→ AGENDA 2015

A Document by the ESA Director General

European Space Agency

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INTRODUCTION

Agenda 2015 reflects the opinion of the ESA Executive only, based on its experience and its attachment to the organisation. We are convinced about the facts, motivations and recommended actions proposed – however, ESA is first an organisation belonging to its Member States and it will become what its Member States will decide.

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1 → ESA TODAY

1.1 Taking stock of the past 35 years – a success story

The European Space Agency has been very successful for more than 35 years in defining, funding and implementing programmes responding to the needs of users, be they scientists, private or public service providers, industry, and in pooling the national resources of its Member States within a global European effort. ESA has also been instrumental and successful in the emergence of a European space policy associating its Member States towards common objectives achieved through jointly developed infrastructures (European scientific programme, European access to space, European manned space programmes, meteorology space infrastructure, initial telecommunication programmes, etc.).

It is worth noting that all Member States allocate a major (if not the largest) share of their space resources to ESA programmes and that those Member States having maintained and developed a strong national programmatic line are also the major contributors to ESA, thus ensuring a good level of coordination and complementarities between their own national activities and those implemented in the ESA framework.

The space sector is a growing economic sector thanks to the growing number of services delivered to citizens based on space infrastructures but it is more than just an economic sector:

- it is an industrial sector, one of the very few where all manufacturing is taking place within Europe;
- it is a factor of competitiveness for the whole of Europe, being a sector of knowledge and technology;
- it is one of the few sectors where transfer of knowledge into services for citizens is the most systematic and rapid.

More importantly, the space sector is one of the very few sectors where Europe has a leading position in the world, be it in the commercial market of satellites, telecoms and launch services, be it in technologies and services, and where Europe is a model, in particular in placing priorities to serve citizens and in being the most reliable partner on the international scene.

The reputation of ESA in Europe and in the world is that of a very capable and reliable organisation. ESA's success is firstly that of its Member States; secondly that of its operating framework based on its original Convention; thirdly that of its own competences; and fourthly that of its capacity to work in a flexible way with different partners (national agencies of Europe,

European institutions and agencies, industry, operators, scientists and international partners). The continuity of its success has been based on a combination of stability and changes; changes able to maintain the basic foundations whilst adapting to the growing importance of space activities for life on planet Earth and to the development of economies, to the geopolitical changes driven by globalisation, to which space is contributing, and to the critical challenges that humankind is facing.

These changes have been steady and regular, with no significant crisis since the beginning of ESA, demonstrating the solidity of the organisation and its foundations. The changes of the last 10 years have been supported by three successive reflections initiated by the Executive: "Towards a space agency for the EU" in 2000, "Agenda 2007" in 2003 and "Agenda 2011" in 2007. These changes have been decided by the Member States mainly at the occasion of ESA Councils at ministerial level in 2001, 2005 and 2008. They concern many aspects of what ESA delivers to Member States, EU and society, and how it does so: the ESA programmes and activities have seen in the last years a significant increase of service-oriented activities: meteorology, navigation, the start of new cycles in telecommunications and Earth observation, and the initiation of security-related activities. In order to achieve this, ESA has developed a number of partnerships: with the EU (Framework Agreement); with national agencies; with industry and operators (in particular Public–Private Partnerships); with international partners (Russia, China) beyond the longstanding cooperation with NASA; and with non-space private investors (Business Incubator Centres).

The success and evolution of ESA has attracted more and more countries to become ESA Member States (from 14 to 19 in 10 years, while it took 25 years from 11 to 14), and it is very likely that there will be a further rapid extension of membership to include all EU Member States, first the currently eight EU Member States, which have already a cooperating agreement with ESA, and later to the two remaining States.

1.2 Lines for improvement

However, today, in order to sustain ESA's success, further changes are needed to take into account **lessons learnt from 35 years of operations**.

The lines for improvement for the future of ESA, which can be derived from these 35 years are the following:

The impact of the economic crisis must be managed
The last ESA Council at ministerial level, in November 2008, already took place in a context of financial crisis. The ESA Member States decided, however, to increase significantly their investments in space, and in particular in ESA programmes, as a tool guaranteeing a return in knowledge, technology and high-value services, driving the competitiveness of Europe, and providing highly qualified jobs therein, in particular in the manufacturing industry. In order to take into account the financial crisis and associated budget constraints for Member States, the Director General has managed these investments in such a way that all commitments could be implemented but with more

efficiency and with payment profiles adapted to constraints. In view of its upcoming Council at ministerial level, ESA must further pursue its efforts for increased efficiency, reducing non-industrial costs and ensuring adequate risk management and cost control, in order to enable Member States to commit new investments without impacting on short-term payment budget issues.

The relation with the EU must further evolve

The relationship with the EU was one of the drivers of Agenda 2007 and the main driver of Agenda 2011. As a matter of fact, in Agenda 2011, the DG stated that "the long-term and political perspective is to make ESA become an Agency of the EU by 2014 (associated with the new financial perspectives of the EU)".

This perspective was challenged by Member States. Nevertheless the relationship with the EU has significantly grown, based on the Framework Agreement, and focused on the delegation to ESA of the Galileo programme and the cooperation on the development of Sentinels within the Space Component of the EU-led GMES.

Since the publication of Agenda 2011, the Lisbon Treaty has entered into force, including an explicit mention of space and of the European Space Agency and conferring a specific competence on space to the EU. The Framework Agreement between ESA and the EU was extended in May 2011 until 2016.

The concrete consequences of this space competence have not materialised fully in the proposal of the Multiannual Financial Framework proposed by the European Commission for the period 2014–2020, in terms of political and budgetary commitments of the EU. Furthermore, the economic and financial crisis will likely have consequences not only on the budget but also on the overall governance of Europe, or even on the worldwide governance.

Although the institutional relation of ESA with the EU has not made significant progress since the Framework Agreement and the Galileo/GMES delegation agreements, the ESA membership has evolved to become closer to the EU membership and it can be expected that all EU Member States will be ESA Member States or European Cooperating States in the coming years. The consequences on the Agency's day to day business and on its longer term prospective will need to be assessed both at corporate and at individual programme level.

Even if the past 10 years show the need for a sharper definition of the respective roles and tasks of the EU and ESA, it is clear that the future of ESA is linked to the EU and its sectorial policies. The EU policies are relevant to many of the services provided by the space infrastructures developed by ESA, the EU has become ESA's largest 'third party' and the EU provides an additional political dimension to space in Europe.

ESA's industrial policy and procurement schemes must become less complex and costly

ESA's industrial policy and procurement have been regularly adapted over the years, in order to match the evolution and maturing of European industry, the evolution of the worldwide commercial market, the evolution of Member States, and the evolution of ESA

programmes (in particular programmes aiming at enhancing competitiveness and developing services). This has led to a succession of additional measures, most of them being measures for more control, more correction and more rebalance. These measures have been successful in reaching all the objectives of ESA's industrial policy and procurement, but have been increasingly constraining for programmes and for industry, and they have rendered the overall system more complex and thus more costly.

It is increasingly difficult to match industrial return measures within the Level of Resources with more and more Member States

ESA has difficulties to match the minimum industrial return to some Member States every five years as required by the Convention. This is particularly the case for activities within the Level of Resources. In parallel, a number of Member States have difficulties to contribute to optional programmes beyond their contributions to mandatory programmes. These difficulties impact the satisfaction of these Member States and require continuous corrective actions, to the detriment of the overall efficiency of ESA. The fair distribution of industrial activities among participating States undisputedly belongs to the foundation and to the success of ESA, but the fairness between distribution of activities and contributions can be organised differently, depending upon programmes and Member States.

The use of resources between ESA and national agencies and their national programmes must become more systematic

ESA is the agency of its Member States and builds on their capabilities in space-related knowhow and technologies. However, Member States' delegations and the Executive do not always work closely together as ONE ESA to reach the strategic goals of Member States. While there are good examples of successful cooperation between national and ESA programmes (such as in scientific missions, the Vega development, EGNOS and Alphabus) these are still far from being systematic and optimal; and substantial difficulties remain in other areas to bring together the objectives of national and ESA programmes. This may be due to a certain lack of dialogue, a lack of trust among the different actors around the ESA table, and the unbalance among national programmes.

However, especially now, the competitiveness of Europe requires using all existing competences, starting with those from ESA and national agencies. The consequences of the economic crisis on public budgets make current inefficiencies unaffordable and should therefore be taken as an opportunity to make such cooperation systematic.

Access to space must be revisited within a different environment

The environment under which the European launcher sector is working today is significantly different from the 1970s when the Ariane programme was developed and exploited. It was innovative at that time; it must be revisited today.

The situation of the European launcher sector is unique compared to the US, Russian and Chinese sectors. The European governmental market for which a guarantee of access to space is secured by ESA Member States is,

first, too small and, second, not committed enough for sustaining by itself a European launcher sector. It thus requires this sector to capture a significant share of the worldwide commercial market. This model has been successful for guaranteeing access to space for governments, but is less and less economically sustainable because the prices are more and more driven by the competitors. Efforts to make this model sustainable by reducing the costs have their limits since exploitation costs are driven by the development organisation, the latter being constrained by Member States' contributions.

At the same time, the largest customers of launch services on the commercial market are European since most of the largest satellite telecom operators are European, even if they have an international dimension: SES, Eutelsat, Inmarsat, Hispasat and Avanti, representing a much larger market for the launcher sector than all European governmental satellites together. These operators benefit from the existence of Ariane first as one option for getting a permanent guarantee of access to space, and second for getting the best prices on the commercial market of launch services. Should Ariane disappear from the launch service market, European telecommunications operators would be hurt and their competitiveness at stake. The guarantee of access does not therefore concern governments only and must be revisited within a wider picture, in which development is driven by exploitation needs rather than the other way around.

Human spaceflight activities need a new driver

Human spaceflight activities started in Europe in the 1970s with the development of Spacelab, driven by transatlantic cooperation. The success of Spacelab, transferred to NASA, has been extended with the contribution of ESA to the Space Station Freedom, which evolved into the International Space Station within a cooperation with Russia initiated by the USA.

This approach has been successful for Europe, which has developed unique capabilities (pressurised modules, life support, rendezvous and docking, etc.) thanks to this cooperation with NASA and under its leadership. However, this approach has its limits for the partnership, including for NASA itself. As a matter of fact, until recently, the USA has always avoided having a partner on 'the critical path' when entering a partnership. This principle is putting any partner of NASA in a situation of 'add-on', upon which NASA is not dependent, while it is itself dependent on NASA.

This principle has failed on the ISS, since NASA has been and still is dependent on the Russian partner for transportation. The future of human spaceflight and exploration worldwide should thus be built according to a different paradigm, based on interdependence and partnership. ESA is far from being in a leading position for human spaceflight activities and is dependent on other partners, but ESA has developed unique capabilities and has a unique experience of interdependent cooperation among its Member States, placing ESA in a good position to promote such a different paradigm.

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2 → VISION 2025

In order to define ESA's priorities and actions in the next four years, it is important to understand the major trends driving global evolution over the next 15 years, and the role of space therein.

2.1 The world in 2025 – relevant trends

ESA and space are not isolated, but operate in a global context, which is continuously changing, with new needs, new challenges and new opportunities. Foresight reports from organisations such as the UN, the EU and the Organisation for Economic Cooperation and Development (OECD) agree on some general trends, which are summarised in this section to provide an outline of the environment in which ESA is expected to evolve, to be relevant and to be successful.[1]

The expected major geopolitical transformations in terms of population, economic development, international trade and poverty are accompanied by likely sources of tension related to natural resources (food, energy, water and minerals), migrations or urbanisation.

In economic terms, the centre of gravity of world production is expected to shift towards Asia with increasing competition from India, China and others. By 2025, the share of Asia would reach more than 30% of the world GDP and would surpass that of the EU, estimated at slightly more than 20%. This evolution is accompanied by substantial investments in infrastructure. At world level, US$200 trillion are estimated to be spent to 2030 devoted to infrastructures and housing (out of which ~US$25 trillion will be spent on energy and ~US$45 trillion on water, waste, transport and telecommunication infrastructures). Alongside economic power, the EU foresees that if the recent trends in research continue,

[1] Most of the actual text in this section is based on reports from the EC Bureau of European Policy Advisors (BEPA), e.g. European Commission, Directorate-General for Research and Innovation, *The World in 2025: Rising Asia and Socio-ecological Transition* (Luxembourg: Office for Official Publ. of the Europ. Communities, 2009) and the Organisation for Economic Cooperation and Development (OECD), United Nations Office on Drugs and Crime. *The Globalisation of Crime, a transnational organised crime threat assessment*, Vienna, Austria, 2010; International Energy Agency. *World Energy Outlook 2010*, Paris, France 2010;

in 2025, the United States and Europe might also have lost their **scientific and technological supremacy** for the benefit of Asia. India and China could account for approximately 20% of the world's R&D, i.e. more than double their current share.

