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Executive Summary

This report entitled "Europe-Japan Strategic Partnership: the Space Dimension" seeks to introduce how cooperation could be strengthened in four prospective areas of space-related activities which could, in turn, contribute to the Europe-Japan strategic partnership more broadly. The four areas examined include: exploration and access to space; Earth observation and related applications; industry-to-industry cooperation; and space security. The report argues that inserting key space issue areas into existing EU - Japan venues for bilateral consultations and decision-making has the potential to bolster the overarching objective of deepening further political, economic, commercial, societal and cultural relations. Space can also serve as a powerful enabler of certain priority foreign policy objectives of both the EU and Japan.

The report first provides an overview of the key space-related institutions and players of both sides, recent developments in their respective space policies, and budgetary considerations as a lead-in to exploring expanded cooperation in space.

The EU and Japan represent the world's largest and fourth largest economies and account for 33% and 11% of world GDP, and 17% and 6% of world trade, respectively (as at February 2011). Both Europe and Japan share the basic principles of democracy, free market economies, multilateralism and several other characteristics that serve as the back-bone of this long-standing partnership.

The formal bilateral relationship between the EU and Japan dates back to 1991 when both partners signed the "Joint Declaration between Japan and the European Community and its Member States". The Declaration instituted a consultation framework for annual meetings between the EU and Japan. At the 2010 EU-Japan Summit, a High-Level Group was established to examine jointly ways to strengthen and integrate the EU-Japan economic relationship. In May 2011, the 20th EU-Japan Summit took place in Brussels with the goal of deepening further mutual political and economic relations. During the meeting, the summit leaders agreed to launch negotiations on a Free Trade Agreement (FTA)/Economic Partnership Agreement (EPA) as well as a binding agreement that would address political and sectoral cooperation in a comprehensive manner. This Summit occurred a decade after adopting a ten-year "Joint Action Plan for EU-Japan Cooperation" in 2001.

In June 2011, the EU and Japan held their first Joint Committee on EU–Japan Scientific and Technological (S&T) Cooperation stemming from the new bilateral S&T Cooperation Agreement of March 2011. With the goal of intensifying gradually S&T cooperation, the Committee addressed two issues at the first meeting: low carbon societies/technologies and critical raw materials. Space technologies can contribute significantly to both of these areas.

With regard to European space policy, ESA and its predecessors have engaged for over four decades in space programmes for science, Earth observation, telecommunications, navigation, human spaceflight and exploration, and launchers. ESA–EU cooperation is based on a 2004 Framework Agreement which coordinates the activities of ESA and the European Commission through a Joint Secretariat. With the entry into force of the Lisbon Treaty in December 2009, the EU was granted, for the first time, an explicit competence in the space domain. Its Article 189 formalised the status of space activities and stated that appropriate relations should be established with ESA. In short, Europe is now positioned to pursue and invigorate current space efforts for the benefit of mankind and Europe's overall global standing. With regard to Europe's position as a space-faring power, the European Space Policy of 2007 emphasises the direct connection between space-related capabilities and the EU's ability to exercise influence regionally and globally.

For its part, Japan enacted a "Basic Law on Space" in May 2008. The law seeks to regulate all space activities, public and private, and establishes the strategic direction for Japan's space programme. After the enactment of the Basic Space Law, the Strategic Headquarters for Space Policy was established at the Cabinet level, with the Prime Minister as Chairman, with a view toward consolidating Japan's space activities. In June 2009, the Strategic Headquarters released the Basic Plan for Space Policy with an overarching goal of implementing a comprehensive strategy for space. The Basic Plan represents a shift from research to civilian and military applications and serves as Japan's fundamental space policy document for implementation of the recent law. It also provides a comprehensive roadmap for pursuing space activities.

Concerning space budgets, the EU's 2010 budget for space-related programmes was €1.33 billion ($1.63 billion). The EU budgeted for space research some €212.85 million ($261.63) in 2010 to support the development of European space applications, including the Global Monitoring for Environment and Security (GMES). Security-related research was allocated €215.05 million ($264.33 million) for the development of space-related technology and knowledge to advance security-oriented activities (e.g. disaster management, anti-terrorist operations, etc.). For satellite navigation, the EU's budget earmarked €896.04 million ($1.1 billion) for deployment of the Galileo programme. ESA's 2010 budget was €3.74 billion ($4.6 billion), it being noted that France, Germany, Italy and other European space agencies also conduct very significant space activities with separate funding. By way of comparison, Japan's national budget allocation for space was $3.83 billion (¥339 billion, €3 billion) in FY 2010. Of this amount, JAXA received $2.03 billion (¥180 billion, €1.6 billion).[1]

With regard to access to space, there have been a number of comparable launcher programmes and goals (i.e. Hermes–HOPE, Ariane 5–H-2A and ATV–HTV). At the same time, there has been relatively little effort made to promote expanded Europe–Japan cooperation at a governmental level as both sides have sought autonomous capabilities. Industry has been at the forefront of promoting business relations between the two sides in the launcher sector. Arianespace and The Mitsubishi Heavy Industries (MHI) have a mutual backup agreement for commercial satellite launches. Space development, including launcher technology, is a long-term, costly endeavour. Accordingly, it might be worth considering cooperation in the area of human launch capability, particularly if this would be part of an overall transportation strategy relative to space exploration.

