Federal Ministry
of Economics
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Innovation Policy, Information Society, Telecommunications

Making Germany's space sector fit for the future

The space strategy of the German Federal Government

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Content

1. Introduction: setting the stage for Germany's space strategy

The International Space Station is the largest international space project, a cooperation between the USA, Russia, Japan, Canada and 11 ESA member states, including Germany.

A **paradigm shift** has occurred within space: once a symbol of the technology race and a contest between opposing systems, it is now, in every sense, a part of our everyday lives and an **essential instrument for the achievement of economic, scientific, political and social goals**. Today space makes a vital contribution when it comes to promoting research and development, education and innovation, economic growth, providing highly qualified jobs, improving our quality of life, protecting the Earth, ensuring our security and defence and furthering international cooperation. Space activities, as the European Commission put it in its Europe 2020 communication, provide us with "the tools to address some of the key global challenges".

In the last decade, the German space sector has achieved a number of **significant successes**. Each time an Ariane launcher lifts off from the launch pad, it does so with a substantial amount of vital hardware on board made in Germany. At the same time, German satellite technology enables us to see with greater clarity what is happening on Earth and in space, while Germany's space scientists are among the very best the world has to offer. Today, Germany can lay claim to **competitive industrial and research structures** in the space domain.

Space activities form a central plank of the German Federal Government's high-tech policy. In the framework of its High-Tech Initiative, the Federal Government has increased the amount it spends on space by approximately 10 % per year. In addition to continuing our high level of contributions to ESA, the national space budget in particular has been substantially increased. The aim of promoting the continuing development of Germany's technological skills, partly through the country's unique strengths in specific areas, has enabled Germany, both within ESA and in other international cooperation, to assume leading positions as is the case in Earth observation, for example, or in the new field of laser communications.

As we enter a new decade, the German space sector is facing **a fresh set of challenges**:

- International **competition** in space is set to increase. Leading spacefaring nations such as the United States, Russia, France and Japan will seek to defend their positions while, in addition, countries such as China, India and South Korea are driving ahead in specific areas, thereby bringing increased competition. Against this background, Germany's space sector will be forced, more than ever, to focus on its key strengths of reliability,

quality and price, and on those areas where technologically it has something unique to offer. In this respect, SMEs have, in addition to the large system integrators, an absolutely essential role to play.

- At the same time, **the environment in Europe with regard to space has changed dramatically**. In addition to ESA, the EU too is now developing its own space policy initiatives, having obtained explicit powers in this area under the Lisbon Treaty. The current major projects, Galileo (for satellite navigation) and GMES (Global Monitoring for Environment and Security) mark the start of EU involvement in the exploitation of space. In future, collaboration between ESA and the EU will require a clear division of roles and responsibilities.

President Obama's announcement in spring 2010 on the reorientation of his country's space activities and, in particular, the new US Space Policy point to a new set of priorities. In addition to, in future, stepping up the intensity of ISS exploitation, the United States will strengthen its civil space development activities through ambitious technology applications and unmanned robotic research. At the same time, the United States is calling for greater international co-operation with the aim of ensuring a safe, sustainable and peaceful exploitation of space. The new cooperative approach is wide-ranging and, with the exception of the launcher field, touches on all the important space science, technological and space policy themes. Europe should approach this as a constructive challenge, both within joint projects as well as in competition among partners. Germany, with Europe's second-biggest space sector, has the opportunity to contribute its specific strengths to this endeavour.

- Both at home and abroad, **new markets** are opening up for space services. **Private enterprise business models** are growing in importance, especially in the United States, where for some time they have been advanced systematically as a means to fulfil governmental Earth observation data needs. In the future, these models will be extended to the procurement of launch services from US commercial providers, with the additional aim of making commercial US launch service providers more competitive in the global market.

German astronaut Hans Schlegel performing a spacewalk at the International Space Station during the Columbus mission in February 2008

With the steady build-up of space capabilities in the emerging economies, competition is increasing in the global market for high technology in the space infrastructure field.

- The dependence of many areas of our daily lives as well as governmental activities on space applications makes them a potential target of hostile governmental and non-governmental entities. As the number of spacefaring nations grows, it is also becoming increasingly clear that, for terrestrial applications, space merely appears endless, while in fact it is becoming ever more crowded. This raises new questions in areas ranging from sustainability to the regulation of access and exploitation, protection of space systems, arms control and verification.

To meet these challenges, **German space policy must focus even more strongly on its strategic objectives**.

In his August 2009 report, the Federal Government coordinator for the German aerospace industry gave an assessment of Germany's positioning with regard to space activities and made a number of

ESA ministerial conference in The Hague, 2008

recommendations concerning space policy. The space strategy follows on from those recommendations.

The Federal Government's space strategy presents the plans and milestones already in place while also forming the basis for future German activities in space. In particular, it serves to facilitate coordination within the Federal Government and sets out guidelines for a consistent representation of the national interest across government departments and in the international sphere.

Space technologies and projects have long development cycles. Due notably to the decisions taken at the 2008 ESA ministerial conference, government funding for space in the next few years is largely tied up in ongoing projects and programmes. Our aim must be to begin setting out, as of now, the direction of travel for the period subsequent to that. The focus will not be on individual projects as such but, above all, on the general orientation and long-term strategic options, which must also form a central plank in the Federal Government's ongoing high-tech strategy.

Excursus:
Space 2010: the status of space activities in Germany

- **In its 2006 High-Tech Strategy, the Federal Government accorded particular importance to space:** indeed, within that strategy, space is the biggest single field in financial terms. The level of funding has made it possible to consolidate Germany's role as a key location for space activities as well as its number 2 position in the European space sector (after France and ahead of Italy). The Federal Government has thus provided the German space industry and German science with a good platform from which to now expand this position in selected areas.

- **In 2010, the Federal Government is spending about € 1.2 bn on space**, with about € 985 m of that coming from the BMWi (Federal Ministry of Economics and Technology) technology budget. The BMVBS (Federal Ministry of Transport, Building and Urban Development) contributes € 96 m towards European meteorological satellites, and to the GMES and Galileo programmes.

- **The biggest single item in German spending on space is the country's contribution to ESA, which stands at €637m.** According to ESA rules, nearly all the amounts paid in flow back to Germany in the form of contracts, thereby benefiting German firms and research facilities directly. Germany – as the second largest contributor to ESA after France – participates in ESA activities in all the key space sectors and has, as a result of its substantial contributions, come to assume the leading position in strategically important programmes such as Earth observation and satellite communications.

- **The second pillar is the National Space Programme, to which the BMWi provided € 240 m in 2010.** The purpose of the national programme is to allow Germany to pursue independent objectives, especially

those that support German-based business activity, and to conduct the preparatory work that enables Germany to play a pro-active and influential role in ESA programmes. In addition, a series of complementary national and bilateral activities are conducted. At the same time, the National Space Programme is a tool which, by setting strategic priorities, enables our industry to prepare for increased competition in Europe's internal market.

- **The German space sector boasts a number of cutting-edge research and operational facilities**. Foremost among these is the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt, or DLR), which receives institutional support from the Federal Government and the German Länder (space budget in 2010: € 151 m). DLR scientists make contributions, both technological and operational, to national and international space missions and to research projects in collaboration with partners in research and industry. In so doing, the DLR makes vital contributions to German space research. In addition, the DLR operates important test and operational facilities such as the rocket test stands at the DLR Institute for space propulsion in Lampoldshausen or the German space operations centre (GSOC) in Oberpfaffenhofen.

- The **Raumfahrtmanagement** (Space Administration) unit within the DLR draws up the German space programme on behalf of the Federal Government, implements the programme, and integrates all German space activities at the national and European level.

- In addition to the DLR, Germany plays host to a number of other **first-rate research centres** in the field of space-oriented research and development. This notably includes institutes and departments at a wide range of universities as well as the Max Planck Society, the Fraunhofer-Gesellschaft, and the Helmholtz centres.

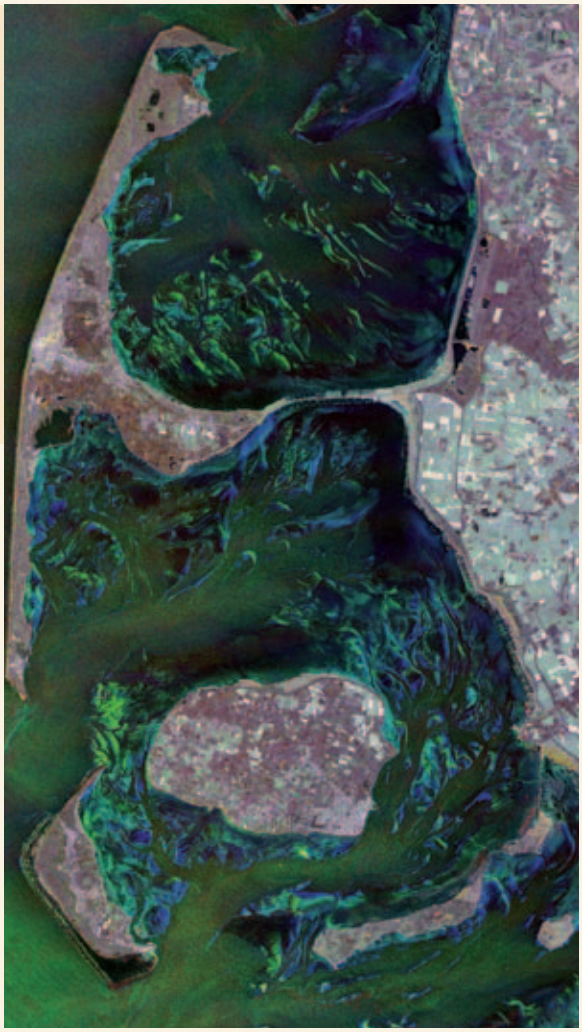
- **EUMETSAT** (the European Organisation for the Exploitation of Meteorological Satellites) and ESA's **ESOC** establishment are both located in Darmstadt. A second ESA site is the European Astronaut Centre **(EAC)** in Cologne.