In demographic terms, according to the UN, between now and 2025, the world population will increase by 14% to reach 8 billion inhabitants (7 billion today) with 97% of this growth occurring in the developing countries (Asia, Africa). The EU will only account for 6.5% of the world population with a growing trend of 'ageing' populations (30% of its population older than 65). International migration pressures are thus expected to remain an issue.

These changes are expected to put considerable stress on world resources. According to the OECD, achieving global **energy** security, climate change and energy access goals will require nothing short of an energy revolution, implying major improvements in the full set of low-carbon energy technologies, as well as unprecedented intervention by governments in developing policies that work with and influence energy and consumer markets. In all energy scenarios, the world primary energy demand increases until 2025, mainly driven by developing countries, reflecting their faster rates of growth of economic activity, industrial production, population and urbanisation. Renewable energy sources (solar energy, wind etc.) will have to play a central role in moving the world onto a more secure, reliable and sustainable energy path, especially for electricity demand, which is expected to grow more strongly than any other final form of energy, however with fossil fuels still providing the majority of our energy. Around 2025 the energy question is expected to remain also a source of major tension (economic and geopolitical).

Today, around 1.1 billion people globally do not have access to improved **water** supply sources. The UN Environment Programme (UNEP) estimates that two out of every three people will live in water-stressed areas by the year 2025, with significant impacts on human health, sanitation, food supply and migratory pressures. These growing disparities in water resources will contribute significantly to political tensions in several regions. The impact of climate change is projected to include a significant rise in the level of the world's oceans. This will cause some low-lying coastal areas to become completely submerged, and increase human vulnerability in other areas.

Similarly, **malnutrition** affects 2 billion people today. With the predicted growth of world population, this number will likely increase by 2025 in particular as food demand in emerging countries increases. On the other hand, obesity is increasing in developed countries as well as the risk from the propagation of **diseases** and non-traditional security issues such as pandemics.

2.2 EU objectives: Europe 2020 strategy

The EU, as the main European institutional actor, has the ambition to address the above challenges with the

support of its Member States and has already set itself targets.

In June 2010, the EU heads of state and of government endorsed the Europe 2020 strategy that aims to get the European economy back on track. At the heart of this strategy is the conviction that in an open global economy competitiveness is highly dependent on R&D and innovation, which are critical for enterprises to create high-value added goods and services.

To measure progress in meeting the Europe 2020 goals, five headline targets have been agreed for the whole EU, and have further been derived into national goals:

1. Employment: 75% of 20–64 year-olds to be employed;
2. R&D / Innovation: 3% of the EU's GDP (public and private combined) to be invested in R&D / Innovation;
3. Climate change / Energy: 20/20/20:
    a. greenhouse gas emissions 20% (or even 30%, if the conditions are right) lower than in 1990,
    b. 20% of energy from renewable sources,
    c. 20% increase in energy efficiency;
4. Education:
    a. Reducing school drop-out rates below 10%;
    b. at least 40% of 30–34-year-olds completing third-level education;
5. Poverty / Social exclusion: at least 20 million fewer people in or at risk of poverty and social exclusion.

These five overall targets are interrelated and mutually reinforcing: education fights poverty and boosts employment, innovation supports employment, 'green' technologies boost innovation, etc. Furthermore, at least three out of the five (R&D, Climate Change, Education) are directly linked with space policy. Space systems provide tools for monitoring climate change. In turn, an efficient and competitive industrial space sector in Europe requires a highly educated workforce and an innovative industry.

The Commission's translation of its objectives in its Communication on "A budget for Europe 2020" follows the general theme of "smart, sustainable and inclusive growth". The proposed budget for Research and Innovation is increased significantly to €80 billion. The likely content of Horizon 2020 (successor to the current FP7) is closely linked to key sectorial policy priorities such as health, food security and the bio-economy, energy and climate change, and includes three headings: excellence in the science base; tackling societal challenges; and creating industrial leadership and competitive frameworks. Space is naturally relevant to these three headings and ESA will support the elaboration of the relevant work programmes.

Overall, the reality of these headline targets and of the EU ambitions, as well as the priorities among them, will be assessed along the discussions to take place in the next 18 months among the Member States in order to agree on the next Multiannual Financial Framework (2014–2020) of the EU.

2.3 The relevance of space

By their very nature, space systems and activities are offering competitive and unique means to address many of the above outlined challenges and opportunities. Space sensors provide global, worldwide coverage, as well as local applications for users on a daily basis; they allow having continuity and repetitiveness of data over long time periods, enabling comparisons and the building-up of models. In addition, space activities are and will probably be increasingly needed for military objectives and operations (intelligence, communication, control).

For example,

- **Climate change:** space-based sensors provide the data upon which our global climate models are built, and they also provide early warning on extreme weather effects and their consequences for specific regions and cities;
- **Water scarcity:** space-based sensors allow understanding of the global water circulation models as well as mapping ground water to increase the success of new drinking water wells and improve local food production;
- **Energy:** space-based sensors allow optimising the location of renewable power plants and improving the efficiency of electric power grids; technological advance in solar cells and energy systems for satellites benefit ground applications;
- **Natural resources and malnutrition:** space delivers data for precision farming and natural resources management (precision agriculture for maximal efficiency in equipment and application of fertiliser, forestry management).

In addition, space infrastructures may also substitute instantaneously for ground-based infrastructures, e.g. in the case of major disasters having destroyed ground networks. The devastation and disruption caused by earthquakes, tsunamis (such as Japan, March 2011) and other natural phenomena (Icelandic ash cloud, April 2010) and disasters bring home to us all the effects a local event can have on a global scale. Space is working at all these geographical scales at the same time with the same infrastructure, and addresses at the same time global and local situations.

While in the past, space assets were a strategic defence tool, a frontier for technological development and scientific progress, space has evolved into being also a suite of necessary assets upon which the good functioning of our economies and societies rely, making their continuous development a necessity to avoid disruption or decline.

Space activities also have an overall effect on the economy, which goes well beyond the traditional space sector itself, encompassing the full value chain including impacts of space-derived products, services and knowledge on the economy and society in a wide range of sectors.[2] In fact, while small with respect to large economical sectors such as energy and health, space **creates significant wealth** and return in its sector and adds high-value niche contributions to these larger

[2] OECD, *The Space Economy at a glance – 2011*, August 2011.

sectors. In the words of the OECD, "*the space sector plays an increasingly pivotal role in the efficient functioning of modern economic societies and their economic development. Despite its usual reliance on relatively high institutional investments up-front, space can increasingly be seen as a source of economic growth.*"[3] The OECD has only recently highlighted the nationally **attractive overall socio-economic returns** of investments in space: the space industries value-added multiplier is between 1.4 and 4.9, depending on country and sector specifics.[4]

Every euro invested in space multiplies by 1.4 to 4.9, creating wealth and increasing European competitiveness.

The design, development and operation of space systems strengthen the engineering and scientific capabilities of Europe, thus stimulating directly the high added-value manufacturing basis required for sustainable growth. Space provides jobs of the highest professional level and furthermore inspires the next generation to embrace science and technology careers. The jobs created contribute to **strengthening a competitive, knowledge based society**.

Space is also indispensable and an enabling means for security and defence, for the collection of data and its distribution in a secure, unrestrained and instantaneous way, including for operations. Security and defence has been the driver of space in most space powers, with the exception of Europe. This is also the reason why space is addressed at the highest political level everywhere else, while in Europe space still suffers from a clear deficit of political visibility.

Against this background, an increasing number of countries are developing space activities leading to an internationalisation and globalisation of the space sector. Today, already more than 50 countries have spaceflight capabilities. Especially the interest and investment by BRIC (Brazil, Russia, India and China) countries create competitors and opportunities for European industry.

Taking into account the uniqueness of space solutions in addressing global challenges and European objectives, as well as the attractive socio-economic return on public space investments, European governments need to sustain their investment in space activities in order to maintain leadership and competitiveness as well as to contribute and manage the future of, and the future on, planet Earth.

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[3] ibid.

[4] For more information on the methodologies used to derive these multiplier effects, which are different for different national setups and assessments, refer to the methodological notes in the above-quoted OECD report.

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3 → A NEW FOCUS FOR ESA PROGRAMMES AND ACTIVITIES

ESA's activities are pushing the frontiers of knowledge, providing services, supporting competitiveness and preparing our common future.

3.1 Space pushing the frontiers of knowledge

Space activities have been continuously extending our understanding of the inner working mechanisms of our Universe and planet Earth. ESA, together with its partners, has been at the forefront of these scientific advances in space, from space and of space, revealing exciting new knowledge about Earth and the origins of life, about basic physical principles and processes, about our Solar System and its objects and even about some of the most distant events from the creation of the Universe.

The pursuit of space for knowledge has a larger scope than fulfilling scientific curiosity: space systems expand our knowledge and contribute to human progress, and by developing new technologies they subsequently enable new services and increase the competitiveness of European industry. There is no boundary between science and applications: science-related achievements eventually turn into operational services, and operational missions support science. Scientific progress is also a driver for developing new technologies, which, in turn, are a vector of competitiveness for European industry to be successful in the worldwide market. The sheer physical challenge of space missions drives the development of systems engineering and new engineering tools and methods, which benefits all other industrial sectors.

3.1.1 Knowledge themes

Space systems allow us to address some of humankind's fundamental questions, grouped in three interleaved and interconnected categories:

1. Understanding the origin of the Universe. What are the physical laws governing our Universe? What is the composition and structure of the Universe? What are the mechanisms for the formation and

evolution of our Galaxy? Are there other habitable planets in it?

2. Understanding the **origin of life** on Earth and possibly elsewhere. What are the mechanisms for the emergence of life? How does Earth compare with other planets of the Solar System? Are there evidences of habitable environments? Are we alone?
3. Understanding the **Earth system**. How does it work and evolve, especially under anthropogenic pressure?

Space allows us to respond to key questions on the origin of our Universe and the origin and evolution of life therein.

With a simplified view, the first topic is mainly addressed by astrophysics missions, the second by Solar System and planetary exploration missions and the third by Earth science missions.

Space systems are unique for addressing the above fundamental questions: they are irreplaceable for observing the Universe outside the narrow band filter imposed by our atmosphere, for physically exploring the Solar System planets and they provide a unique capability of global, continuous and repetitive Earth coverage, enabling the monitoring and better understanding of the Earth system. The exploitation of the International Space Station, offering to scientific communities permanent access to a unique environment, allows better understanding of the influence of gravity on living organisms and the physical behaviour of materials.

3.1.2 The challenges to face

The global economic crisis and key ESA partners' conjectural difficulties are today hampering ambitious international cooperation. This situation amplifies the challenge for ESA to preserve the technical excellence of future missions. The approach will be to strengthen and expand the cooperation with the Member States, to increase the technology capabilities enabling high-quality Europe-led science missions and to diversify as far as possible international partnerships.

Breakthrough science missions require today the development of more and more complex technology leading to longer preparation activities and heavier investments. As a consequence, some mission development schedules have a tendency to increase and the number of missions to reduce within the slightly decreasing science programme budget, although this is not the case for missions reusing technology and industrial development from other missions. Furthermore, performance is no longer significantly improving for the production of one-off complex spacecraft. Corrective actions must be taken:

1. the mission definition and the associated technology developments shall be jointly optimised, and focused on critical feasibility areas that are affecting the development schedule;

2. the relation with industry shall be revisited and tailored to improve science spacecraft development performance.

High-potential Earth science missions also often rely on complex instrumentation, which also entails long technology development cycles. On the other hand, pre-operational missions are usually faster, allowing rapid delivery of new products, and push for a reuse of previous developments against innovative approaches. A challenge for ESA is to maintain the right balance in science instrumentation between innovative developments and heritage reuse, and between innovation and development risks. For that purpose, maintaining a long-term strategy and perspective as offered today by the Earth observation envelope concept is of importance to prioritise the investments and to secure European leadership in selected future niches (e.g. space lasers)

Increasing the number of mission opportunities remains a challenge for both Earth and space science. The relation with Member States needs to be tightened to enable the implementation of fast-track small-size missions with focused science and development objectives.

Exploitation of current and developed Earth observation missions holds the promise of delivering some of the key information necessary on water, carbon and biomass cycles. Realising that promise requires new ways of performing research, involving web-based collaborative tools to exploit petabytes of data streams from various satellites and instruments in a harmonised framework, and integrate them with model data and other information in an era of growing 'data democracy'.

