oil spills monitoring • Maritime surveillance • Erosion • Coral reef mapping

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Areas of social needs	Space-based related responses and services
Energy and infrastructure	• Oil, gas and minerals exploration • Oil seeps data • Slick mapping • Geological interpretation • Pipeline and infrastructure planning and monitoring • Seismic quality studies • Land cover and land use • Classification data for telecom network efficiency • Mining support • Hydrocarbon basin studies
Civil Security	• Change detection • Flood risk management and monitoring • Assets mapping • Damage assessment • Crisis management tools • Reconstruction planning • Risk management system • Disaster and post-disaster databases
Urban Planning	• Spatial planning services at local, regional, national and international levels • Infrastructure planning • Route planning • Powerline management
Transport	• Help with navigation of land vehicles • Traffic Information • Helpline for vehicles and passengers • Driving Assistance • Help for vigilance • Conduct automated • Location of stolen vehicles • Vehicle Tracking sensitive • Transport and monitoring of hazardous materials • Positioning of agricultural machinery • Monitoring of leased vehicles • Management of freight and parcel (trucks, barges, combined transport, etc.). • Support for public transport and motorway operators Control means Information for users Preventive Security Detection of incidents Emergency Calls Management of emergency vehicles • Support for rail road Control / Safety Command Absolute positioning of vehicles locomotives, wagons and containers fleet management Information users Assistance to the track inspection • Air transport Assistance to navigation Traffic Monitoring

Areas of social needs	Space-based related responses and services
Health	• Tele-training • Early warning systems in epidemiology • Epidemiological monitoring • Tele-expertise and support
Humanitarian Aid	• Damage assessment • Crisis management tools • Reconstruction planning • Disaster and post-disaster databases • Land cartography • Infrastructure cartography • Localization and navigation transport of aid and equipment
Telecommunications	• All telecommunications services • Broadband interactive links and HDTV broadcasting services • Digital broadcast and transmission • Mobile communications

EC R&D PROJECTS

The following table presents the EC funded R&D projects under research area « space »

Project	Focus	Theme
AQUAMAR	Marine water quality monitoring	Marine
ASIMUTH	Detection of harmful algae blooms, early warning, HAB forecasting	Marine
BIO_SOS	Habitats monitoring, biodiversity monitoring, automatic land cover maps, change detection	Biodiversity
BOSS4GMES	GMES service sustainability	
CARBONES	Quantification and understanding of CO2 surface fluxes	ECV/Climate change
CoBiOS	Ecological models, evolution of algae blooms, early warning	Marine
CORINE Land Cover	Mapping of the European environmental landscape, land cover, biotopes (habitats), soil maps, acid rain, natural resources, policy decision instruments	Land
CryoLand	Snow and land ice monitoring	Land (Snow, ice, glaciers)
DG JRC activities	Crop forecasting, food security	Land
DOLPHIN	Decision support models for border surveillance, traffic safety, environmental protection, fisheries control, search and rescue	Maritime surveillance
DORIS	Detection, mapping, monitoring and forecasting of ground deformations, landslides, land subsidence	Emergency
DORIS_Net	European network	Regional networks
EAMNet	Create an EU-Africa Marine Earth Observation Network	Regional networks (Marine)
EFAS	Early flood alert system, river flooding, real-time flood warnings	Land
EFFIS	European forest fire information system	Land
ENDORSE	Renewable energy sources validation and promotion, assessment of surface air temperature and solar radiation	Renewable energy
EUFODOS	Forest damage assessment, forest mapping	Land (Forestry)
EURO4M	European climate, climate variability and change monitoring	ECV/Climate change
EVOSS	Volcanic hazards monitoring	Emergency
FIELD-AC	Coastal-zone oceanographic prediction	Marine
FreshMon	Water quality monitoring	Water
GARNET-E	Emergency training provision for Africa	Regional networks (Emergency)

Project	Focus	Theme
GEMS	European air quality, European atmospheric composition, UV radiation for Europe	Atmosphere
GEOLAND 2	Land monitoring services, the agriculture state and trends, the farming pressure on water and soil resources, the contribution of agricultural land use changes to sustainability in terms of impacts on biodiversity and landscapes, soil erosion maps.	Land
GEOPICTURES	Real-time geo-referenced in-situ multimedia assessments, rapid mapping	Emergency
GLOWASIS	Water scarcity assessment, forecasting, reporting on drought, climate change	Water
G-MOSAIC	Situation awareness, damage assessment, crisis indicators assessment, routes surveillance	Security
GRAAL	European network	Regions networks
HELM	Land monitoring, thematic maps, land use, land cover, sustainable development	Land
ISAC	Agricultural change monitoring	Agriculture
LandSAF	Land surface variables,	Land
linkER	Preparatory action, platform to provide direct access to GMES emergency management service products	Emergency
MACC	European air quality, global atmospheric composition, monitoring of greenhouse gases, global fire emissions, monitoring of aerosols, climate forcing, monitoring and forecasting of UV radiation, monitoring and forecasting of ozone.	Atmosphere
MAIRES	Monitoring Arctic land and sea ice, mapping, forecasting, understanding climate change	Sea Ice
MALAREO	Malaria monitoring, vector detection and control	Malaria
MEDEO	EO data exploitation and integration	EO data
MOCCCASIN	Agricultural monitoring,, crops monitoring, climate effect on crop	Agriculture
MONARCH-A	High latitude and Arctic region monitoring	ECV/Climate change
MS.MONINA	Habitats monitoring, service implementation	Biodiversity
MyOcean	Hydrodynamic forecasts for all regional seas, remote sensing observations and forecasts for sea-ice, ship routing services (currents, ice), offshore operations or search & rescue operations, fish stock management, management of living marine resources, water quality monitoring and pollution control, coastal and marine monitoring, weather, seasonal forecasting & climate, global warming detection, sea ice extent	Marine
MyWater	Water resource management, water resource monitoring, forecasting	Water
NEREIDS	Maritime surveillance, data sharing, integration	Maritime surveillance
OPERR	European river discharge model	Marine