- With sales revenue approaching €2bn and providing roughly 6200 jobs in 2009 (figures from BDLI, the German aerospace industry association), Germany has, after France, the **second biggest space industry in Europe**. The bulk of these highly qualified jobs are in the system segment domain for EADS Astrium or for the OHB group.

- A particular feature of the German space industry is the **large number of small and medium-sized enterprises (SMEs)** involved in the development and manufacturing of subsystems and components. It is a reflection of their high level of technological competence that they are highly sought-after partners both at home and abroad. The Federal Government attaches special importance to these firms since they frequently provide the impetus for innovation in technologies and processes in space as well as entering into important cooperative arrangements with scientific institutes. Providers of test and system services and regional clusters and initiatives also play an increasingly important role.

- A central element in the coming years will be that, in implementing this strategy, German space industry and science actors will, through increased efforts of their own, improve their competitiveness in Europe and the wider world. Germany's "2nd place" in Europe should not be merely a reason for satisfaction but should also provide Germany with the impetus to achieve even more.

2. Space: a key to solving global challenges



Images recorded by TerraSAR-X showing turbulent waters around the island of Sylt

Space is a means to an end. Space technology provides infrastructures and services with a view to achieving social, economic and scientific objectives outside of the space sector itself. Germany's space strategy pursues this aim and thus forms an integral part of the Federal Government's political objectives. All space projects must therefore be measured according to the contribution they make to achieving those objectives.

The Federal Government's strategy aims to use space to address key global challenges and, in so doing, to exploit its economic potential to the utmost:

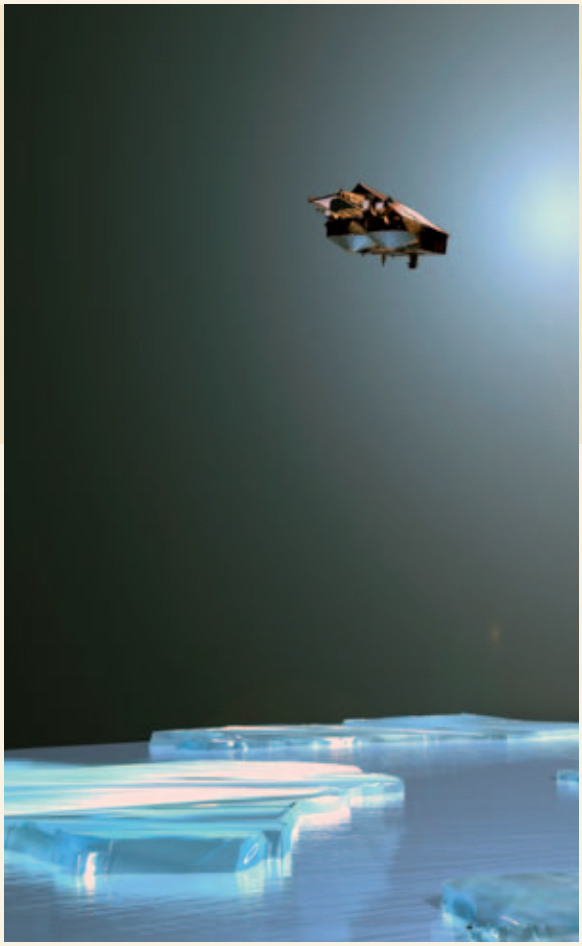
Globalisation

One of the principal challenges facing Germany, as a leading exporter, is globalisation. Flows of data, transport and goods are set to expand still further in the future. The security of worldwide goods traffic is essential in a distributed global economy characterised by mutual dependencies. The only way to deal with this challenge efficiently is to harness space technology while carrying out the control, distribution and tracking of these global flows. Dependable access to satellite-based services is absolutely essential to the efficient management of land, sea and air traffic.

The knowledge society

Knowledge, for a country short of raw materials such as Germany, is a strategic resource. Science and research form the basis of technical innovation and are thus also a source of economic added value and social development. It is a decisive advantage to always remain one step ahead through innovation and knowledge as we seek to defend our position in competition with the rest of the world. With missions to explore both space and our home planet, as well as research in space conditions and technology developments on the very edge of what is feasible, space makes a crucial contribution to the attainment of knowledge.

Being able to access information at any time from anywhere is one of the core requirements of the knowledge society. Doing business effectively is only possible, in the age of globalisation, with secure communications. A globalised media landscape opens the way to transparency within political systems and prevents national isolation. Space-based infrastructures make it possible, by means of satellite communication, to obtain high-quality data anywhere on Earth at any time, and thus prove themselves to be an effective instrument for the dissemination and exploitation of knowledge.



With the help of the European satellite Cryosat-2, launched in 2010, scientists can observe the evolution of polar ice.

Climate change, preserving essential natural resources and global change

The preservation of natural resources essential to our very existence, together with the measurement, analysis and actions to deal with changes in our planet, including the consequences of climate change, are urgent priorities for all humankind. The monitoring of environmental treaties, weather forecasting, basic scientific research, predicting the consequences of climate change, effective management of natural resources such as land, water and minerals and coping with natural disasters all require innovative Earth observation and communication technologies, which, in many instances, only space is able to deliver. It is particularly essential in the case of climate change, due to its global dimension, for a reliable, neutral and comprehensive assessment to be made of its consequences as well as a proper evaluation of the measures taken in responding to it. Space applications are particularly – if not uniquely – suited to promptly providing policymakers with the data and monitoring instruments they need to pursue evidence-based policies.

Whole-of-government security preparedness

Germany's security policy environment has undergone substantial changes in recent years. While previous threats to Germany and its citizens may have receded, Germany must now join forces with its allies and partners to confront a new set of global risks and challenges. This calls for a coordinated, "networked security" approach that encompasses all means available to the state and also includes the participation of non-governmental actors. Space-based systems play a key role in providing early warnings of impending crises and thereby boosting the Federal Government's assessment capabilities. They enable the targeted deployment of forces even far from Germany's borders and can deliver information vital for the rapid mobilisation of aid efforts. Military operations, in particular, are now inconceivable without the support of space-based systems. Space systems in the domains of communication, navigation and Earth observation make a decisive contribution to Germany's ability to conduct an effective foreign and security policy and to achieve whole-of-government security preparedness.

3. Guidelines of the Federal Government's space policy

Space robotics – a driver for the very latest technological developments (First German national conference on space robotics, 13–14 May 2009, Berlin)

Orientation toward benefits and needs

The overriding aim must, at all times, be to continue improving human living conditions. State-funded space activities must therefore be channelled towards "space for the benefit of the Earth".

Space projects will be judged according to the contribution they make to solving the challenges facing global society and whether the long-term application of high levels of funding can be expected to bring adequate benefits.

These benefits may lie in a variety of areas: in contributing to global environmental management, in providing efficient support to government in the performance of its duties, in space functioning as a tool of science and not least in bringing economic added value. In that last area – and extending way beyond the space industry proper – significant potential lies in applications and services markets which are only made possible through space-based infrastructures.

The Federal Government focuses its space policy strictly on benefits and needs while, at the same time, targeting visionary goals. To that end, space must, in competition with other instruments and with terrestrial processes and infrastructures, demonstrate that it offers the better solution from a cost-benefit standpoint. As tools of research, space projects must be guided by the "benchmarking" (scientific excellence) principle. In large-scale projects they must show that they can prevail in competition with other methods and scientific disciplines.

The focus on benefits and needs requires early and wide-ranging involvement of, as well as a sharing of responsibility by, users of space systems and services in the concept design, funding and execution of projects. It is immaterial whether those users are public entities, scientists, research facilities or companies, especially from the industrial or service sector. Ultimately, the design and execution of a space project must depend not only on its technological appeal and scientific excellence, but also, and above all, on the needs of the users and their readiness to assume responsibility themselves.