3.1.3 Why and how ESA can make the difference

Space and Earth science missions are areas of choice for global cooperation because of their universal goals. Through its international structure, ESA is ideally positioned for initiating and fostering cooperation towards these goals with major international space agencies, both within Europe and beyond.

Furthermore, space in general is probably one of the most promising fields for interdisciplinary research and innovative interactions among engineering, the physical and the biological (including biomedical) sciences. Via its programmes, ESA is already contributing to creating and maintaining worldwide leading expertise in key science fields at European universities and research institutes. By better tailoring its activities and increasing the emphasis on this aspect, ESA will further boost European scientific competence, and its knowledge base for innovation and growth.

The mandatory science programme has a privileged role in the Agency. It systematically triggers tight collaboration between ESA and all Member States, and simultaneously wide collaboration within the European science communities, who define the objectives and provide instrumentation hardware and science data exploitation. ESA has also demonstrated its capacity to

pool existing European expertise to advance Earth science, attract the international scientific community and put Europe in a credible position to cooperate on the international scene. Via the Earth Observation Envelope Programme, ESA provides Member States, scientists and industry with a solid, consensus based long-term planning horizon, which has a critical mass and offers flexibility. ESA can rely on one of its biggest assets in pushing the frontiers of knowledge about the Earth system: its relation with the science community, both in terms of recognition (e.g. more than 5000 Principal Investigator (PI) teams in Earth Observation to date) and cooperation potential (e.g. Dragon cooperation with China).

3.1.4 Destinations

Astrophysics

Today, ESA's Space Science missions are hitting a striking series of firsts and are recognised as the leading programme in the field for the upcoming decade. This is thanks both to the strong expertise present today in Europe, in the scientific community, in the Agency and in industry, and to a rigorous bottom-up process. Europe is currently operating the largest space telescope ever launched, Herschel, which is providing astronomers with the best views ever of the 'cold Universe'. It observes radiation coming from hidden, dusty regions of the Universe, allowing astronomers to observe the ongoing birth of stars and violent phenomena at the centre of galactic nuclei. Planck is currently providing the most accurate view ever of the Universe's 'first light' (the Cosmic Microwave Background), emitted when the Universe was just 380 000 years old. It is allowing European scientists to determine the nature of the forces that propelled the Universe into existence and that shaped its structure as we observe it today. The soon-to-be-launched Gaia mission will give European scientists a leading position in the study of the formation and evolution of our galaxy, perfecting the uniquely European technique of space astrometry pioneered by Hipparcos. The newcomer in ESA's portfolio, the Euclid mission, will put European scientists at the forefront of the study of the most fundamental forces shaping the Universe and its still-mysterious accelerating expansion, whose discoverers were recently awarded the Nobel prize in physics. Similarly, ambitious missions are currently being studied, providing the Agency with a portfolio of possible choices that will ensure that Europe will continue to strike hits as fundamental and spectacular as the ones described here.

Solar System and planetary science

While manmade probes have visited most of the planets orbiting the Sun at least once, the exploration of the Solar System is still in its infancy. The 'easy' trips on which robotic probes have engaged to date have provided humankind with tantalising glimpses of the spectacular diversity and richness of the worlds around our Sun, and have certainly raised many more questions than have provided answers. Although undoubtedly a newcomer to the field, Europe has also in this domain stricken a number of spectacular firsts. Europe holds by far the record for landing on the farthest body from Earth, with the breathtaking landing of the Huygens probe. The Rosetta probe, currently on its way toward its target comet, will

provide the first landing on such a body, when its Philae lander descends to the comet's surface. The most recent addition to the fleet, Solar Orbiter, will penetrate the inner Solar System, studying the Sun from inside Mercury's orbit, a closeness never achieved by any other probe. Mars continues to tantalise scientists with indications of possible tracers of past, and perhaps even present, life. The evidence for abundant surface water in the past, dramatically shown by the wonderful views offered by Mars Express, together with the surprising evidence for the presence of methane in its atmosphere, have more than ever convinced scientists of the importance of pursuing its study, with the long-term objective of bringing back a sample of martian soil to Earth. To extend its series of firsts in this area into the upcoming decades, Europe needs to develop critical technologies, such as novel power sources that will allow European probes to explore the darkest corners of our Solar System, from the remoteness of the outer Solar System to the nearby but dark and little-known polar craters of our Moon.

Planet Earth

The understanding of the mechanisms and interactions in Earth's atmosphere between atmospheric circulation dynamics, its chemistry and its interactions with the land and oceans surfaces and their respective interactions with solar radiation and gravity is essential to better understand our role in this complex system. ESA will continue to provide reliable key data for these models. In the framework of global change, there is specifically the need to reduce the uncertainties on critical parameters such as cloud impact on Earth's thermal balance, carbon storage balance of biomass and soils, thermal feedbacks of changing concentration of certain atmospheric gases, etc. The next generation of ESA Explorer missions will need to address this data gap.

Earth observation data are now systematically used for global change models and forecasts (e.g. in IPCC reports). Through GCOS (Global Climate Observing System), the international science community requires the provision of long time-series of critical products. ESA has started pioneering in this field by providing the requested 'Essential Climate Variables' to the science community.

Since 'global information' and thus international cooperation is required to tackle the major 'global issues', ESA will continue its efforts towards a dialogue on 'heterogeneous mission accessibility'. International cooperation is a prerequisite for deploying the complex monitoring systems needed for Earth science (e.g. CEOS answer to the requirements of the Global Climate Observing System).

The high performance level in space and Earth science activities is based on an unbiased scientific selection process for the missions. The relation with the science community as users and as a source of proposals for future payloads needs sustained efforts on the ESA side (involving the young generation of scientists, networking of the science community, impacting up-front science endeavours such as IPCC reporting, etc). Some ESA seed funding for core scientific exploitation is required, including of data from operational systems such as meteorological satellites and/or GMES Sentinels.

Low-Earth orbit and ISS
With the assembly of the ISS completed, including a full-time crew of six, the ISS provides outstanding opportunities for in-orbit research and discovery. Research in fundamental and applied life and physical sciences, closely linked to the European Programme for Life and Physical Sciences (ELIPS) is at the core of research on the ISS. To date a very active user community has already performed more than 200 European experiments, many involving international cooperation.

However, the value of the ISS as a research platform and an accessible in-space laboratory extends far beyond the key research areas of life and physical sciences, serving also as a unique asset for research in the fields of astrophysics, space and fundamental physics, atmosphere and climate change studies as well as on space technology. Further benefits are expected in areas such as advanced materials, energy and health.

The ISS will therefore serve both, expanding our knowledge in key science areas benefiting needs on Earth while preparing the way for future space exploration.

3.2 Space for developing services on planet Earth

Satellite-based public and commercial services provide benefits to the economy, industry and to citizens' daily life, safety and security.

Currently, the most consolidated space applications focus on services for the information society, in line with the dominant technological shift of the contemporary society. New types of space-based services and integrated applications may emerge in areas such as energy, health, resource management, materials and biology. Such sectors have a much larger turnover potential than the entire current space sector.

The competitiveness of space-based services will be the driver for consolidating mature services and opening new services.

3.2.1 Services themes

Established public and commercial services
In many sectors (e.g. telecom, meteorology, navigation) space is already recognised as a competitive contributor to relevant services and ESA has proven to be a reliable partner for the development and the support to operational uptake of services – and the associated space infrastructure.

The importance of space technologies in sustaining information services stems from a number of specific features:

– their capability to establish services providing regional or global coverage, such as mobile communications services provided by Iridium, Globalstar or Inmarsat, or the fixed satellite or television services provided by SES and Eutelsast as for example GPS, Galileo, WAAS and EGNOS for

navigation, and meteorology services based on Meteosat and Metop.

- their capability to have information services penetrate national territory or extract information from it without material intrusion in sovereign space.
- the absence of any realistic and economical ground-based alternative, as in remote sensing applications, trans-oceanic navigation and communications in low density population or rural areas.

Commercial services are the most attractive services for private investors and industry, and they generate a growing and fierce competition among space industries and telecom operators, requiring from European actors continuous investments to consolidate its competitiveness (see section 3.3.2).

New types of services and integrated applications

Contrary to established services, the details and scope of space contributions for new types of services are not yet widely shared beyond the space actors. Space does not yet have legitimacy as potential contributor to many services, which are traditionally based on ground infrastructures. The awareness of service actors is still to be developed and solid relationships between service and space actors to be built up in order to demonstrate the added value of space-based services and their competitiveness compared to ground-based services. Space will likely only be a minor contributor to niche-service market needs. These will include the needs of large sectors such as energy, health and natural resources. By supporting the emergence of new services and integrated applications in such sectors, including also some GMES services, ESA will better serve European society, enlarge its impact and increase its relevance in the future.

This entails a new way for promoting space, which needs to seek leverage on industry and administrations, and to make sure that the next generation of satellites and related ground-segment provides the critical tools to governments, citizens and markets.

Security and defence

Space-based services for the defence sector are well established everywhere in the world, except at European level. In the US and Russia, defence-related services are even the main driver of domestic space activities. One can assume that, with the building-up of a European Security and Defence Policy, relevant services will develop on the basis of experience accumulated for the above-mentioned established services.

As a matter of fact, security and defence form a domain for which space data and means are critical enablers. Even though services from space for security and defence share technologies, industrial experience and infrastructure with other civilian applications, they also come with specific operational boundary conditions:

- autonomy of access to data (or guaranteed unrestrained access): this means in general the need for own independent systems and infrastructures;

- rapid access to data (near-realtime). This calls for a) dedicated/agile systems; b) access to multiple sources, in case of multiple crises, in order to allow timely response; c) rapid dissemination of acquired data (frequent data downlink, data relay system, onboard processing helping downlink rate);
- protection of data: need to have the ability to restrict access to its own resource, or at least 'discretion' (requirements must remain confidential), data encryption as necessary;
- hardening of satellite commands, mirror archive (backups).

3.2.2 The challenges to face

The operational uptake of space-related services requires a solid service provision and exploitation framework. This includes

- the creation of a competent organisational framework comprising an R&D entity (e.g. ESA) and an operator (e.g. Eumetsat for meteorological services), which is able to collect user requirements, cooperate with the R&D entity to develop new generations of satellites, fund recurrent satellites and ground segment, and deliver services;
- the implementation of an appropriate data policy;
- a cycle of actions demonstrating the availability, reliability and affordability of these services.

In the case of Eumetsat, it was also important that ESA could play the role of interim operator to ensure a smooth transfer of responsibilities between a mature ESA and a budding Eumetsat.

Key to such a governance scheme is that users take part, which implies partnering with users and service actors who have a *vested interest* in the successful exploitation of space-based services.

A major challenge is the acceptance of space-based solutions by the user communities and service providers, accustomed to ground-based solutions, which they own and operate individually, as opposed to space systems.

As an example, in public services like meteorology, such acceptance was obtained by:

- ensuring the sustained existence of the space infrastructure required to support the service. In the case of space meteorology, the user community can rely on operational systems with a lifespan of some 20 years.
- ensuring a simplified access to data (efficient technical solutions for dissemination of data, appropriate and stable data policy).
- securing the timely preparation and funding of the next generation of satellite.

Not surprisingly, reaching this level of consolidation requires time and energy – more than 15 years in the case of meteorology.

The same challenge will be encountered in other domains, such as environmental monitoring, where

Creating a competent organisational framework for services, including solid, trust-based partnerships takes time! More than 15 years in the case of meteorology.

the long-term funding of GMES operations and maintenance remains to be settled.

Another challenge is that, in contrast to meteorology, the vast array of operational services in navigation, environmental or resources monitoring corresponds to scattered user communities. For instance, Galileo and GMES will have to refer to operational proxy organisations capable of representing collectively and legitimately the interests of all user communities. The translation of this scattered user demand into a meaningful and efficient common space infrastructure remain a major challenge.

Serving small niche markets in much larger sectors (energy, health, resources, etc) could become substantial business for space. Space needs to make the initial effort in engaging with these sectors.

In the case of new services, the challenges for the space sector, starting with ESA, to succeed is to engage in new meaningful partnerships with relevant non-space actors from typically much larger sectors (health, energy, resource management, etc). Industries involved in these sectors often have a much larger turnover than the entire space sector, no connection to the space sector and no understanding of the opportunities it offers. The **initial effort therefore needs to come from the space sector**, especially in targeted niche applications. Niche markets in such large domains offer the potential to become substantial activities for space. Key to this endeavour will be new, non-traditional partners such as European regions, large non-space companies and SMEs. Although the implementation of these integrated services add another degree of complexity, if successful the benefits for society and the space sector would be large.