Project	Focus	Theme
PanGeo	Geo-referenced data layers for cities	Land (Geology)
PASODOBLE	Regional and local air quality monitoring	Atmosphere
PRE-EARTH-QUAKES	Earthquakes prediction	Emergency
PREVIEW	Atmospheric, geophysical and man-made disasters	Emergency
PROMOTE	European air quality, European atmospheric composition, UV radiation for Europe	Atmosphere
ReCover	Forest cover, forest cover changes and biomass monitoring, deforestation and forest degradation estimation	REDD*
REDDAF	Forest cover and land use monitoring, deforestation and forest degradation estimation, carbon stock accounting, forest over maps, forest cover change maps, degradation maps, biomass maps	REDD
REDD-FLAME	Forest monitoring, early detection of logging, identify deforestation, sustainable development, carbon accounting, forest resources management	REDD
REDDINESS	Monitoring forest changes, carbon accounting, deforestation and degradation.	REDD
RESPOND	Rapid mapping, humanitarian aid	Emergency
RISK-EOS	Floods and fires	Land
SAFER	Rapid mapping, geographic reference, disaster extent, damage assessment, early warning	Emergency
SAGE-EO	Framework for African GMES.	Regional networks
SeaU	Habitats monitoring, service implementationPollution monitoring, oil spill detection, damage assessment	Marine
SEMEP	Earthquakes prediction	Emergency
SIDARUS	Ice forecasting, sea-ice and iceberg mapping, animal tracking, sea ice thickness detection	Marine
SIMTISYS	Detection and tracking of small vessels, maritime borders monitoring, maritime routing and traffic, pollution management	Maritime surveillance
SIRIUS	Water resource management, sustainable agriculture, river-basin management	Water
SubCoast	Assessing and monitoring subsidence hazards in coastal lowland areas around Europe	Emergency
TERRAFIRMA	Landslides, Ground motion hazard, flood management	Land/Emergency
Urban Atlas	High-resolution mapping of urban areas with more than 100000 inhabitants, pan-European comparable land use and land cover data	Land
WatPLAN	Water resource monitoring, water accounting via water use and evaporation rainfall, land use, soil moisture and biomass production	Water
ZAPAS	Assessment and monitoring of forest resources, biomass maps, biomass change, land cover maps carbon accounting model	Forestry

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This project is funded by the European Commission

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2 Galileo is actually only part of the Global Navigation Satellite System (GNSS) flagship programme that also includes the European Geostationary Navigation Overlay Service (EGNOS), nevertheless Galileo is referred to as a flagship programme in itself throughout the Reference Book.

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12 Information taken from the OECD report: The Space Economy at a Glance 2011, published in July 2011 in Paris.

ACRONYMS

ATHENA-FIDUS	Access on THeatres and European Nations for Allied forces
ATV	Automated Transfer Vehicle
CoC	Code of Conduct
CSDP	Common Security and Defence Policy
DG	Directorate General
DVB	Digital Video Broadcasting
EC	European Commission
ECHO	European Commission Humanitarian Office
ECV	Essential Climate Variable
EDA	European Defence Agency
EGNOS	European Geostationary Navigation Overlay Service
ELDO	European Launch Development Organisation
ENP	European Neighbourhood Policy
EO	Earth Observation
ERS	European Remote Sensing
ESA	European Space Agency
ESDP	European Security and Defence Policy
ESP	European Space Policy
ESRO	European Space Research Organisation
ESS	European Security Strategy
ESTIB	European Space Technology and Industrial Base
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EUSC	European Union Satellite Centre
GDP	Gross Domestic Product
GEOSS	Global Earth Observation System of Systems
GMES	Global Monitoring for Environment and Security
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IMINT	Image Intelligence
INSPIRE	Infrastructure for Spatial Information in the European Community
ISS	International Space Station
IT	Information Technology
ITAR	International Trade in Armaments Regulation
IXV	Intermediate eXperimental Vehicle

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SEVENTH FRAMEWORK PROGRAMME
REA RESEARCH EXECUTIVE AGENCY

MDG	Millennium Development Goals
MFF	Multiyear fundingFramework
MS	Member States
MUSIS	MUltinational Space-based Imaging System
NATO	North Atlantic Treaty Organisation
NGL	Next Generation Launcher
NGO	Non-governmental Organisation
ORFEO	Optical and Radar Federated Earth Observation
PPP	Public-Private Partnership
R&D	Research and Development
REDD	Reducing Emissions from Deforestation and Forest Degradation
RELEX	External Relations
SAR	Synthetic Aperture Radar
SATCOM	Satellite Communications
SEIS	Shared Environmental Information System
SIGNIT	Signal Intelligence
SME	Small Medium-sized Enterprise
SPOT	Satellite Pour l'Observation de la Terre
SSA	Space Situational Awareness
UGS	User Ground Segment
UN	United Nations

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