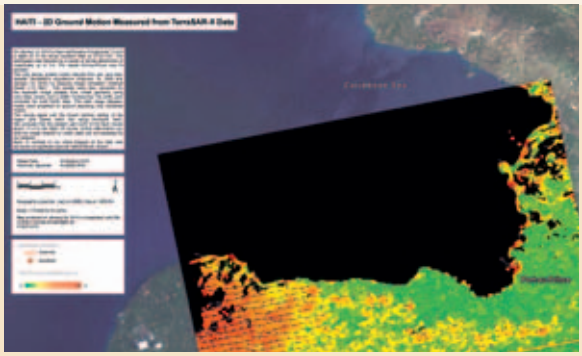
Orientation toward the principle of sustainability

The government, the economy and society all depend increasingly on properly-functioning space infrastructures. It is highly developed industrial nations such as Germany which particularly require secure communication, navigation and Earth observation if they are to be able to protect their citizens. Yet at the same time, it is important to realise that threats to important space-based infrastructures are on the rise, due to natural causes such as solar storms or meteorites, but also from space debris such as decommissioned satellites and jettisoned rocket stages or their fragments, and finally from potential targeted interference, notably from Earth.

Germany's contributions to space activities are consistently oriented toward the notion of sustainability – that is, they are implemented in a way that will also allow future generations to take full advantage of the possibilities of space. Thus, it is essential when it comes to designing future space activities, that these are based on an effective, generally accepted regulatory framework at national and international level, that there is an avoidance of producing space debris, and that space systems are afforded proper protection. This principle continues to gain in importance as the trend is increasingly towards miniaturisation, the availability of new technologies at reduced cost and, therefore, towards increasing numbers of space users outside state-sponsored space programmes and the big space firms.

Intensifying international cooperation

Due to their technical complexity and high cost, many space projects can be realised only through international cooperation. The Federal Government therefore intends to further expand international cooperation through coordination with its partners as a means of avoiding unnecessary duplication of effort and overcapacity while also improving space sector efficiency. To that end, the priority remains, in particular for the creation of large strategic infrastructures, European cooperation through ESA and EUMETSAT as well as bilateral and multilateral cooperative efforts. In the field of Earth observation,



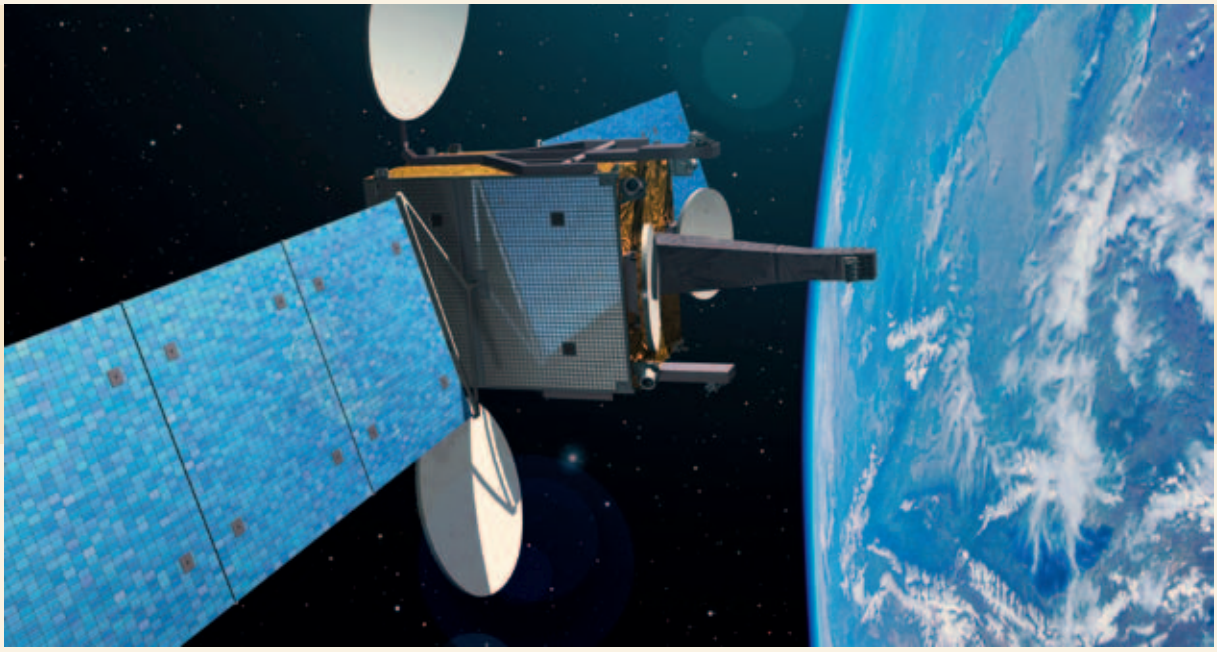
The German Earth observation satellite TerraSAR-X provided data on movements of the Earth's crust after the Haiti earthquake at the beginning of 2010: green indicates minimal movement, red is for shifts of two metres.

forums for international coordination such as the Group on Earth Observation, the Committee on Earth Observing Satellites and the International Charter Space and Major Disasters are increasingly important.

In areas such as space research, exploration and human spaceflight, projects will also be carried out in well-established long-term partnerships with non-European partners. In this regard, it must be ensured that German and joint European contributions to such cooperative efforts form a substantial and essential part of the missions in question. To achieve this, it is vital to be in a position of strength in the key technology areas.

At the same time, we aim – as in all other industrial export markets – to enhance our competitiveness in the increasingly crowded commercial space markets. In each individual case, the correct balance between cooperation and competition will have to be struck. Thus we will be guided by the following principle: strategic space activities affect German national interests (including commercial interests) and therefore require Germany to maintain its own competences and expertise; large-scale scientific or operational space missions are to be carried out through international cooperation.

4. Fields of action: making Germany's space sector fit for the future



A S-GEO-type satellite in Earth orbit (artist's impression)

Our country is bound to a long tradition of outstanding scientists and pioneers. The Federal Government will therefore make greater use of the growing opportunities offered by space, with the primary focus on the following areas:

a) Expanding strategic space expertise

To ensure comprehensive exploitation of space, Germany must maintain its own system competences, enjoy guaranteed access to strategic key technologies, and have the capability to operate such systems and control the associated value chain. This requires the existence of a scientific, technical and industrial base within Germany, not least in the interests of autonomy of action. Long-term, such domestic competences serve to maintain competitiveness and the scope for sovereign political action and strengthen Germany's competitiveness relative to its partners in Europe and across the world.

Through a combination of its National Space Programme and selective involvement in ESA's technology and applications programmes, Germany aims to develop capabilities and key technologies in application domains that are both promising commercially and relevant strategically. High-calibre, globally competitive firms and scientific excellence are indispensable to ensure Germany's interests are best served when it embarks on international cooperation, within ESA, for example, but also as it faces increased competition within Europe's internal market.

In this context, attaining, expanding and maintaining system capabilities and technological superiority in selected key, pace-setting technologies are of fundamental importance. Missions that manage to achieve the broadest possible application of these technologies are particularly suited to promoting German core competences in space and serve to enhance Germany's profile.

In the fields of Earth observation, space science, and recently in satellite communications, Germany has demonstrated its ability to acquire systems competence and take the technological lead. Germany has assumed the lead role in the development of a small communication satellite within ESA (S-GEO) and, as a result, will in future be able to act independently in this commercially attractive and strategically important field. In addition, "system capability in the ground segment", in international standards for transmission technology and in the corresponding terminal technologies, form the basis for added value downstream.

By aiming for cutting-edge performance in high-tech domains, Germany also aims to develop national competences in areas offering great future potential. We will also establish clear priorities in service areas outside the space industry proper such as the analysis and distribution of Earth observation data. Though the space sector creates infrastructures, most of the added value occurs in product and service domains outside the classical space domains that make use of those infrastructures. Only when the economic potential of these domains is successfully unlocked can the high, mostly governmental, investments in infrastructure be justified.

Federal Chancellor Merkel and President Sarkozy at the event marking the start of the Franco-German satellite project MERLIN, February 2010

Objectives:

- Germany will further expand its already first-rate capabilities in Earth observation, in particular in the radar domain (and above all in X-Band, suited to high geometric resolution) as well as acquiring control over the complete system chain. Germany will also support future technologies in Earth observation such as hyper spectral remote sensing, in which complex satellite-based sensor systems capture wavelengths ranging from short-wave ultraviolet to long-wave infrared. Using hyper spectral remote sensing, it is possible, for example in the agricultural domain, to assess crop yields and analyse damage to forests, but also to conduct mineralogical exploration and environmental monitoring. At the Franco-German Ministerial Council in Paris in February 2010 the starting gun was fired on the Franco-German climate mission MERLIN (Methane Remote Sensing Lidar Mission) whose aim is to monitor the formation and spread of the greenhouse gas methane worldwide and thus to support international action to protect the climate. In this Franco-German partnership, Germany has taken on the task of developing the complex instrument. In Earth observation, new markets are also clearly emerging for space technology, high-value data products and downstream services with the result that Earth observation is not only becoming a driver for geoinformation but is also an economic factor in its own right. In Earth observation especially, efficient exploitation is dependent to a high degree on having a state-of-the-art ground segment. In addition to the technologies and infrastructures used to control satellites, and to receive and process data, a central role is played by cutting-edge technologies for long-term archival, evaluating data or combining and linking data from different sensors. Efficient exploitation, though it depends both on ongoing basic research and on applications-focused developments, is also underpinned by a continuous process of fostering young talent through first-rate university education.