3.2.3 Why and how ESA can make the difference

ESA's role in the domain of service development is to define and develop, on the basis of user requirements, the future generation of space infrastructure and to ensure the successful transfer of its exploitation to a well-structured and mature service provider maintaining the link with the user communities.

At the level of the different thematic domains, ESA comes with its established credibility to cooperate with major actors, with no vested interested in the further commercialisation of the services as such. ESA's credibility is reinforced by offering:

- its expertise in ensuring state-of-the art (but proven) operational solutions;
- mitigation of risks, by appropriate R&D efforts, thus lowering the threshold of risk acceptability by the service industry and the users;
- provision of the 'best-value-for-money' system;
- respect of the future operational role of the exploitation entities, connected to the end users.

Regarding the translation of the aggregated demand into a 'shared' infrastructure, ESA is ideally located – as per its Convention – to provide the platform to define the optimal common space solution. With its Long-Term Plan, ESA further offers to the other space actors a stable horizon against which their own activities can be mapped, in a mutually reinforcing manner.

The added value of ESA to the development of commercial, non-traditional services and applications will be by either supporting the development of a new space segment (infrastructure), by setting-up *ad hoc* Public-Private or Public-Public Partnerships for co-development of integrated applications and services tailored to the benefits and risks of each partner, by supporting the development of new services from existing space capabilities in partnership with existing providers, or by supporting the incubation of a new company to provide these new services.

The rapid success of the Integrated Applications Promotion (IAP) Programme, which was included in Agenda 2011, is a clear demonstration of the ability of ESA, Member States and the Executive together to initiate new operational services based on existing space infrastructures. After three years, 14 services are in a promising demonstration phase, three are in a pre-operational phase and two are already fully operational and sustainable.

New areas, such as the Arctic region, where climate change causes a complex set of environmental, security, commercial and strategic concerns and opportunities and thus attracts political attention of concerned nations and the EU, offer new applications for space-based services.

Space systems offer unique opportunities for monitoring the environment, facilitating navigation and communications, enhancing marine safety and supporting sustainable exploitation of natural resources. The potential role of space infrastructures in the region is already explicitly recognised by all nations taking interest in the Arctic, including e.g. high-bandwidth communications, high-reliability navigation above 75°N, complete circumpolar GMES services, integrated international trans-Arctic vessel traffic services, Sentinel-3 ground infrastructure and systems for the Arctic.

Regarding space services for security and defence, space efforts in Europe remain so far very limited in size compared to other major space powers and are mostly handled at national or multilateral levels. In order to take part in the elaboration of spaceborne solutions in the domain at multilateral and European levels, ESA must demonstrate its capacity to handle such programmes (protection of assets, confidentiality) as it did for Galileo. ESA's institutional and programmatic cooperation with EDA represents a first step in this direction. The capability of ESA to enter into partnerships with national agencies will also be an important factor. ESA can thus be a space agency ensuring the procurement of the space segment and ground segment of a system defined by the Defence community, whilst operations and data exploitation/ dissemination would remain the users' responsibility.

3.2.4 Next generation of services

For the established services and related communities, ESA will continue helping to prepare for the next

generation of the required space infrastructure. This is already the case with MTG and upcoming MetOp-SG for the benefit of Eumetsat, reaching a horizon 2020–2030. An even longer-term and deeper-lasting cooperation partnership would be desirable. In the case of GMES, the stabilisation of the long-term funding and governance schemes, including firmness of data access policy, remains the top priority. Funding of Global Navigation Satellite System (GNSS) infrastructure evolutions to meet user requirements could be obviously organised through a dedicated ESA optional programme, to which the users (or, better, the designated anchor organisations) could also ensure contributions similarly to the Eumetsat–ESA arrangement. A solid GNSS exploitation framework is the prerequisite to drive the activities of any future GNSS Evolution programme, involving anchor organisations like Eurocontrol, and starting with the consolidation of the EGNOS operational set-up and, in parallel, with the preparation of the Galileo operational phase. Another promising service is the satcom component of the EU Single European Sky project SESAR, called Iris. This service has attracted support and interest from the aeronautical community and, while it may take some time to get implemented, its feasibility and attractiveness have been proven.

Cooperation with partners beyond space actors will be key to succeeding in developing new services from space.

For new services (finance and insurance, energy, water, etc.), ESA will have to establish cooperation and possible partnerships with representative anchor user organisations (e.g. World Bank, major commodity suppliers). International Conventions dealing with major environmental issues (e.g. UN Framework Convention on Climate Change) offer another interesting case of leverage potential for ESA, to promote spaceborne mandatory reporting mechanisms. This will entail major cooperation efforts with non-traditional types of partners such as European regions, large-scale non-space companies and SMEs. This process will also enlarge the spectrum of actors at the Member State level traditionally involved in the space sector, and thus open up new cooperation opportunities.

ESA will therefore further strengthen and intensify its proven approach with services so far: preliminary investigation of the theme, presentation of some concrete success case to the user community, early 'pre-operational demonstration' with a major and recognised actor in the thematic domain, plans for service expansion. In addition, new technologies open the way to new services and the interaction with other sectors enhances the spin-in and spin-out to and from these sectors.

The following domains – including technology transfer from the space to the non-space sector – have been identified as promising:

Energy

- space as a lead market for energy technologies, e.g. high-density energy storage means (fuel cells, H_2, novel metal-oxides);
- advanced energy grid management;
- energy efficiency (including data for regulatory purposes).

Health

- from local to global health information systems (e.g. communicable disease risk maps and access to health care centres for WHO, national health services, private sector such as insurance companies);
- risk maps in real/near-real time allowing the monitoring of atmospheric hazards;
- new tools and methods for distant/remote medical support (e.g. diagnosis, minimally invasive surgery);
- health and wellbeing aspects related to resources management.

Resources management (water, food, recycling)

- services for monitoring and control of water (policing versus planning);
- services to help planning of crop growth and develop a more sustainable farming (e.g. precision farming);
- services for the food industry (e.g. quality of water and food) such as the improvement of detection and control systems;
- improved models of the ecosystem (e.g. long-term effects of contaminants);
- climate services and provision of information systems to support carbon trading and energy consumption;
- advanced water recycling systems based on fully closed life support systems being developed for sustainable human exploration of space (MELiSSA).

To ensure their operational uptake, most of these developments will be based on existing and lasting infrastructures.

3.3 Space for the competitiveness of Europe on the world market

3.3.1 The challenges to face: sustaining the competitiveness of European industry on the commercial world market

As discussed in chapter 2, space will continue to play a key role in meeting the objectives of Europe, not least contributing to a competitive European economy through a growing space economy. For the European space industry to remain a source of economic growth and competitiveness, it needs to make a significant part of its turnover in the commercial world market.

The turnover generated by sales to private customers (primarily in Europe) in the European space manufacturing industry (excluding operators, downstream actors), already represents almost 50% of its total turnover. Within the European space manufacturing industry, satellite application systems are the major source of revenues (€3.1 billion in 2010). Telecommunications systems represent two thirds of

these revenues. The European telecommunication industry is therefore the most important part of European space industry in volume of activities, but is also the most commercially exposed manufacturing industry as European institutional customers are the source of less than 15% of its revenues. [5]

Europe has today a strong deficit in the use of space by the security and defence sectors, compared to all major space powers. This situation represents a major weakness of the European space industrial sector, since European industry and operators cannot benefit, like their competitors, from a large captive market, and thus rely on their performance on the commercial market to maintain core capacities. This makes these core capacities fragile because of the volatility of the commercial market and the unbalance of the competition for European industry vis-à-vis its competitors. This fragility is a risk for all space activities in Europe.

On the contrary, industries of other countries such as United States, Russia or China have benefited from a very sizeable and captive institutional demand to an extent that their industry has been sustained primarily by institutionally funded civilian space activities and military applications. A paramount example is that of launch service sector where institutional launches represent approximately 80% of the total launches in 2010 and where, with the only exception of Europe, all launch vehicles carried more domestic institutional than commercial payloads in 2010. Non-European space industry can in turn afford to sell on the commercial market at marginal cost whereas the sustainability of European industry depends heavily on the commercial market.

The European space industry is therefore on more fragile ground than space industries in the rest of the world and this situation may even worsen. With the general tightening of institutional budgets, there is a trend for non-European industry (mainly US) to turn to the world commercial market, thus increasing competition with European industry even in European domestic markets, including institutional ones. This is all the more critical as emerging space-faring nations, while creating new markets and opportunities, also add potential new competitors that can often undercut European prices due to lower operating costs.

The competitive presence of European space industry as a whole on the world commercial market is therefore essential for its viability and for the affordability of European space systems.

In the wider space economy the market of space-related products and services amounted to some US$150–165 billion in 2009. This is growing along with the impact and derived return of space on non-space sectors, and the very existence and sustainability of European space industry depends on its ability to capture a significant share of the worldwide accessible market of space-related products and services. As underlined by the OECD[6],

[5] All figures in this section are derived from *The European space industry in 2010*, Eurospace Facts and Figures 15th edition, June 2011.

[6] OECD, *The Space Economy at a glance – 2011*, Publishing.

competitiveness depends both on the country's starting conditions in terms of institutional and structural features and, in the long-run, on stable foundations such as sustainable budgets for R&D and operations.

3.3.2 Why and how ESA can make the difference

ESA can make a difference in strengthening the competitiveness of the European space industry by contributing to maintain the differentiation of the European offer through:

- sustaining upfront investments in technology, investing in innovation on a long-term basis and providing European industry with demonstrated technology, ready for acceptance by commercial users, and with engineering capabilities that make their solutions competitive;
- turning guaranteed access to space into a factor of competitiveness for Europe, i.e. serving the European governments and the European telecom operators in a competitive manner, to guarantee an access to space at best prices.
- fostering the creation and development of new applications and services and promoting business development through exploiting synergies in industry between the activities for ESA and for the global commercial market. This in turn should contribute to self-sustainable undertakings in the longer term.

To that end, ESA needs to partner more closely with industry to support the expansion of markets, new users and new services. In so doing, the European public sector will not only, as a customer, be a direct beneficiary of an increasingly competitive European space industry but also contribute to generating wider socio-economic returns such as regional and national economic growth and employment.

Sustaining upfront investments in technology

ESA can contribute to ensuring a broad and competitive technological base aimed at deploying competitive and non-dependent space systems. This relies on a strong commitment to technology research, innovation, inflight demonstration and coordination of resources.

In partnership with the scientific community and technologists, from space and non-space, ESA must continue taking actions to:

- Identify and develop the key cross-cutting technologies that will enable Europe to take a significant leap-forward in science, bringing the future closer and underpinning the foundations for new services;
- Establish plans of work for spin-in/out and specifically for joint RTD with related non-space sectors.

The Future Technology Advisory Panel (FTAP) put in place by the DG and associated with the High-level Science Policy Advisory Committee (HISPAC) has already identified the top seven key technologies that are expected to make the difference to scientific progress

as well as help Europe to make the difference: ultra-stable deployable masts, formation flying and autonomous rendezvous, large monolithic telescopes and mirrors, infrared detectors, lasers atomic interferometry and optical clocks.

In partnership with industry and in coordination with other institutional actors, ESA must continue taking actions to:

- Develop the technologies that enable the space services of the future (e.g. payload technologies for broadband access, multispectral systems for the incipient Earth observation markets) in a general context of total improvement (e.g. miniaturisation for lower mass, volume and power consuming systems);
- Facilitate in ESA missions the balance between product exploitation and innovation so that industry benefits together with ESA from economies of scale, from reuse and from derisking achieved in ESA missions and demonstrations outside the commercial projects;
- Develop engineering and operations practices and tools that allow delivering and exploiting systems more efficiently, using lessons learnt from innovative concepts such as GIOVE-A, Proba and PPPs in telecoms.

ESA shall furthermore:

- Strengthen cooperation and harmonisation with national programmes and European institutional actors in order to increase the total value of European space technology programmes;
- Contribute, in collaboration with other European institutional and commercial actors, to sustaining the full supply chain and provide non-dependent access to critical technologies, in particular basic supplies such as materials and EEE components. This does not require full European independence on all technologies, but unrestricted access to sources;
- Consider the establishment of a three-risk class model: pre-commercial missions with minimum risks; research missions with acceptable risks in the mission specific innovation; high-risk demonstration missions;
- Facilitate the means to demonstrate, including PPPs, for demonstration in-orbit, such new technologies, products and practices to convince commercial customers and institutional programmes.

Turning access to space into a factor of competitiveness

The concept of guarantee of access to space for governments has been and will continue to be a pillar of any space strategy for all space powers.