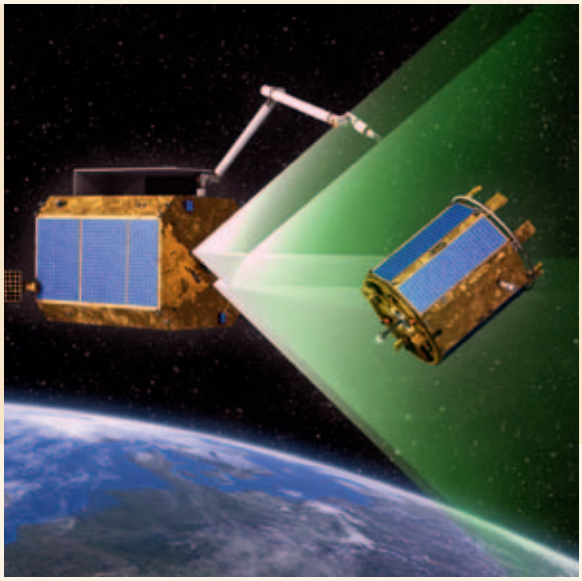
- In satellite communication, Germany will extend its systems capability with regard to the building of geostationary communication satellites and will drive forward strategic satellite technologies such as laser communication. In this way, Germany will acquire a strong competitive position in this commercially and strategically important space sector, while at the same time making an important contribution towards ensuring the efficiency of Europe's communication infrastructure for security-related applications, Earth observation, space research, and exploration.

- In satellite navigation, Germany will maintain its lead role in Europe's Galileo navigation system and develop the necessary innovative navigation applications and procedures aimed at ensuring that the highest security requirements can be met. As well as building the Galileo satellites in Germany, our immediate focus is on building up and extending the Galileo Control Centre at the

DLR Oberpfaffenhofen site (and also the Italian centre in Fucino). The Federal Government's long-term aim is to ensure that Galileo exploitation is a commercial success and, in particular, to facilitate access to international markets for innovative smaller firms. To that end, the Federal Government is making national funding available, through the BMWi (Federal Ministry of Economics and Technology), for several test beds for the Galileo Test and Development Environment (GATE), providing an early incentive to develop and test innovative Galileo products and applications in Germany.

- We will place particular emphasis on the further technological development of robot capabilities, mechatronics, artificial intelligence and autonomous systems, which, in their ability to act as cross-cutting future technologies, are clearly especially suited to meeting space-specific challenges while also delivering benefits back on Earth and developing future global markets. In this respect, Germany already has excellent foundations in place, as seen in the new focus on robotics research within the National Space Programme and the expansion of the DLR Institute of Robotics and Mechatronics. The task now is to pool and further develop our national capabilities in a selective manner so as to allow Germany to take further strides within the leading group of space faring nations. In this connection, the central challenge in the coming years will be to establish synergies between space robotics and "terrestrial" robotics, as well as between various research institutes and various firms. On-orbit satellite servicing will open up a new dimension for the commercial space sector, too: in future, robots will be responsible for the refuelling, servicing, repair, and controlled disposal of satellites in orbit, enabling operators to manage entire satellite fleets. In this way, it will be possible also to address the growing problem of space debris and improve the sustainability of space activities.

- Particular attention must be paid to establishing a competitive industry in downstream growth markets. Whether German industry positions itself successfully in the large markets for services and terminals will depend largely on the initiative it shows and on its independent strategic positioning. There are a great many new opportunities in this area, particularly for SMEs with their high potential for innovation.



The DEOS project is intended to capture satellites that stray from their orbital path.

b) Establishing a unified legal framework

For private investment in the space sector and the development of private enterprise business models to occur, there is a need for a dependable legal framework and reliable planning data. Germany, with its rules on satellite data security, has already taken the lead in Europe, as recognised by the international community. This has enabled the Federal Government to press ahead with the task of developing commercial markets in the Earth observation sector and also to ensure the protection of its foreign and security policy interests. The Federal Government is currently working on a German Space Act aimed at providing a clear and comprehensive legal framework for non-governmental, especially commercial and private space activities. This is in response to Germany's obligations under international law with regard to the approval and monitoring of such activities. Together with a long-term strategy and future-oriented space programme, the law will provide a clear framework in which science and industry will be able to operate in Germany.

The number of satellites orbiting the Earth is constantly rising (artist's impression, objects not to scale in relation to the Earth).

The need in specific cases to protect strategic high technologies in an increasingly globalised industrial landscape presents a particular challenge. In the case of the technologies in listed military or dual-use products, transfer is already fully regulated and is subject to national and European export control provisions; the export of critical space technology to non-EU, non-NATO or similarly categorised states is subject to strict conditions.

There is a growing need for a national and international legal framework in the space sector. This already exists in areas such as frequency allocation and the definition of orbital positions for satellites. What is urgently needed today are regulations on preventing and disposing of space debris, liability in the event of collisions in space and other accidents and the protection of space-based infrastructures from attack. The EU has touched on this theme with its slogan "Security in Space and from Space" and has developed a "Code of Conduct for Outer Space Activities". Order and security in space can only be achieved through international cooperation.

The Federal Government has for many years been active in pressing for the establishment of international standards to prevent the generation of further space debris. The guidelines drawn up within the framework of the UN Committee on The Peaceful Uses of Outer Space (COPUOS) are an important first step. The DLR, for its part, is actively involved in the European Network of Competences on Space Debris. German scientists, meanwhile, are taking the lead in developing procedures to measure and model space debris. In addition, work is ongoing into ways of extending satellite lifetimes and recovering objects from space.

Preventing an arms race in outer space remains an important objective for Germany. We make clear our views on this in the relevant forums for international cooperation – following close coordination with our (EU) partners. The Federal Government is in favour of a resumption of the substantive work of the Geneva Disarmament Conference and would welcome discussions and negotiations within the "Prevention of an Arms Race in Outer Space" working group. As it currently appears impossible to obtain acceptance at international level of any new binding

instruments regulating arms control in space, the Federal Government proposes taking pragmatic steps in the meantime, such as confidence-building measures, notably through the EU Code of Conduct for Outer Space Activities.

Objectives:

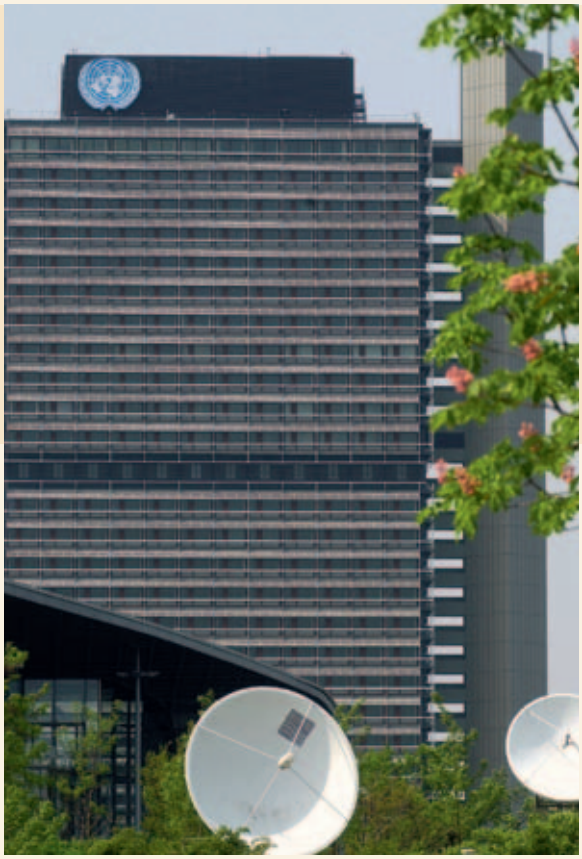
- In order to give full weight to the space sector's increasing importance to Germany and to the competitiveness of its industry, the Federal Government is in the process of drawing up a national space law which, in conjunction with the legal framework established in the last parliamentary term on remote sensing data security in the Earth observation domain, will provide a comprehensive and dependable legal framework for private and commercial space activities.

- We will further seek to persuade the EU and our European partners to introduce similar rules at EU level and in other space faring EU partner countries in order to ensure a level competitive playing field.

- We will also work, within UN COPUOS, towards a strengthening of the international legal framework in the aforementioned domains.

c) Sustainably reinforcing our strong position in space research

Space activities provide wholly new opportunities for engaging in basic scientific research while also addressing questions as to our existence and place in the universe. These extend from the examination of scientific principles and theories to the discovery of completely new phenomena. As well as pure acquisition of knowledge, basic research also provides an important boost to innovation on Earth. In the extreme environmental conditions that prevail in space, science missions frequently operate at the very limits of technical feasibility. As such, they frequently act as drivers for technological excellence. It is important also to remember that our top scientists have another responsibility: to the education and training of the next generation of scientists.



The UN-SPIDER programme coordinates space-based disaster management from the UN offices in Bonn.

Germany has a strong position in space research – i. e. in space exploration (astronomy, Sun, planets, comets) as well as research under space conditions (physics, materials science, biology, medicine). We aim to consistently and sustainably expand this position. In addition to ESA's science programmes, the National Space Programme also has an important role to play in achieving this goal, notably through bilateral cooperation with other countries and funding national contributions to ESA missions.

A proper balance must also be struck between scientific and applications-related space activities. Together, they power the further development of industrial and research structures and competence in key pace-setting technologies.

As well as placing a high value on basic research, we aim first and foremost to prioritise, wherever possible, the transfer of scientific results to economic

Artist's impression of the European astronomy satellite, Herschel

uses and applications, while also focusing on sustainability and the protection of our environment and technical systems (notably from external influences on the climate, space weather, near-Earth asteroids). As far as possible, these factors should be identified and taken into account at an early stage in the development and design of any mission.

Objectives:

- Basic and applied research in space and under space conditions constitutes an outstanding investment in the future of our knowledge society. Germany aims to reinforce and expand the strong position it has established at the European and international level in the fields of space exploration, the use of space for scientific purposes, and the study of the Earth system. As one of the world leaders in space research, we intend to ensure that greater use is made of German expertise and excellence in the context of ESA missions as well as in national and bilateral missions. Leading German research institutes – such as those based at the Max Planck Society, the DLR and at various universities – make major contributions to international cooperation across a range of key projects. Examples include infrared and X-ray astronomy, research into gravitational waves, fundamental processes in plasma and colloidal physics, Bose-Einstein condensates and space weather. A new large-scale project that will take place in the near future is the Alpha Magnetic Spectrometer (AMS), designed to search for antimatter and dark matter in space from an external platform on the ISS. AMS is scheduled to be transported on one of the last Shuttle flights to the ISS, in 2011.

d) Tapping new markets

Space activities, at international level, are still predominantly conducted on behalf of public authorities and receive state funding to provide the space services required for official governmental purposes. Space activities, as an "enabling technology", also have a significant economic impact. They provide infrastructures that enable new value chains to be created in other economic sectors, especially in downstream value-added services. In some cases, the value added in the downstream sectors is many times the value added in the space industry itself. This is the case, for example, in the markets for satellite TV reception (with dishes, receivers, etc.). The overall economic activity generated by space infrastructure is greater roughly by a factor of 10 – and even many times that in some cases.

As it becomes increasingly applications-oriented, space is providing a basis for commercial activity in a number of fields. Satellite communication, navigation and, to a large extent, Earth observation are just a few examples of the increasing practical benefits to

Human physiology experiment under conditions of near-weightlessness on board the A300 Zero-G parabolic aircraft

German Earth observation satellites TerraSAR-X and TanDEM-X provide data used to generate a 3-dimensional digital elevation model of unique quality. These data are also used for commercial purposes.

be derived from space. The markets springing up in these areas are a source of growth and prosperity. As these markets grow, the government – after providing the initial spark through substantial investments – can focus increasingly on its role of setting the appropriate policy framework and promoting new types of future technologies.

The objective is to develop in a systematic manner the competences that give rise to business models for services. By focusing on private enterprise and commercialisation, Earth observation activities in particular will be given a sustained boost, while established technologies will be supported from outside R&D budgets. Governmental demand, too, will be met, where appropriate, through commercial/private enterprise business models. Public-private partnerships (PPPs) and new models for funding and operating space-based infrastructures must be promoted. From an industry perspective, PPP models are a strategic measure particularly suited to the development of new markets.

Space is a dynamically developing sector, presenting both challenges and opportunities to German industry. The growing international markets in countries with no space industry of their own, in particular, offer considerable opportunities to German firms. In addition, the commercial and institutional markets in the emerging economies of Africa and South-East Asia will gain in importance in the future. The economic potential of these emerging markets is already improving in many sectors with the help of satellite communications. At the same time, public authorities in almost every country in the world also use space applications and the associated services to varying degrees.

German industry must display creativity and entrepreneurial spirit if it is to establish a presence in world markets, both with space products themselves and with downstream services. Further, in view of the increasing competition from the emerging economies in the markets for space infrastructure and launch services, German industry must concentrate more than ever on achieving cutting-edge performance in high-tech areas. Currently, it is new and continuing development activities directly or indirectly connected to payloads, applications and data that form the basis for the future commercial success of Germany's space industry. The development of additional markets will depend on whether major technological advances in the launch services sector can bring about a substantial reduction in launch costs and/or

the development of innovative new propulsion or re-entry technologies. Core competences in the space applications sector must be further developed in systematic fashion to achieve success in the market by producing unique and outstanding technical solutions. The aim must be to bring about a substantial increase in German industry's share of global sales revenue in the commercial space sector.

Objectives:

- Satellite-based services constitute a rapidly developing, dynamic field of business. Just as with satellite communication, entirely new markets will be created in satellite-based Earth observation and navigation – as well as through their links with integrated applications. This in turn creates the necessary conditions for the build-up of know-how and intellectual property. German firms are therefore ready to take up the challenge of using creative and innovative ideas to meet domestic governmental demand and to develop new markets. Industry must make full use of this opportunity to increase its share of global space sector activities by ensuring that it remains at the cutting-edge in high-tech areas.

e) Exploiting space for civil and military security purposes

Space-based systems for Earth observation, communication, navigation and the observation of the Sun and near-Earth asteroids are central to many areas of national security. Satellite data and services make a vital contribution, notably to disaster relief and management, environmental and climate protection, to warning of threats, development aid, border monitoring and arms control.

Many civil applications have become quite inconceivable without the assistance of meteorological and other satellites. Reliable and safe transport by air, land and sea is no longer possible without satellite-based weather forecasting. Environmental, energy, town and regional planning can be precisely and efficiently supported by means of satellite mapping. For climate research and monitoring the global view provided by satellite systems is absolutely indispensable.

The Fraunhofer-Gesellschaft analyses space debris using the space observation radar system TIRA as well as other space objects, thereby contributing to safety in space.

In particular, Germany's highly developed capabilities in radar remote sensing and the associated assessment methods make it uniquely positioned to provide support in dealing with natural disasters and other crises. We will ensure that Germany is able to count on a national civil system for the reliable provision of such services. At the same time, these operational capacities will make a valuable contribution to European needs in this area.

In the military domain, too, satellite-based systems have become completely indispensable. Strategic reconnaissance and long-distance command and control capabilities are now among the essential requirements for modern, efficiently-run armed forces. An essential element in this development is the increased use of space-based systems for independent national communication and reconnaissance capabilities. These capabilities are vitally important if Germany is to continue to contribute to international peacekeeping missions and play its proper role in global politics. Space competences form a crucial part of operational capability.

Our nation's internal and external stability depends increasingly on the proper functioning of our space-based infrastructures. This makes us vulnerable to accidental or deliberate interference (electronic interference, hostile takeover of satellites, etc.) or

The German army's five-satellite military Earth observation system SAR-Lupe (artist's impression)

even to targeted attacks aimed specifically at important space-based capabilities. In future, our efforts to guarantee our security must also extend to the protection of these infrastructures and to a situational assessment capability. For any such infrastructure to function satisfactorily, it must also be provided with secure communications for its control and use. To ensure compliance with the specific IT security requirements applying to space activities, we will encourage the establishment and continued updating of the corresponding procedures.

The availability of key technologies and national systems competence in the military space domain is of fundamental importance to the Federal Ministry of Defence. The Satcom BW und SAR Lupe satellite systems constituted important milestones in that regard. Whereas in the United States and many other countries, it is the military that is far and away the main driver of new and innovative developments in technology, in Germany, innovations in the space sector tend to stem mostly from technologies developed for civil and scientific applications. We shall therefore, wherever possible, exploit synergies between civil developments and dual-use technologies when further developing system capabilities and strategically important competences in key technologies both in Germany and Europe. All government departments involved in space activities are called upon to engage in the continuous coordination of their technology and industrial policies aimed at promoting Germany as a centre for space and innovation and to review their policies in terms of their implications for whole-of-government security preparedness.

Tasks in core areas of state activity are fundamentally different from the standard tasks of a research establishment or research administration. We will review the current administrative structures within the German space sector to determine whether they meet these specific requirements and adapt them as necessary.

Objectives:

- Germany will make greater use of the potential for synergy between civil and military space research in the development of security-related technologies in the Earth observation and telecommunications sectors, for example.

- Within the limits imposed by the national budget, we will secure for the long term and gradually build up the space infrastructure Europe requires for environmental, climate, transport and security purposes. In particular, we will also increase the use of this infrastructure for government purposes, thereby contributing to the modernisation of government.

- Space-based systems perform an increasingly important function with respect to civil and military security in Germany and Europe. Closer coordination between the various arms of government as well as over government activities will prevent duplication and ensure a better use of resources.

- It is of vital importance to Germany's security that we ensure the proper functioning of space systems in the face of natural and human threats while also allowing access to the exploitation of space. These objectives are of particular importance in respect of all government activities relating to space. With that end in mind, an essential contribution will be made by building up a national competence for space situational awareness through the use of existing resources.

f) Shaping the distribution of roles in the European space sector

With the entry into force of the Lisbon Treaty, the EU has now acquired competence in respect of space activities. Member states of both ESA and the EU have been preparing themselves for this new situation for years and, through the ESA/EU Framework Agreement of 2004 and the resolutions passed in 2007 by the Space Council (joint meeting of the ESA and EU Councils), have already established the basis for implementing new EU space activities.