Access to space is an enabling service before being a technology.

As described in chapter 1, in today's environment, access to space must be revisited within a wider picture embracing a larger community of European customers and, as a result, be driven by the delivery of competitive services to these

customers. Access to space is an enabling service before being a technology[7].

A revisit of the model should therefore start by the identification of customers benefitting from a guarantee of access to space: European governments are certainly the first of these customers, but do not constitute all together, today and in a foreseeable future, a customer basis sustaining by itself a cadence of launches guaranteeing efficiency and reliability of a launch service. European telecommunications operators are also part of these customers since access to space is an enabling factor of their competitiveness. They can certainly find today on the commercial market competitive launch services, but most, if not all, of these launch services are under government control or dependent on a government market. In addition to the guarantee, their competitiveness requires also that they can find the best product at the best price, with the earliest availability of service. It is obvious that the requirements of European governments as customer of launch services are not different: guarantee of access and best product at the best price.

To better serve the competitiveness of the entire European space sector, European access to space needs to be service oriented rather than technology-focused.

There is therefore a commonality of interest between European telecoms operators and European governments provided the latter act as customers. The combination of requirements for launch services from European telecoms operators and European governments, in terms of performance, performance flexibility, reliability, availability and cost, should therefore constitute the set of requirements against which the European launcher industry and service provider should design, develop and provide the launcher(s) that meet these requirements, including the launch service costs.

Since it can be assumed that the launch service costs required by the European customers will be competitive against the cost of the worldwide competitors, the European customers should not have any difficulty to commit to use the European launch services responding to their requirements, for 100% of their spacecraft if customers are governments, for at least 50% of their spacecraft if customers are telecoms operators. Against such commitment, which can be materialised into periodic framework contracts with the European launch service provider, these customers would get guarantees and priority of launches availability. In the current perspective of number of spacecraft to be launched for both European governments and European operators, the above commitments represent a market large enough to sustain by itself a launch rate per year guaranteeing the reliability and the availability of the launch service.

This new way of implementing the concept of guarantee of access to space therefore combines the

[7] This shift is already occurring in the United States, where even if SpaceX benefits from US government contract awards that absorb the largest part of the offer, it has focused its developments and manufacturing rationale on reducing costs through use of proven technologies and off-the-shelf components, avoidance of technological breakthroughs and high engineering to management ratio

guarantee to governments with the guarantee to operators. It furthermore addresses both the competitiveness of the customer sector and the competitiveness of the provider sector, since the model creates what is missing today: a customer base large enough for the provider to sustain launch services on this customer base. This is a Public-Private Partnership combining the interests of governments and telecoms operators of Europe for sustaining the exploitation of a European launch service.

This revisited model drives the European launchers sector by customers rather than by providers, i.e. by the services rather than by the technology and the development. However, a reliable launch service relies upon relevant engineering capabilities of the European launcher sector, and such engineering capabilities can only be maintained by development activities. This is the reason why an associated public private partnership must be organised between governments and the European launcher industry, in order to maintain proper development activities able at the same time to respond properly to the evolutions of requirements from the customer base and to sustain the engineering capabilities required for a reliable exploitation.

Governments keep therefore a pivotal role as customers on the one hand and as developer on the other hand.

Fostering the creation of new applications and services.
Traditionally, the Agency has been successful when managing mid- to big-size projects with the involvement of the European manufacturing space industry. This upstream industry remains a relatively small sector that is highly centralised with four large industrial holdings directly responsible for more than 70% of the total space industry workforce, with employment concentrated in few big countries in Europe. The barriers to entry in such upstream industrial sector are quite significant for SMEs, which account for less than 8% of the total space industry involvement. Thus, the chance for innovation relies on the competence of a few actors.

On the other hand, it is undeniable that the service midstream and downstream sectors have an increasingly dominant role in the EU economies, accounting for two thirds of employment and GDP already in the early 2000s.

Innovative activities are increasing, with services accounting for a greater share of overall R&D, patenting and trade marking. Therefore, it is key that the full potential of space assets (data, technologies and products) is made more accessible to potential service innovators on a European-wide basis, if not beyond.

The service industrial sector and the chances for innovation are by far more distributed over all EU countries, and the barriers to entry for SMEs are less important. Member States joining ESA would certainly find more opportunities when investing in this sector, rather than in the manufacturing sector.

It is probably easier for the Agency to aim towards the midstream sector, i.e. the sector that enables and prototypes services, than to target directly the downstream application sector. This has actually been the goal of success stories such as the Business Incubator Centres (BICs) and the Integrated

Applications Promotion initiative. The success of the IAP programme has been mentioned above.

As for the ESA Business Incubation Programme, it provides, together with the host Member States and/or regions technical, financial and business supports as well as partnering opportunities to SMEs. While incubation is a successful economic development tool for the Member States, it allows ESA and its technical partners to provide direct (technical) expertise, facilities and assets crucial for the companies' development. With a survival rate of space spin-off of 92%, the programme shows that the Agency and Member States and/or regions can offer the right set of tools for SMEs to grow and become competitive in the market place. Currently with the five ESA BICs, 50 space spin-offs per year benefit from this programme, which could also profit SMEs in new Member States. New BICs are being planned, demonstrating the growing interests of Member States and regions.

3.4 Space for the future of humanity and of the planet

3.4.1 The challenges to face

The challenges to face for the future of humankind and of our planet are multiple. They range from securing and preserving peace on Earth, ensuring that humankind has access to food, water, resources, education and health; to protecting our planet from environmental damage, major disasters including those coming from space (e.g. NEOs: Near-Earth Objects); promoting biodiversity and sustainable development; developing clean energy sources able to sustain the needs of the world's population; and in general ensuring that we transmit to future generations a better legacy than the one we have received, in terms of planet and human wellbeing. As described in previous chapters, space may provide a limited yet real contribution to solving many of these challenges, and it is thus also important to ensure that future generations may still have access to and use space in an unhampered way.

3.4.2 Why and how ESA can make a difference

Promoting human spaceflight as a factor of peace and a symbol of global cooperation

Human spaceflight started as the most spectacular part of the competition between two worlds until the first US astronaut stepped onto the surface of the Moon. Soon after, it became the symbol of cooperation between space powers, starting with the Apollo–Soyuz mission in 1975 and culminating today with the International Space Station, a partnership among five. The success of this cooperation has required significant efforts from each partner to develop technically compatible hardware and operation procedures and to coordinate utilisation plans. This has required minimum transparency among partners and overall coordination by NASA. These joint efforts have developed

understanding and solidarity, which have overcome all the difficulties of cooperation, in particular after dramatic accidents. This partnership will stay much longer than the hardware. Cooperation in space generates a much wider cooperation on the ground, since having six people work together in space requires thousands of people closely cooperating on the ground.

However, some lessons learned from the operations of ISS have demonstrated the need for improvement in the cooperation, from the development of common interfaces up to the acceptance and the design from start of on-purpose mutual dependence among reliable and capable partners, including for transportation. This is the only option for a partnership to be even more solid and more affordable. This would lead to a mutually dependent partnership where the interests of the leader could be preserved but within a concerted rather than unilateral approach (the model of ESA for such partnership could be inspiring).

The cooperation of a few astronauts of different nationalities in space triggers the close cooperation and build-up of trust among thousands of people on the ground, bringing nations closer together.

In addition, the cooperation should be extended, from the current ISS partnership to other space powers willing to join and to bring their own capabilities and their own culture. This extension can be organised in steps, which could start by multilateral cooperation between some of the current ISS partners and non-ISS partners, with a view to build-up new cooperation aiming at reinforcing the partnership without necessarily involving all partners. ESA could play a unique role in this type of approach, being the most successful model of cooperation among 19 countries on an optional basis. Mars500 could be, as an example, the starting point of cooperation between Russia, ESA and China. China is only the third nation to develop independent human launch capabilities, is currently experimenting with the building blocks of a space station and has announced ambitious lunar exploration plans. While close cooperation in some domains might prove complex, ESA should be ready for increased cooperation with China in the domain of human spaceflight.

Finally, the cooperation should also involve other countries than space powers able to bring space capabilities. As an example, the utilisation of the unique environment provided by the ISS could be opened to scientists from all over the world, through one of the five partners, but under conditions set up by all partners. ESA has already initiated such an opening for a pilot phase towards all EU Member States not members of ESA. This type of opening could be extended further in steps, for example, to countries participating in the FP7 of the EU.

Supporting exploration as a continuous process of humankind

Exploration belongs to the history of humankind, and space exploration just continues this process. The objectives for exploration are multiple, and in many cases the eventual outcome of exploration has not been related to the initial objectives, but has nevertheless profoundly changed the evolution of life on planet Earth.

This continuous process has been composed of accelerations and pauses, the accelerations

corresponding to periods of economic growth and technological breakthroughs, and the pauses corresponding to different budget priorities and technology obstacles. However, competition among different communities has always boosted exploration while cooperation has always been slower to implement and sometimes more risky than competition. It took as many years to define the partnership on which the ISS has been developed as it took to go from the first human spaceflight to the first human step on the Moon.

We are currently, after the assembly of the ISS, in a situation of defining the next step in exploration. All partners are in agreement to make this definition starting from the current ISS partnership, but discussions and budget constraints have delayed such a definition for several years.

ESA has taken the initiative of ExoMars, which has evolved from a European technology demonstration mission towards a more ambitious scientific mission together with NASA, within a long-term cooperation on Mars robotic exploration. Unfortunately, the recent budget constraints of NASA are requiring ESA to make a choice: either to extend the cooperation to Russia as a third partner, or to reduce its own objectives. This example is a demonstration of the risks and slow pace of cooperation, but the time and energy invested to day may not be lost if rewarded by a long-term cooperation for exploring Mars.

Other discussions are taking place:

- with the ISS partners, for defining a common vision beyond the current ISS;
- with Russia, for missions to the Moon and Jupiter for which studies made and technologies developed by ESA could be valued in joint missions with Russia;
- with China also, on a bilateral basis and on a trilateral basis with Russia, as a follow-on to Mars500.

Exploration therefore concerns several destinations, from low-Earth orbit to planetary systems, including the Moon and Mars. All currently considered missions are cooperative missions, cooperation being within different formats: bilateral, trilateral and multilateral, with different partners.

Whatever the destination and the cooperation format, ESA can bring in addition to its daily experience of cooperation, technologies and systems which, for some of them, are unique worldwide and make ESA an attractive and reliable partner in exploration endeavours.

These technologies are listed below since they address both the objectives of human spaceflight and the objectives linked to clean, responsible and sustainable space.

Implementing clean, responsible and sustainable space as a legacy to future generations

From its early exploration phase, space has gradually evolved and matured: humanity has extended its sphere of activities (commercial, military, possibly soon societal) into space and near-Earth space has become a natural resource indispensible for many aspects of modern societies. This build-up of activities and their

importance also require us to be more conscious about the consequences of our space activities, both on Earth and in space environments. Expanding on the leading role ESA is already playing in mitigation measures of space debris, ESA tomorrow has the ambition of being a model agency for clean, responsible and sustainable space activities.

ESA tomorrow has the ambition of being a model agency for clean, responsible and sustainable space activities

Clean and sustainable space

With the rapid development of space activities in an increasing number of countries and regions, some near-Earth space environments are becoming crowded, with many operational and defunct spacecraft occupying the same orbital regions and competing for the same electromagnetic frequency ranges. The sustainable use of space is a necessity and duty for Europe since a safe and secure space environment is a requirement for all current and future space activities. ESA will support and promote the interests of preserving Earth's orbital environment as a safe area in which to operate satellites, by limiting or minimising harmful interference in space activities. ESA has already taken the initiative to remove its satellites (e.g. ERS-2) from crowded orbits (e.g. polar orbits) by managing the end of their missions rather than waiting for a failure to declare the end of mission. ESA will also support the development of space traffic management rules to ensure the orderly, predictable and safe conduct of activities in outer space.

While efforts should continue on promoting a code of conduct for space activities worldwide and on monitoring debris through Space Situational Awareness (SSA) activities, research should also be increased on methods of deorbiting critical pieces of debris safely and effectively (active space debris removal). This would provide the European industrial base with a leading-edge position and improve its overall competitiveness. It would allow ESA to be the first space agency actively engaging in 'cleaning up space'.

ESA should also extend the sustainable use of space beyond immediate Earth orbits by following planetary protection guidelines.

Responsible space

The EU directives and regulations RoHS[8] and REACH[9], introduced to target sustainable development, environmental impacts and human health, have considerable implications for European space activities, above all due to possible obsolescence issues of qualified materials processes and technologies. A prime example is that of hydrazine propellant, which could enter the 'Annex XIV list' in 2014, with corresponding impacts on both satellite and launcher programmes. ESA must continue to work with European industry and national space agencies to find ways for European space programmes to meet the regulations, while minimising at the same time European supply chain disruptions through exchange of information and active risk mitigation.