In the field of space policy, the guiding criterion for the distribution of work among institutions must remain the preservation of the overall performance and capabilities of the European space sector. Duplicate structures must be avoided and expenditure on coordination and administration kept within limits.

The European Space Agency (ESA) controls most of its missions from control rooms at the European Space Operations Centre (ESOC) in Darmstadt.

Accordingly, tried-and-tested structures which have helped make the European space sector a widely acknowledged and technologically cutting-edge player on the world stage must be maintained and, wherever possible, strengthened.

In the framework of ESA, which coordinates European space activities, European countries have been working together with great success for 35 years. ESA member states are still responsible for funding well over 90 % of institutional space activities in Europe. Inside Europe, ESA is firmly established as the focus for European cooperation in the space sector. It has wide-ranging experience and the right tools to conduct complex, demanding space projects. Its funding system ensures a fair division of costs and benefits within European space projects. In addition, ESA has, through its actions, proved itself to be a thoroughly trustworthy partner in international cooperation. For all these reasons, an independent, strong ESA continues to be essential to the success of the European space sector. The Federal Government therefore remains committed to strengthening ESA as an intergovernmental institution.

It is against this background that the EU will develop its space activities. With regard to space applications and exploitation, it should focus on such activities as complement or supplement already existing activities carried out by ESA, member states and specialist user organisations such as EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites). Due also to limited budgets, the two key projects, Galileo and GMES, will remain the prime

focus for some time to come. These projects are already managed by the European Commission and are intended to make a major contribution to the EU2020 Strategy. Alongside their build-up, long-term operation, and user-driven further development, which – in a context of increasing international competition – will demand yet more substantial effort, the potential for applications, in particular, must also be borne in mind. This factor is expected to strengthen Europe's competitiveness and enhance its capacity for innovation. Successful implementation of these two key EU projects will be the test of the EU's ability to set up and operate space infrastructures in a cost efficient manner.

Looking ahead to the long term, the EU must, if it is to be able to take on new space activities, first acquire the necessary tools to do so. We shall continue to insist that – as frequently called for in the Space Council – adequate instruments, funding schemes and procurement procedures, must be introduced within the EU to meet the specific requirements of the institutionally dominated "space market".

Like member states, the EU will also be able to use ESA in the future as a service provider for the implementation of its space activities, task it with carrying out space programmes and take part in ESA optional programmes.

In addition to ESA and the EU, the member states themselves – with their national programmes and bilateral/multilateral cooperative projects – form the third pillar of European space activities, particularly on defence projects. This latter pillar is the principal framework for cooperation in the view of the Federal Government.

Objectives:

- Germany, with the largest economy in the EU and as its biggest contributor, will have a crucial say in determining the role of the EU based on the provisions of the Lisbon Treaty. Given the background of budget restrictions, the Federal Government will also call, above all, for a clear demarcation of roles based on the principles of subsidiarity and complementarity, avoiding duplicate activities and structures, and establishing the necessary funding and contract procedures to meet the specific requirements of the space sector. The completion and ongoing operation of Galileo and GMES will have top priority.

- Germany will continue to press for a strengthening of ESA as an independent intergovernmental organisation. ESA alone has the many years experience of management and coordination, as well as the set of tried-and-tested instruments required to conduct complex, highly demanding space projects. In the view of the Federal Government, therefore, even after the entry into force of the Lisbon Treaty, ESA remains the most suitable framework within which to implement the European space policy and to conduct Europe-wide cooperation in space matters.

- Moreover, after 35 years of successful operations, ESA remains a vibrant, still growing organisation. Its continual evolution, as seen notably with regard to voting rights, financial reform, and programmatic priorities, remains – not least because of its willingness to accept additional member states – an important task in which Germany is actively and constructively engaged.

- For Germany, this participation in European space activities also means that it must be adequately represented by qualified German staff at all levels across the European institutions, but particularly in the senior leadership positions. The Federal Government will continue to support measures to optimise the proportion of German representatives within all European bodies. We call upon industry, when filling management positions in European firms, to ensure that all participating nations are equitably represented.

g) Defining the roles of Germany and Europe in exploration

Missions to explore space "in situ" always exert a particular fascination. They give rise to the hope that, by venturing into space, humankind will be able to provide new answers regarding the origin of life as well as the "where from" and "where to" – i.e. the starting point and destination – of human existence. This

Inside Europe's International Space Station laboratory module

applies equally to manned missions to low-Earth orbits (for example, to the International Space Station) as well as to robotic missions to explore the depths of the cosmos.

Human spaceflight efforts will continue to be directed towards the International Space Station for at least another ten years. Thus the ISS – with its consistent and well-established division of labour among partners – will remain the centrepiece of scientific research under space conditions. As a result, a key priority here must be to obtain the best possible return on European investment within the existing structures and commitments. A decision on possible follow-up activities, based on a full cost-benefit analysis of ISS operations, will have to be taken in a few years time.

Exploration projects too must be measured according to the extent to which they contribute to solving the challenges facing our society. Exploration missions must therefore serve a clear scientific purpose, such as basic research into the origin of the Solar System, for example. They must be of high technical quality and their results must be subject to transparent verification. We will therefore continue to insist that Europe's commitment to exploration must concentrate on projects of high scientific value with great potential for technological applications, including in non-space domains. ESA, with its many years of experience with the planning, funding and execution of long-term European space projects must therefore continue to play the central role in this regard in the future. Europe must bring to the table its specific strengths and experience, most notably in the area of robotics, sharing out work in cooperative endeavours with other spacefaring nations.

Intelligent, autonomous robotic systems are key technologies when it comes to the further exploration of space. Extending mankind's reach into space, intelligent robots will permanently change the face of future space activities: robotic systems will land on planets, moons and asteroids and explore them, bringing major advances in our exploration of the Solar System. Initially, the Moon, as the subject of scientific exploration closest to Earth, is ideally placed to begin the testing and demonstration of robotic tech-

nologies. Technologies tested and further developed there at reasonable cost can then be used on exploration missions to more remote destinations involving a global coordination and cooperative effort. The crucial factors in the success of robotic systems are a high degree of mobility, precise manipulation, and the ability to operate autonomously in far-away locations.

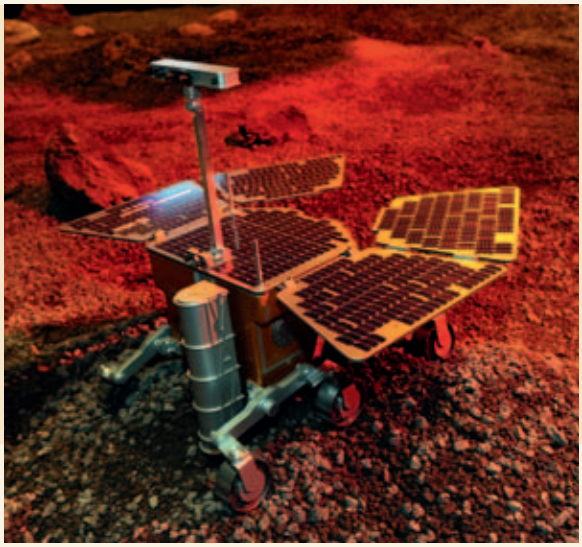
Space robotics provides very direct benefits to society. Developing robotic space technologies requires the highest level of engineering and science prowess in a multidisciplinary environment that ranges from artificial intelligence, autonomous systems, virtual reality, miniaturisation, materials engineering and mechatronics to information and communication technology. It also opens up the widest range of terrestrial applications. Robotic capabilities are key elements in future space technologies and act as "springboard technologies" for applications on Earth. Robotics is also a highly innovative branch of industry that offers substantial market opportunities to SMEs.

With our space robotics strategy, we are already investing in technologies with great future potential of considerable importance to the development of Germany's economy and society. This strategy also sends out a clear signal that Germany intends to be a strong presence in European and international robotic exploration of the Solar System. Robotic systems "made in Germany" are set to become a significant new brand presence on the international market.

Objectives:

- The International Space Station is a symbol of peaceful international cooperation in orbit and should be exploited intensively since it is a unique laboratory allowing research of the highest level to be conducted. A comprehensive assessment of ISS operations will be made that will provide us with the basis for a decision on a possible follow-up system or on other options.

- For Germany, developing autonomous systems, especially in the field of robotic exploration of the Solar System, is a matter of the highest priority. We will continue to extend Germany's proven competences in this domain.



DLR study for a Martian rover

h) Securing technological independence and access to space

Access to key technologies and high-performance launchers are essential preconditions to civil and military space activities. However, in that, both are no more than the means to an end. Germany's aim is to ensure access to technologies and space transportation systems for the lowest possible cost so as to remain internationally competitive and obtain the maximum benefit from investments in space applications.