[8] Directive 2002/95/EC of the European Parliament and of the Council of 23 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

[9] EU Regulation 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the registration, evaluation, authorisation and restriction of chemicals (REACH).

Notwithstanding, ESA should even go a step further and devote increasing attention to the environmental impact of its activities, including its own operations as well as operations by European industry working on ESA missions. This means introducing effective new processes to manage resources (e.g. energy efficiency, use of raw materials, waste reduction) and minimising the environmental impact of its activities in space and on the ground. ESA should promote eco-friendly technologies and encourage and guide European industry towards a leading position in more eco-friendly space activities, building an exemplary image in and of space and leading eventually to new services. By being a pioneer in adopting an eco-friendly approach (e.g. end-to-end launcher environmental life-cycle assessment) and technologies (e.g. green propellant for launchers and satellites), Europe can develop new processes and technologies and be in the position of shaping future regulations on the subject. ESA should thus initiate further scientific and technical research to quantify and understand the issue of environmental impact of space industry. Finally, ESA sites and infrastructures should also be greener promoting the use of renewable energy sources and increase recycling.

Managing the threats from space for planet Earth

Several salient natural challenges pose a major threat to the disruption of space activities and human activities in general.

Space weather is a hazard to which human civilisation has become vulnerable, through our use of advanced technologies. It has impacts on many socio-economic domains going beyond the sole space sector (e.g. aviation sector, power sector, energy supply and distribution services, maritime and rail transport, communications). To mitigate these threats, ESA should continue supporting the provision of timely and accurate information, data and services regarding the space environment, and particularly regarding hazards to infrastructure in orbit and on the ground.

NEOs pose major direct threats to both space infrastructures and activities on Earth. A collision with an asteroid or comets could have dramatic regional or even perhaps global consequences. Increasing the survey capabilities of NEOs at ESA (e.g. SSA) would allow a better understanding of the threats posed by these objects. Furthermore, initiating a planetary defence mission (possibly in cooperation with non-European partners) would increase Europe's competitiveness since such a mission would require the development of new technologies also relevant to other missions.

3.4.3 Developing common enabling technologies

In order to prepare concretely the above-mentioned objectives, all related to the future of humanity, and to materialise the image of ESA as a model agency, some key technologies should be developed and associated to missions in order to be demonstrated.

These technologies must represent breakthroughs in order to place ESA in a unique position in future partnerships be they for human spaceflight, exploration or clean space. They have also to capitalise on industrial

capabilities, which have been developed in the recent past, and on ongoing programmes.

Without being exhaustive, the following list of technologies responds to the above criteria:

- Rendezvous and docking with a non-cooperative target, which would be an enhancement of the technologies developed for the rendezvous and docking of the ATV to the ISS. In-orbit demonstration of such technologies could take benefit of planned ATV missions.
- Landing techniques, using different technologies depending on the destination, based on current activities (EDM of ExoMars, Moon lander) and previous experiences (Huygens, ARD).
- Robotics, which would be a follow-on of developments currently done in DLR with a strong participation of ESTEC, as well as the development of ERA which will be launched and tested within a few years.
- Life support systems, a well-established European capacity, in particular on the ISS. Pilot programmes including resources recycling (e.g. Melissa) could lead to significant breakthroughs for space exploration but also for eco-friendly ground-based systems.
- New propulsion systems, which could lead to lifting the current technology obstacles for deep space exploration and, at the same time, introducing eco-friendly propulsion.

In order to streamline the activities related to the above technologies and other ones as necessary, they should be combined and integrated into demonstration missions, e.g. removing Envisat from polar orbit and ensuring its controlled reentry, docking a European vehicle to the Chinese space station, or contributing to a Moon sample-return mission, which would give a target and a calendar to these technological developments.

3.5 Priorities

None of the above-defined goals and related activities can be considered as a luxury and they are all closely connected: scientific knowledge and competitiveness are two pillars upon which enhanced and new services can be delivered to citizens. Cooperative activities require also adapting to partners' calendars. Clean space cannot be dissociated from the development of space activities any more.

In other words, all the above-defined goals and related activities should be initiated in the short-term. However, budget constraints require setting budget allocation priorities: it is not therefore priorities among objectives, but priorities in budget allocation with consequences on calendars of implementation. The priorities for ESA will also depend on what will eventually be funded through the EU MFF 2014–2020.

Priorities are set by the Member States and the optional character of ESA programmes and activities allow Member States not to have all the same priorities at the same time. However, all Member States share the same

interest to have ESA programmes and activities properly funded. This is the reason why the DG proposes below his views on the degree of urgency among activities and therefore on budget allocation priorities in the short-term.

- Competitiveness: revisit the model of guaranteeing access to space, as a factor of competitiveness of the European space sector. Changing the model will require investments and a transition in the exploitation of operational vehicles. This change is required in order to achieve a sustainable model. Not changing could lead to a break in the guarantee of access to space, which could propagate to all space developments. The competitiveness of European industry, in particular of telecoms manufacturing industries and telecom operators, on the worldwide market should be a priority of short-term investments, as a vector of economic recovery.
- Science: in science, the bottom line is to maintain the level of investments in all fields of science: space science, Earth sciences, sciences under microgravity, and to introduce leverage on its utilisation by different types of cooperation, among ESA programmes, with national programmes and with international partners;
- Services: the bottom line is to maintain existing operational services (meteorology, navigation, environment and security) and to develop new services based on existing space infrastructures (e.g. IAP) since the return on investment is important, considering the low level of investments required based on partnerships.
- Exploration and ISS: the overarching goal is to implement new missions using new enabling technologies as described in section 3.4.3 and leading to new discoveries, before 2020. In order to implement them within budget constraints, the DG's objective is to reduce the financial burden of the ISS exploitation by 30%. This will be achieved by streamlining and efficiency increases based on lessons learned and through synergies among the partners' capabilities.

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4 → REQUIRED CHANGES FOR ESA

The most significant and visible changes for ESA in the years to come is undoubtedly the increase of the number of its Member States with a progressive accession of all the EU Member States to the Convention of ESA. This will make a different ESA, much closer to the membership of the EU, with many more Member States, but still with programmes and budget driven by a few big contributors.

The second driver of changes will be the role of ESA among the three main governmental actors in Europe: EU, ESA and Member States, as a consequence of the Lisbon Treaty. The role of ESA should stay the one of a mission- and project-oriented agency, be it for its Member States or for the EU. As a consequence, ESA will stay the most important government customer of European space industry, placing its relationship with industry at the heart of its actions and of the competitiveness of European industry on the world market.

It is clear also that the efficiency of the role of ESA will depend on its capacity to act in close relationship with its Member States and their national programmes as well as their national capacities.

The attractiveness of ESA for investors, be they Member States and the EU, or private partners or international partners will depend on its added value, its programmatic reliability and its expertise.

The DG proposes therefore to conduct the following changes, subject to relevant decisions to be taken by Member States, which will shape the ESA of the future, responding to the expectations of all its Member States and ready to take up all the challenges described in the previous chapters.

4.1 Adapting the programmatic framework to an ESA of 20+ Member States and acting by delegation for the EU

The Level of Resources (LoR) is the backbone of ESA and must be maintained. However, with the growing number of Member States, which will emphasise the difficulties underlined in chapter 1, the content of the mandatory programmes (science and basic activities) will have to better take into account the fact that it is financed by a contribution scale based on relative GNP. In addition, the growing importance of activities

managed by delegations of 'third parties', which are not contributing to the basic activities, requires a reassessment of the objectives and content of basic activities, against other activities currently financed by recharges to programmes. Finally, the reinforcement of partnerships between ESA and the Member States for mandatory and optional programmes must be organised in order to stimulate the dynamism of the respective programmes and quicker innovation.

4.1.1 Optimising the benefits of using mandatory and optional programmes

After 35 years of operations, the LoR has not changed whilst ESA has been significantly evolving:

- the number of its Member States has progressively increased, starting from 10 to currently 19, with a perspective to reach 29;
- optional programmes are not contributed to at GNP level as originally foreseen in the Convention, and substantial differences between Member States and between programmes can be systematically observed.
- a growing part of ESA activities (25% nowadays) are not funded by its Member States but by 'third parties'.

The mandatory programme is a founding element of ESA and reflects solidarity between all Member States. It must therefore be able to guarantee the foundations of ESA, which are its technical capability (staff and technical infrastructure), its activities useful to all Member States (such as education or technology transfer) and the scientific programme.

The two parts (Scientific Programme and Basic Activities) of the mandatory programme must be reviewed.

Actually, the Scientific Programme also depends on national contributions, which fund scientific instruments, either through national programmes, or through the PRODEX programme. These national contributions constitute *de facto* an optional part: the overall implementation of the scientific programme is *not* therefore done at GNP level. The arrival of new Member States allows increasing the Level of Resources granted to the Mandatory Programme, which is beneficial to the whole community, but raises the problem of the guaranteed return associated with the contributions of all Member States. As a matter of fact, a balanced return is difficult to achieve for both new Member States and 'old' Member States, notably large contributors. Large contributors have a structural over-return in the strict perimeter of the ESA mandatory part, while their return is per principle equal to one in the perimeter of their national contributions. The solution adopted so far consisted in putting in place special measures, which have detrimental effects on the cost-at-completion of optional programmes and on their participants. Two types of alternative solutions could be envisaged, namely reducing the contribution to the mandatory programme for acceding States, and keeping the contribution to the mandatory programme but allocating a fraction of this contribution to develop

industrial capabilities in optional programmes. The goal of these solutions is to guarantee a return in the Mandatory Science Programme in a sustainable manner (i.e. without successive special measures), even with an increasing number of Member States.

As for the Basic Activities part, its content is heterogeneous and currently unable to guarantee the maintenance of ESA 'assets' (i.e. its technical expertise and infrastructure), which represent ESA's added value for Member States and third parties, but which are increasingly funded through recharges to optional programmes. This model puts the maintenance of ESA assets all the more at risk as 'third party' activities do not contribute to this maintenance, which transfers in turn more and more charges to ESA optional programmes. A complete review of the objectives and contents of these basic activities is therefore important for the future of the Agency, taking into account lessons from the past, the evolution of ESA and of its activities as mentioned above. Such a complete review must encompass not only activities funded by the mandatory programme but also all internal activities funded by the recharge system or directly charged to programmes, that is all the spending, which is not linked to industrial contracts of projects. This review also needs to address the corporate risk management and identify possible funding sources, which are today missing, in particular for the management of 'third party' programmes, which represent currently one quarter of the Agency's activities.

The above reviews will be organised together with the Member States in the first part of 2012, in order to introduce findings and consequences in the DG's proposal to be made for the next Level of Resources.

4.1.2 New Innovative Concepts and Approaches

Innovation at all levels will be key to succeeding in the themes outlined in chapter 3: space for knowledge, space for services, space for competitiveness and space for the future of humanity and the planet. It requires adopting new partnership and innovative cooperation schemes, enhancing ESA's and industries' technical and conceptual innovation capacity and complementing internal innovation and R&D schemes by embracing open innovation. Given the role of ESA within the European space sector, ESA and Member States also have a responsibility for creating the right conditions, which stimulate innovation in industry and the service sector for the competitiveness of the overall European space sector.

Innovative partnerships and cooperation

Over the years, ESA has proven to be flexible in adapting its programmatic framework to new ways of cooperating, new partners and new methods. The public private partnerships (e.g. in the telecom sector), the relationship with the European Union and the relationship with spun-off operational entities are just a few examples. In order to continue being successful, ESA will need to flexibly adapt and experiment with innovative ways of engaging with partners, in particular when competitiveness in the world commercial market is at stake.

With rapid and substantial changes taking place in the space sector, e.g. new commercial, privately funded launcher developments, privately funded suborbital space tourism, ever more nations with space capabilities, the emergence of new

entrepreneurial approaches to space exploitation, ESA also needs to strengthen and widen its own capacity for innovation as well as support European industry to drive such trends, rather than adapt to them. Together with Member States and industry, and in synergy with the space-related R&D and innovation programmes of the EU (e.g. Horizon 2020), ESA needs to define and implement the most suitable approaches for Europe.

Supporting industry with innovation schemes dedicated to high-risk high-payoff

European space industry operates with a handicap with respect to radical, potentially disruptive innovation compared to its US competitors. High-risk, high-payoff approaches for the defence sector in general and DARPA in particular benefit US industry by offering them opportunities and incentives to work on radically different approaches to space systems and technological solutions. European industry lacks similar mechanisms. Together with partners, ESA will increase its current offer for such activities or put in place a dedicated approach to strengthen the mid- to long-term competitiveness of European industry.

Innovation in spacecraft and mission design

New space object families (minisatellite) and the combination of space and other non-space (e.g. unmanned aerial vehicles) objects provide opportunities for innovation in spacecraft and mission design. Small and less demanding payloads – which are sufficient for a range of services – can be accommodated on individual spacecraft or on swarms of minisatellites, avoiding single-point failures and increasing global availability of services. Small satellites could individually be appropriated by different stakeholders, and offer the potential for large international cooperation.

Small missions also allow focused science investigations and increasing the number of launch opportunities. They could serve the validation of a specific technology, ease the geographic return distribution and facilitate the integration of new Members States. Small missions and more frequent launch opportunities also allow rebalancing of the acceptable risk level of individual missions and thus encourage the introduction of new technologies and the testing of new concepts. Small missions could be led by Member States with contributions from ESA.

Open innovation

Space is still perceived as a relatively closed sector with a traditional tendency to seek its own solutions within the sector and adopt custom-made, tailored approaches. Open innovation is about adopting new processes and practices rather than technology, beginning with the understanding that others outside of the space sector can contribute with non-space specific expertise.

Therefore, in its future calls for opportunity/ideas and in its dialogues with Member States and industry, ESA should leave the door open for innovative approaches from industry and partners and for innovative and quick missions. The programmatic framework must be adapted to fit with these objectives, which requires short processes and flexible cooperation schemes.

The DG has opened a dialogue with relevant actors, in Europe and outside Europe, in order to prepare proposals driving these different innovative concepts, both within the current programmatic framework (e.g. GSTP) and by creating new instruments which could better fit with these innovative approaches.

4.2 Simplifying a mature relationship between ESA and industry

The industrial policy as set out in the ESA Convention is an essential pillar for Member States to invest in ESA programmes and activities and for European industry to be competitive on the world market.

The industrial policy is certainly the most important feature of ESA and also one of the features that makes ESA different and valuable. As a consequence, this is a very sensitive subject for Member States, EU and industry. This is the only subject present on the agendas of all Councils at ministerial level to date and was even the only subject of a dedicated Council at ministerial level in 1997.

As outlined in chapter 1, industrial policy and procurement have evolved in two directions:

– more and more measures to adapt to the evolution of Member States, the evolution of industry and the evolution of ESA programmes and activities. These measures have reached their objectives but to the detriment of global efficiency. In addition, the more industry is being specified by ESA, the less ESA can take benefit of the expertise of a now mature industry (which is altogether much higher than that of all space agencies put together), and the more ESA is opening doors to industrial claims for additional funds. In brief, ESA has a tendency to specify a product and to buy activities, rather than specifying objectives and buying a product – a more effective approach for a mature and competitive industry.

– new concepts have arisen:

  • fair contribution rather than fair return for market driven products such as Alphabus;

  • new development concepts based on objectives rather than detailed technical specifications, such as for GIOVE-A;

  • Public Private Partnerships with telecom operators relying much more on industrial requirements and capabilities;

  • industrial procurement according to EC rules introducing new procurement processes (e.g. the competitive dialogue), but also the difficulties in procurements based either on mixed funding (e.g. GMES Sentinels development) or on successive funding (e.g. Galileo FOC succeeding to Galileo IOV).

The two directions have demonstrated the capacity of adaptation of ESA processes to different

customers, partners and programmes, but have increased the burden on the Executive, the complexity of the overall processes, the duration of preparatory activities and end-to-end procurement, and, as a result, the total costs.

In addition, two issues have become increasingly important for industrial actions:

- the difficulty for industry to cope not only with a more complex and heterogeneous ESA world but also with the difference between the ESA world and the commercial world, in terms of industrial teaming, competitiveness evaluation and selection criteria;
- the aspects of Intellectual Property Rights when national investments are used in ESA programmes, when European industrial companies are for sale, when ESA and the EC are co-funding industrial activities, etc.

Taking the above analysis into account, the totality of the relationship between ESA and European industry must be reviewed as a whole on the basis of 35 years of lessons learnt, and no longer piece by piece, each piece being driven by specific problems raised by either Member States or industry. It is clear that such a review must be made together with Member States and ESA partners, starting with European industry itself.

The drivers of such a review must obviously be the efficiency of ESA programmes, the competitiveness of European industry on the worldwide market, and the fairness among investors (Member States or other partners). These three drivers correspond exactly to the provisions of ESA's industrial policy as set in the Convention. An important driver will of course also be the fairness and transparency of the procurement process.

Without anticipating the results of such a review, which will be organised in the first half of 2012, the main questions to be addressed with industry concerns the balance of respective interests (efficiency of ESA programmes and competitiveness of industry), of respective roles (control of government investments and development of the best product), of respective investments and of the share of risks, in one word partnership rather than a customer/provider relation. It is clear that this main question will lead to the respective assessment of different lines of action, among which:

- reduce the number of requirements in ESA Invitations to Tender to 'what'-type key requirements (function, performance, interface, operations, verification, standards) and avoid to the maximum extent possible 'how'-type requirements (design), limiting them to geographical distribution targets;
- focus the role of ESA on the evaluation of industrial proposals in competition to the maximum extent possible, based on a set of what-type key requirements and then to the evaluation of industrial deliverables against these requirements as well as to cost control;
- promote a constructive dialogue with industry in preparation of the competition phase and during

the bid phase for refining ESA requirements against lowering risks and costs;

- strengthen incentive schemes for motivating industry in meeting key performance and programmatic requirements;
- review the level of documentation from ESA and requested by ESA from contractors in order to reduce it to the minimum necessary compatible with successful deliveries;
- extend fair contribution schemes experienced on Alphabus to the development of new and innovative products to be competitive on the worldwide commercial market, and reflect on an extension of this concept to other single object development programmes (e.g. launchers) to allow a more competitive environment to be created without creating deficits and surpluses to be balanced by other programmes;
- define a programmatic frame that will ensure that projects established in partnership with industry and operators will have reached the appropriate level of technical maturity prior to the development phase to private investors will contribute;
- more generally, better tailor procurement policies to each programme objectives and specific constraints.

The efficiency of ESA's industrial policy must be assessed in its entirety, including the competitiveness of European industry on the worldwide market, but its implementation should be tailored according to the type of programme (mandatory, one-off, production line, competitiveness, etc.).

An extensive exchange on the above will be organised in the first half of 2012, involving Member States, industry, operators and other partners.

4.3 Reinforcing the relation with Member States and the cooperation with their agencies

The relationship with Member States concerns three different levels:

- Executive and delegations;
- ESA and national programmes;
- ESA and national expertise and capacities.

A good degree of cooperation exists today at each level for the benefit of all Member States. However, further progress can and must be made in order to further increase the global efficiency in the use of resources available in Europe. Such progress must be based on lessons learned from current experience at each level:

- Council, Programme Boards and committees for the cooperation between the Executive and delegations;

- Science programme, Alphabus, Vega, EDRS, technology development harmonisation for the cooperation between ESA and national programmes;
- Management of Ariane programme, integrated teams on Vega, EGNOS, Alphabus, Columbus Control Centre, ATV Control Centre etc for the cooperation between ESA and national capacities.

This three-level cooperation must be addressed systematically by the Executive and all delegations together in order to enhance and extend cooperation for the benefit of all.

At the first level, Member States' delegations and the Executive must work, operate and behave as ONE ESA. There is no gap of interests between the Executive and all Member States. The Executive must help Member States to develop consensus among them. This culture of consensus requires:

- more dialogue and interactions, which should be developed between the successive meetings of Council, Programme Boards and Committees. Systematic information and consultation of Member States will be organised by the Executive, which may result in a reduction of formal meetings. The current informal meetings of Heads of Delegations with the DG have proven to be very helpful;
- more transparency, which requires open exchange of information between delegations and the Executive as well as among delegations;
- more coherence between the different layers of the Executive and of delegations;
- more respect of the respective roles: the delegations decide and the Executive manages.

At the second level, the cooperation between ESA programmes and national programmes must be assessed as early as possible in the elaborations of a new ESA programme proposal, be it under the initiative of one or several Member States or the initiative of the Executive, in order to be transparent as early as possible to all potential Participating States. In order to avoid weakening the ESA part of such cooperation, the Member State involved on the national part should also contribute to the ESA part, as a matter of principle. It is to be noted that, in most, if not all, current experiences of such cooperation, the above principle is respected to the point that, usually, the Member State bringing a national part is at the same time one of the biggest contributors to the ESA part.

The third level of cooperation is usually driven by the cooperation at programme level, but not only. Synergies among existing expertise in ESA and in national agencies must be systematically pursued before any new expertise and capability is created at ESA or national level. This search for synergies, again as early as possible in the preparations of new ESA programme proposals, is the best guarantee of efficiency.

Regular meetings will be organised between the ESA Executive and national agencies in order to systematically review the status and lessons learned

about ongoing cooperation as well as perspectives of new cooperation. This process of dialogue will be fully transparent to all Member States.

4.4 Consolidating the relationship with the EU

The future relation between ESA and the EU will be based on the following:

- the role of the EU towards its Member States, in general, including in the security and defence area, which is of importance for space developments at European level;
- the relationship of ESA with its Member States;
- the EU Multiannual Financial Framework 2014–2020.

As noted above, the proposal of the Multiannual Financial Framework by the European Commission for the period 2014–2020 does not provide the EU with resources able to replace resources provided until now by Member States, in particular within the ESA framework.

The success of the relationship with the EU will be measured by how well space is supporting the achievement of the EU objectives as outlined in Europe 2020, and how strongly space is considered by the EU as a crucial tool accessible in a guaranteed and unrestricted way.

This general objective, as well as the lessons learnt drawn from the experience gained in implementing the Galileo and GMES programmes, will be the drivers for adapting the current Framework Agreement into a more operational and efficient relationship between ESA and the EU, which should be facilitated by a converging membership.

The following high-level principle is proposed for an efficient relationship between the two institutions, based on a clear and well-defined sharing of roles and responsibilities:

- R&D for new space infrastructures should remain the responsibility of ESA and the Member States, because it interests a smaller number of Member States (which have a space industry), and because the ESA rules are well suited to research and development for such space programmes;
- Exploitation of space infrastructures and associated services are the responsibility of the EU, because they are of interest to all Member States. As a consequence, R&D related to space-based services under the responsibility of the EU must be piloted by the needs expressed and/or federated by the EU.

The proposed scheme is thus the following: the EC and relevant EU bodies define, gather and federate the needs in terms of space-based services (whether for their own policies or from user communities). ESA transforms these needs into technical specifications for space infrastructure and manages the relevant development programme. This is optimally done by ensuring also a close link with the future operator of

the services, or at least by setting up the operation scheme in parallel with the development, and not after it. Once services are operational, ESA hands over to the operator selected by the EU the exploitation of the infrastructure, which must be ensured on a sustainable basis through the EU. Finally, in close coordination with users through the operator, and on the basis of their feedback, ESA ensures the R&D for the evolution and future generations of space infrastructures. This scheme has been tested successfully in the case of meteorology, and combines simplicity with an optimal use of competences.

This will be to the Member States to drive the relationship between ESA and the EU and to allocate respective roles. The coming decisions to be taken on the proposed Multi-annual Financial Framework will be a first concrete opportunity to show direction.

4.5 Promoting international cooperation

The international dimension of space activities has been addressed in all the above chapters, be it in terms of cooperation for knowledge, for public services, for human spaceflight or for exploration, or be it in terms of the worldwide competitiveness of the European industry.

It is clear that, as for any type of industrial activities, the competitors are also the partners, meaning that cooperation must be chosen and not imposed, must be based on mutual interests and, if possible, on mutual dependence and must follow clear rules, in particular concerning no exchange of funds and technology transfer protection.

ESA is undoubtedly an attractive partner for international cooperation thanks to its intrinsic culture of cooperation, its long-demonstrated reliability as a partner, and its technical capacity based on European industrial capabilities. Member States can therefore choose the partner with which they plan to build up future cooperation.

While cooperation in space endeavours is part of an overall international policy of Europe, debated among Member States at EU level, space can also be a precursor for wider international policy, as successfully demonstrated in the past with the West–East dialogue.

As already mentioned in the previous chapters, the DG considers that three strategic partners are particularly important for future cooperation:

- The USA, in particular through NASA, which has been the long-lasting partner of ESA since the start of space activities in Europe, in most of the scientific missions, in human spaceflights and in exploration. Future cooperation should be consolidated in the same fields on the basis of lessons learnt and should be extended to new fields of activities, in particular Earth observation and transportation.