Within the framework of ESA, European access to space is guaranteed by Ariane 5, to which France's contribution is some 60%. Through its contributions within the ESA framework, Germany currently has a 30% share in Ariane 5 and as such is the second biggest partner in the Ariane programme. Germany is responsible for developing and building the launcher's crucial upper stage, delivers essential components such as the boosters, tanks and parts of the propulsion system and has expertise in propulsion technology based on storable propellant.

With its mix of commercial and institutional launches, Ariane 5 is currently the best means of guaranteeing European access to space. However, if this situation is to continue, Ariane must remain commercially successful in the launcher market.

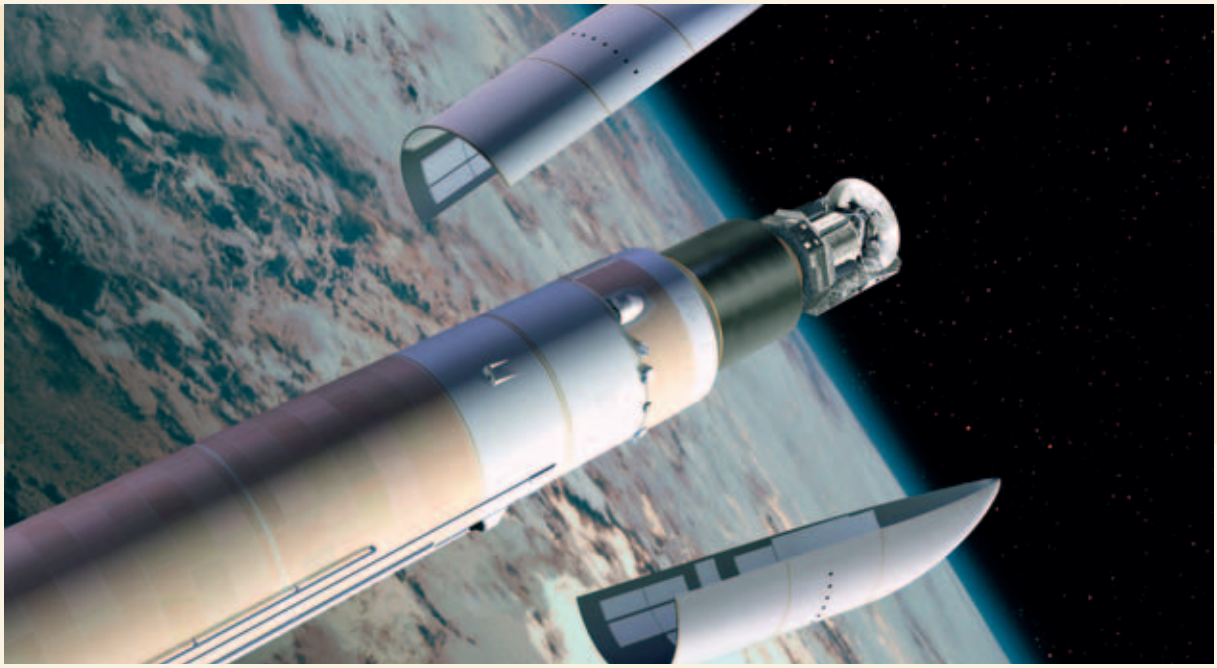
The European Ariane 5 launcher lifts off from Kourou spaceport, French Guiana

The Federal Government will therefore continue to support technological measures aimed at improving Ariane's competitiveness in the launcher market.

As a result of the shift in emphasis in US space policy, which, after the Space Shuttle is retired from service, will rely on commercial launch service providers for transport to the ISS, substantial changes and further overcapacity in the global launcher market may well occur. Were that to be the case, it could be necessary to conduct a thorough, "root and branch" review of European launcher policy. Our aim is to ensure that Europe has access to space transportation systems that is as cost-effective as possible. To this end, possibilities for international cooperation and an international division of labour should also be considered.

The western world must retain a human spaceflight capability for as long as robotic systems remain incapable of fully replacing the human presence for conducting space activities. We will continue to discuss this with our partners in Europe, the United States and Japan.

The Federal Government will continue to support efforts aimed at guaranteeing unhindered access to key technologies. It is essential for critical components and hardware to be readily available in Europe. At present, certain hardware items can only be obtained in the US and are subject to ITAR export restrictions. Nevertheless, complete autonomy is impossible or at least can only be achieved at enormous expense. In each individual case, therefore, it is important to find the correct mix of autonomy, coop-



A successful conclusion to an Ariane launch: payload separation, in this case for Herschel and Planck (artist's impression)

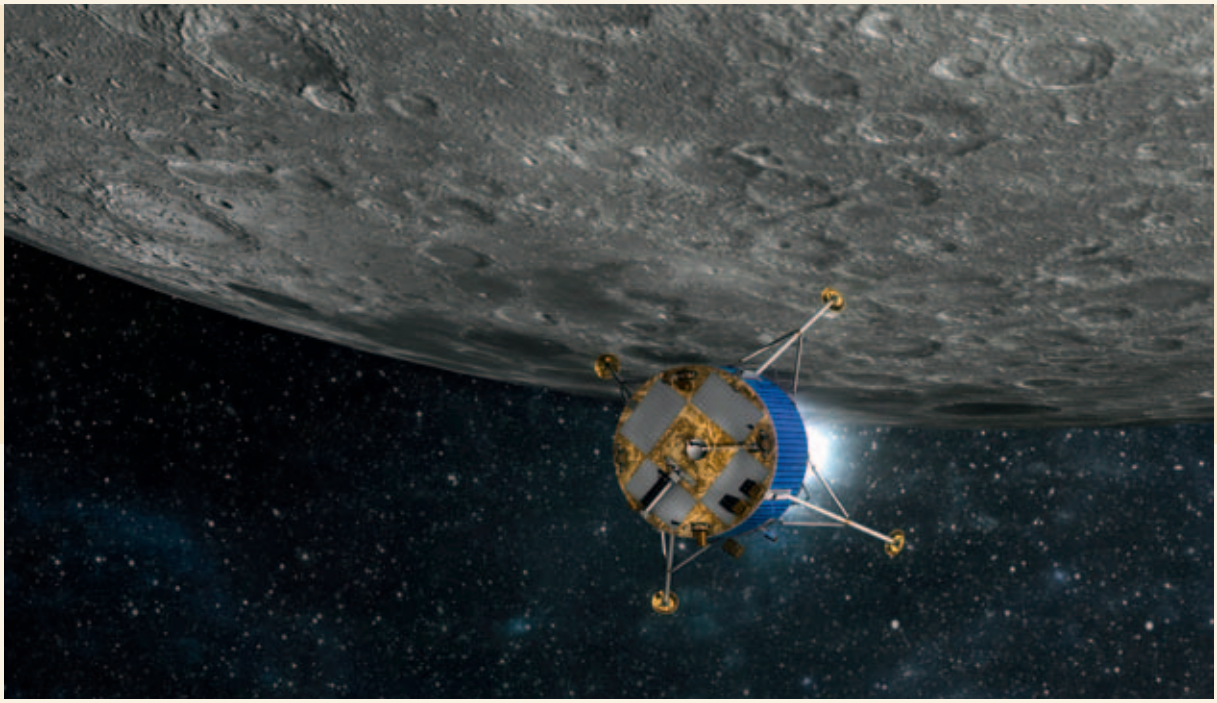
eration and a reliance on freely accessible commercial providers.

Objectives:

- Unhindered access to space transportation systems constitutes an essential element of European political sovereignty. Germany is extensively involved in the research and development of space transportation systems and in shaping European launcher policy. Its main focus is on system competence for the Ariane 5 launcher upper stage. Germany aims to ensure the most cost-effective possible access to space transportation systems, to maintain the international competitiveness of Ariane 5 and, in so doing, to ensure a high level of national added value.

- It is essential for critical components and hardware to be readily available in Europe. Germany therefore supports intensified efforts to develop critical hardware and components in Europe in order to avoid dependency on any single source.

5. Summary



Lunar Lander, a study for an unmanned moon lander (artist's impression)

Germany's space sector can point to some remarkable successes in recent years. There are a number of reasons for this: the country's research and development performance, the increase in the national space budget and the maintenance of our ESA budget contributions at a high level. Through targeted support for the further advancement of national technological capabilities (some of which are unique worldwide), Germany has succeeded in gaining a leading position – often within the framework of ESA and other forms of international cooperation – in key fields such as Earth observation and the new field of laser communications.

The German space sector currently confronts a **new set of challenges**.

- Space technologies will be the site of increasing competition at the national, European and international level.
- **Private enterprise business models** are gaining in importance: the new US Space Policy unveiled in June 2010, for example, laid special emphasis on the need to develop and expand commercial markets through and for space technologies.
- New players are taking the stage: in Europe, the **Lisbon Treaty** has given the EU its own competences in the field of space policy. This raises questions as to the future division of roles between ESA, with its tried-and-tested processes, the EU and the National Space Programme.
- The **United States**, the most significant player among all spacefaring nations, has effected a **fundamental reorientation** of its space policy: with the halting of the Constellation programme, robotic research, Earth observation, utilisation of the International Space Station (ISS) and technology development are now to the fore, replacing the earlier priorities of manned missions to the Moon or Mars.
- In addition, the increased activities of **countries such as China, India and South Korea** are strengthening the competition within global space markets.

The central focus of the Federal Government's space policy is on space applications and concrete benefits for humanity. Space activities must be in **competition** with other technology domains and be judged

according to whether their high cost is adequately compensated for by the scientific, social or commercial benefits they bring.

To summarise, a clear orientation towards **benefits and needs**, the principle of **sustainability**, and intensive **international cooperation – particularly within Europe** – are the guiding principles of our policy in the following areas:

1) Expanding strategic space expertise

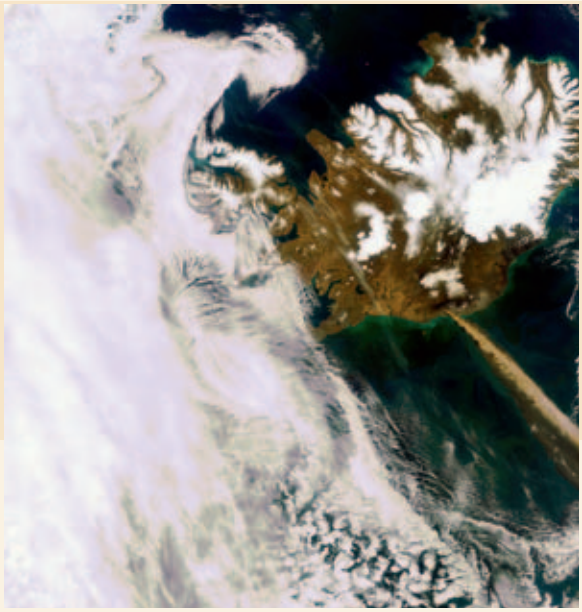
We aim to strengthen systems capability and technology leadership in selected key or pace-setting technologies.

- We will further expand Germany's first-rate Earth observation capabilities, particularly in the radar domain (and especially X-band, suitable for high geometric resolution) with the aim of acquiring expertise along the entire system chain. Germany is also prioritising the development of future technologies such as hyper spectral Earth observation and lidar measurements of atmospheric composition. In this field it is particularly clear that, in addition to basic Earth system research and monitoring tasks for the public sector, commercial markets are also beginning to emerge. Thus, Earth observation is not only a driver for geoinformation but is very much an economic factor in its own right.

- In satellite communication, another important sector commercially, we will extend our systems capability with regard to geostationary communication satellites while pressing ahead with strategic satellite technologies such as laser communication and electronically controlled antennas.

- In satellite navigation, we will develop innovative navigation applications and procedures for satisfying the strictest security requirements.

- We will place special emphasis on the ongoing technological development of robot capabilities, artificial intelligence and autonomous systems, which, in their ability to act as cross-cutting, future technologies, are clearly especially suited to combining space-specific challenges with terrestrial benefits and the development of future global markets.



The dense ash cloud from Iceland's Eyjafjallajökull volcano as seen by the European Earth observation satellite, Envisat in April 2010

- Particular attention must be paid to establishing a competitive industry in downstream growth markets. Gaining a successful position in the vast markets for services and terminal equipment will largely be up to the initiative of companies themselves and the way they position themselves strategically. There are a great many new opportunities in this sector, particularly for SMEs, given their great potential for innovation.

2) Sustainably reinforcing our strong position in space research

- We aim to expand Germany's strong position, in European and international terms, in the exploration of the Solar System and cosmos and in the scientific exploitation of space for physics, materials sciences, biology and medicine (research under space conditions). As one of the leading nations in space research, we will bring German expertise and excellence to bear more strongly within the framework of ESA missions as well as

national and bilateral missions. By efficiently implementing the National Space Programme, we will continue to strengthen German competitiveness in science, and thereby play a greater role in shaping ESA programmes.

3) Tapping new markets and establishing a unified legal framework

Satellite-based services are a rapidly developing, dynamic field of business. Alongside satellite communications, Earth observation and navigation are giving rise to a whole new range of market opportunities. German industry faces the challenge of using creative and innovative ideas not just to meet public sector demand at home but also to move beyond that and develop new markets.

- We will draft a German Space Act which, together with the Satellite Data Security Act (SatDSIG) already in force, will provide a comprehensive legal framework for commercial and private sector space activities.

- We will also seek to persuade the EU and our European partners to introduce analogous rules at EU level and in other spacefaring EU partner countries in order to ensure a level competitive playing field.

- We aim systematically to extend competences that give rise to business models for services, while also bringing about a durable increase in private-enterprise orientation and commercialisation. Demand of governmental origin, too, will be met, where appropriate, through commercial/private enterprise business models (such as PPPs).

- We aim to bring about a substantial increase in German industry's share of global commercial space turnover.

One of many navigation services: highly accurate route information for mountain bikers

4) Using space for purposes of whole-of-government security preparedness

Space-based Earth observation, communication and navigation systems make vital contributions to disaster relief and management, environmental and climate protection, to warning of threats, development aid, border monitoring and arms control. In the military domain, satellite-based systems have become indispensable. Yet, many civil applications too are now quite inconceivable without data captured by meteorological and other satellites.

As part of a concept of networked security, space technologies play a vital role in protecting Germany and its citizens and ensuring an effective and independent German foreign and security policy. Thus the protection of space systems – both governmental and civilian – holds essential significance for the common good.

- We will make greater use of the potential for synergy between civil and military space research when developing security-related technologies in the Earth observation and satellite communications sectors, for example.

- By strengthening coordination across government departments and activities, we will avoid duplication, put resources to better use, and foster a whole-of-government approach to security preparedness from the outset.

- We will safeguard for the long term and gradually improve and extend the space infrastructure required in relation to the environment, climate, transport and security. We will also step up the use of this infrastructure for government purposes, thereby contributing to the modernisation of our administrative structures.

- To protect space systems and applications, we will conduct our own national space situation assessment and exchange and compare this information with key international partners.

5) Shaping the distribution of roles in the European space sector

With the entry into force of the Lisbon Treaty the EU has acquired a "parallel" competence in respect of space policy, which leaves unaffected the existing competences of member states (and of ESA as an intergovernmental organisation). European countries have collaborated in joint space projects for 35 years, with great success, within the framework provided by ESA. ESA member states are responsible for funding well over 90% of institutional space activities in Europe.

- Consequently, we will call for a clear demarcation of the tasks of the EU in accordance with the principles of complementarity and subsidiarity, avoidance of duplicate activities and structures, but also for the introduction of the necessary funding and procurement procedures to meet the specific requirements of the space sector and reflect the fact that budgets are limited. The highest priority will be given to the completion and continuing operation of Galileo and GMES.

- We wish to strengthen ESA as an independent intergovernmental organisation with long years of experience and the tried-and-tested instruments required to carry out complex and demanding space projects. We are of the view that, even after the entry into force of the Lisbon Treaty, ESA remains the primary framework for European space policy and European space cooperation.

6) Defining German and European roles in exploration

The reorientation of US space policy has made it clear that International Space Station utilisation is set to continue until at least 2020 and will, for the foreseeable future, remain the only relevant objective in the human spaceflight field.

- Against this background, we will, while maintaining the existing distribution of tasks and costs, use the ISS intensively as a unique laboratory for first-rate research so as to obtain the greatest possible return on European investment. A comprehensive assessment of ISS operations will be conducted that will provide us with the basis for a decision on a possible follow-up system or on other options.

- For Germany, the development of autonomous robotic systems is a top priority, not least as key technologies for space exploration. We shall continue to extend Germany's established competences in this technology of the future. This will include robotic technologies for the safe and sustained management of satellite systems in orbit (servicing, disposal) but also for robotic exploration of the Solar System.

7) Securing technological independence

- Unhindered access to space constitutes an essential element of Europe's political sovereignty. We are deeply involved in the research and development of space transportation systems and play a part in shaping Europe's launcher policy. Our principal focus is on system competence for the Ariane launcher upper stage. Through our involvement in the launcher sector, and with a view toward new private operator models, we aim to

ensure that Europe has the most cost-effective possible access to space.

- It is essential for critical components and hardware to be readily available within Europe. We therefore support intensified efforts to develop critical hardware and components in Europe so as to avoid dependency on any single source.

8) Human spaceflight

The western world must retain a human spaceflight capability for as long as robotic systems are incapable of fully replacing the human presence for conducting space activities. We will continue to discuss this question with our partners in Europe, the United States and Japan.

9) The Moon as a target for exploration

The Moon continues to be of interest as the "archive of our Solar System" and a potential platform for space exploration. Exploration and exploitation of the Moon remains a political and scientific challenge. We will therefore further examine the option of an unmanned mission to the Moon within the ESA framework.

10) Ensuring the sustainability of space activities

- An unrestricted peaceful use of space is, for future generations, an essential prerequisite to freedom and prosperity. Germany, therefore, places particular importance on ensuring the sustainability of its national space missions.

- Germany, together with other spacefaring nations, both in the EU and UN context, advocates a common international legal framework to cover space activities, the avoidance of space debris and the prevention of damaging attacks on peaceful space activities.

Germany is therefore open to any initiatives aimed at bringing about the substantial advancement of space-related arms control policy.