- Russia, with which cooperation has significantly grown over the last 10 years, culminating in the

recent first launch of Soyuz from French Guiana. The momentum of such cooperation should be kept, taking into account the new orientation of Russian space policy, into ambitious exploration programmes towards the Moon, Mars and Jupiter.

– China, which has become a leading space power, involved in the full range of space activities, and which is open to cooperation with Europe. Considering that China is becoming one of the strongest economic powers of the world, significant cooperation should be developed between ESA and China, in particular in scientific missions and in human spaceflight, with the objective to reinforce the current ISS partnership.

It is clear that cooperation with these three strategic partners is not exclusive from cooperation with other important partners (e.g. Japan, India) or from other types of cooperation (distribution of scientific data, geographical extension of public services, in particular to the Mediterranean region and Africa), since the dimension of space activities is global.

4.6 Establishing a new relation with the general public

Ambitious space programmes depend on resilient broad political support, which ultimately means the general public. ESA therefore needs to be convincing that the benefits to society are such that investment in, and support of, space developments are well deserved and ESA is the most effective mean for these investments. The expectations of the general public to information have been changing: from information *consumption* towards *participation* enabled by new communication and interaction tools and the rise of new media. Though space continues to attract broad public interest, it competes for attention in an increasingly diverse, overheated and unstable media environment. Engagement is key to this process to ensure that the rationale for European long-term space activities is both understood and shared. ESA therefore will go beyond a communications approach with the public and will organise a concrete interaction between its programmes and the public not only by taking advantage of new direct communication channels but also by introducing when possible in the design of its programmes the objective to introduce a level of interaction with individuals and civil society. Using new tools and adapting these to changing requirements and opportunities, ESA will actively reach beyond the existing audience to attract interest from that larger subset of Europeans who know little or nothing of ESA programmes and activities, and to keep that interest over time.

The number of avenues by which people can actively engage in space has already multiplied in recent years, accommodating a spectrum ranging from the casually interested spectator to the most ardent enthusiast. Technology has been central to this broadening of the space community in both direct and indirect ways. Directly, space technology has now become available to students and even amateurs in the form of CubeSats

and their components. Indirectly, Internet and social media are bringing together individuals to form active communities of interest, enlisting the intellect and enthusiasm of volunteers worldwide to advance knowledge about the Universe, specific tools and technology. Volunteers, users and space enthusiasts should have easy, free access to no-longer-protected space datasets, allowing them to find and new creative ways to process them and extract information. In addition to the traditional and established media channels, content is increasingly disseminated through new media using new communications standards, including multi-way communication. ESA's activities will take this paradigm shift into account from their inception until the end of future missions (e.g. name choosing, purpose, payload composition).

Examples of this revolutionary new way of people to interact with ESA's space science, research, and technology development and of fostering public engagement are:

- increasing the amount of data being placed online for members of the public to use and developing online services allowing the public to access, process and interact with space data (environmental parameters, planetary missions results etc);
- making a systematic and structured use of social media and engage the general public in a dynamic way in ESA space missions and activities (e.g. contests, interactive forums/blogs);
- partnering with global organisations that share similar values and concerns as ESA, well known personalities (e.g. artists, writers, movie makers, scientists) and institutions (e.g. science centres, museums);
- crowdsourcing ideas from citizens, with regular competitions (ranging from new slogans for missions or activities, illustrations etc. to more complex tasks);
- engaging with the gaming industry on 'participatory exploration', giving the public the opportunity to participate virtually in ESA exploration missions.

4.7 Increasing the added value of ESA: its expertise, its motivation and its efficiency in managing space programmes in a changing environment

The implementation of ESA's objectives for the coming years will rely heavily on ESA's human capital delivering value to its partners.

The relevance of the Agency to its partners is:

- firstly, its capability to efficiently manage the development of systems which can successfully

operate in space, as such requiring a particularly high level of reliability and quality.

- secondly, its flexibility and creativity in the setting up and implementation of programmes and activities in cooperation, meeting the requirements of increasingly diverse interlocutors (Member States, national agencies, scientific bodies, industry, EU, international partners, operators, ...)

Building on its recognised trade mark of competence, it is therefore a priority of Agenda 2015 to progress further on its managerial and technical excellence by focusing on staff (its best asset) and to further improve the effectiveness and flexibility of its processes.

4.7.1 A competence- and knowledge-centric community

The Agency sets itself the objective of enhancing its human capital through further development of its staff whilst, in parallel, continuing to recruit externally so as to procure any missing competences. This should be achieved through:

- Developing a knowledge and learning culture expanding the existing bodies and taking inspiration from the 'community of practices'[10] and 'social networks' so as to have knowledge and experience shared and beneficial to all. In order to support this objective, the DG will encourage the development by ESA staff of an internal social network, offering modern tools to connect, and exchange ideas and knowledge for the benefit of all.
- Ensuring the senior-to-junior exchanges of knowledge through apprenticeship and informed sharing of experience and lessons learnt, from senior to junior as well as new and challenging ideas from junior to senior.
- Recruiting the 'best and the brightest'. ESA has to be in a position to attract the best people, bearing in mind that this is in competition with the (space) industry. Without attractive conditions this cannot be successful. To support this objective, the relationships with the best universities in Europe will be further developed. Young graduate trainee schemes are supporting this as well as raising the awareness of the attractive working environment offered by ESA.
- Developing bridges between ESA, national space agencies, space industry and operators able to provide exchanges of staff and competences for the benefit of the overall European space sector, including in the new Member States of ESA.

4.7.2 A person-centric community

The Agency, being aware that "it will only be as strong as its people" aims at ensuring motivation and pride of staff.

[10] A 'community of practice' is a learning process emerging when people with a common interest freely undertake to cooperate. This entails the sharing of ideas, searching for solutions and design of new objects.

The first motivation to be ESA staff is to be part of challenging and interesting projects; challenging technically, challenging scientifically and challenging because of cooperation; challenging also to meet a calendar that is not too distant (not beyond 2020) in order to see full and fruitful implementation of the project, including launch and operations. The culture of ESA is project-oriented and the cement of staff is the success of a project. The motivation of staff is therefore associated with the materialisation of the above proposals on programmes, activities and cooperation. It is a collective motivation.

The second motivation to be ESA staff is to be effectively responsible for a task, be it technical, scientific or administrative. Today, the structure of the organisation of ESA and the multiplication of different processes have superseded the responsibility of individuals, putting at risk the important culture of accountability. The simplification of organisations and processes, addressed in the next section will aim at restoring the responsibility and accountability of individuals, which is of prime importance for the organisation and also for the motivation of individuals within a team.

The third motivation is career development, either within ESA or within partners of ESA. Career development requires, first, transparency of rules and their proper implementation for moving and progressing within ESA, or within a partner of ESA, and, second, time for learning and training by individuals. The high motivation of the staff of ESA and optimal use of human resources in the organisation have to be supported by proper workforce management that will remove obstacles to mobility and will better distribute workload and time among individuals. Such a workforce management will be put in place. Its main focus is the ESA staff, but it will also 'manage' the significant contractor workforce, being a critical success factor for the performance of ESA.

4.7.3 An efficient community

The structure of the organisation will be reviewed and streamlined in order to make the overall organisation lighter, more flexible and simpler:

- **Lighter.** Programmes and projects are the driver for ESA's organisation. The resulting emphasis on programme management and the related interaction with Member States via the Programme Boards are leading almost naturally to a compartmentalisation of ESA into several parts, each more driven by programmes and budget rather than by an overall management. Successive DGs and reorganisations were aiming at introducing a corporate management supported by support directorates. Improvements have been achieved in the overall management and overall transparency to Member States, but the balance is not optimal and the internal costs higher in particular because these successive steps have also produced contradictory complexities in the functioning of ESA.
- **More flexible.** The current staff-to-post relationship, staff management by directorates'

complement and standardisation of procedures are introducing rigidity to the management of the ESA workforce. Managing more than 60 different space programmes and projects at ESA, with different calendars, but all technically challenging, require optimising the allocation of workforce to projects according to their needs, rather than according to pre-allocation of complements. Reviews of rules in force associated to proper workforce planning will provide the flexibility required for proper workforce management.

– **Simpler.** The successive introduction of different processes have led to complexity in the structure: the first to overcome the compartmentalisation of the organisation, the second to standardise processes (including the financial reform), and the third to respond to different customers, in particular the EC in addition to Member States. Further complexity has been added via special measures, in particular for industrial procurement. All these complexities must now be reduced, not by another reform, but by making individuals responsible and accountable.

Fortunately, the above characteristics of the organisation have not hampered the capacity of ESA staff to deliver the most advanced spacecraft of the world, thanks to the dedication and expertise of staff, its capacity to adapt to evolving and new customers, and its attachment to the organisation. But this capacity to deliver has a price: continuous overload of some teams, internal frictions and risk of demotivation.

Changes are therefore necessary and will be implemented in steps, following three lines of changes:

– simplification of organisation and processes;
– workforce management;
– responsibility and accountability of individuals.

The success of these changes will rely upon

– the will of the directors' team;
– the adherence of staff;
– the support of delegations.

An overall plan will be discussed first with staff, presented to Member States in March 2012 and then implemented in steps to be completed in 2015.

Agenda 2015

5 → ESA IN 2015 AND BEYOND – A MODEL SPACE AGENCY FOR THE 21ST CENTURY

The ESA of 2015+ will have addressed the main open questions and lessons learnt from the past 35 years, and will be able to help its Member States and Europe to address the pressing challenges outlined in chapter 2. Tomorrow's ESA, the ESA of 2015, will need to be different from the ESA of 1975 and from the ESA of today.

The role of space agencies in the 21st century will anyhow be very different from their past and current role. A new space agency will have a partnering role vis-à-vis industry and an enabling role vis-à-vis the non-space sector, but it will also need to address the environmental impact of space activities and, more generally, to be among the designers of the future on planet Earth. By contributing with relevant partners to address the pressing needs of humanity in an open, transparent and collaborative manner, tomorrow's ESA should serve as a model space agency for the 21st century.

ESA must therefore be at the forefront of worldwide actions relevant to these challenges, in close partnership with the actors in charge by consolidating relevant activities and preparing new ones. ESA will build upon its experience in developing space-based services, its ability to build up partnerships with relevant operators and its reputation in the space world.

ESA cannot fulfil these ambitious objectives alone, but needs to implement such activities with relevant partners who share these objectives, be they from the space sector starting with Member States, from the non-space sector starting with actors in charge of energy, resources, health, from the public sector starting with the EU, from the private sector, including manufacturers and service providers, from the scientific and from the application sectors. These partnerships will require from ESA, Executive and delegations a change of culture in order to understand and to be understood by these different partners.

To provide its partners and customers the full potential of space and an undisputable added value, the space sector, starting with ESA, must increase its efficiency, maintain and increase the expertise and motivation of its personnel, and sustain and expand the uniqueness of its technical facilities.

Finally, because ESA aims to make increasingly relevant contributions to the future of citizens on planet Earth and because citizens are concerned with what space can bring them, citizens should feel they are also stakeholders of ESA. Thus ESA must interact more and better with the general public by associating them with its activities and progress.

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→ CONCLUSION

The above analysis and axes of reflection only commit the Director General of ESA. In order to elaborate them, he has drawn on his own experience, and on the large experience of his team of Directors and of the ESA staff. He is guided in this exercise by his strong belief that ESA is necessary to its Member States, to the European space sector, to Europe and that it may even contribute to the future of the planet.

The implementation of Agenda 2015 will be made in successive steps, most of which will be achieved thanks to the will of Member States who have the decision-making power. Other parts, in particular concerning the internal evolution of the Agency, can be implemented through the collective support of Directors and the Executive. The first step will be ESA's Ministerial Council at the end of 2012, which will take place in a difficult economic situation. Nevertheless, most proposed orientations may and must be implemented as of end-2012, since the world is evolving at a fast rate and ESA must anticipate rather than follow, to continue to be the most effective framework to implement the needs and ambitions of its Member States.

Some of the proposed orientations correspond to substantial changes. For these changes to be successful, new methods are necessary, notably concerning the relations between the Executive and the Member States as well as between Member States. Dialogue will be more necessary than ever, including with key partners of ESA: EU, industry and operators, in order to share the analysis and to define orientations in a balanced approach where each Member State is listened to and where major contributors have a power commensurate to their responsibility.

ESA Member States

Austria
Belgium
Czech Republic
Denmark
Finland
France
Germany
Greece
Ireland
Italy
Luxembourg
Netherlands
Norway
Portugal
Romania
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