Concerning space exploration, Europe and Japan, through the ESA–JAXA partnership, have demonstrated that both sides share similar visions of their research and development efforts. Decisions made in the nearer future, although framed during times of economic/financial uncertainty, will, however, play a significant role in determining the future of space exploration. Many experts assert that international cooperation in space exploration is essential and that Europe and Japan have a number of opportunities to engage in closer dialogue concerning future joint endeavours. BepiColombo or Astro H are concrete expressions of this kind of cooperation. Space exploration will also always have a strong human dimension. In the near term, ESA and JAXA might explore new angles of bilateral cooperation with respect to ISS operation and utilisation within the overall framework of the multilateral project.

Europe and Japan also share many key policy priorities that involve use of Earth observation satellites and derived information. These include space for societal and economic benefits, environmental protection and climate change monitoring, and security (including disaster management). Accordingly, enhancing Earth observation capabilities are a priority for both Europe and Japan. Societal and economic benefits, as well as security, including through international cooperation, will be derived from Europe's GMES and Japan's Sentinel Asia Project. Active engagement of both Europe and Japan in Earth observation-related undertakings is based on solid national foundations and accomplishments. Europe and Japan have also embarked on a joint EO project. EarthCARE, which is the largest and most complex of ESA's Earth Explorer missions, is being developed as a joint venture between ESA and JAXA. There is also a cooperative mechanism established within the International Charter Space and Major Disasters, where both a number of European actors and Japan are involved. Using EO-derived information effectively offers fertile ground for enhancing key foreign policy objectives via bilateral and multilateral cooperation.

The industrial dialogue between the EU and Japan has been conducted through various channels. The goal of these dialogues has been to establish a transparent, open and stable business environment and contribute, through better cooperation between the EU and Japan, to an overall stronger economic situation. The success or failure of any cooperative endeavour depends, to a large extent, on industrial capabilities. This needs to be accompanied by shared understandings concerning the practices, culture and methodology of the partner. Mitsubishi Electric Corporation (MELCO) and Astrium, for example, have successfully pursued a Rendezvous- and Docking Sensor (RVS) for ATV and HTV. European and Japanese companies are also already engaged in various institutional and commercial programmes and both partners can provide world-class technical quality and

[1] "The Space Report 2011". Space Foundation (2011): 42, 43 and 54.

management skills. Venues such as the Europe-Japan Business Roundtable (EU-Japan BRT) and the broader EU-Japan Summit can serve as important platforms for promoting the space industries of both sides.

Both Europe and Japan view space as an important strategic asset and seek maximum autonomy in a number of space activities. With regard to space security, they actively participate in diplomatic exchanges on the future governance of space, including via the UNCOPUOS and initiatives such as the International Code of Conduct for Outer Space Activities and enhanced Space Situational Awareness (SSA). The space debris issue area is also high on the agendas of both partners. They are likewise in the process of establishing more comprehensive space security policies. With regard to leveraging space for security-related activities on Earth, the EU emphasises counterterrorism, combating piracy, and international peace activities, all areas of increased interest to Japan.

To conclude, Europe and Japan are well-positioned for a new level of space-related cooperation provided that both sides have the right mix of patience, persistence, budgetary capabilities, administrative coordination and political will. To maximise the benefits and capabilities of space cooperation, the following recommendations should be considered for each of the four areas covered in this report:

Access to Space and Space Exploration

Access to Space

- *More affordable human access to space through collaboration:* Europe is currently deciding on an Ariane 5 successor, known as the Next-Generation Launcher (NGL) or Ariane 6. Europe is also developing the Ariane 5 Midlife Evolution (ME). In Japan's case, JAXA and MHI plan to upgrade the H-2A and H-2B rockets to improve their performance and enhance their competitiveness on the commercial launch market. The first launch of the so-called H-2A Upgrade is planned for early 2013. The development of the Ariane 6 and Japan's next flagship launch vehicle, H-X, are going to be costly, long-term endeavours. Accordingly, Europe and Japan could contemplate to expand considerably cooperation with regard to the next launch vehicle of each side to reduce cost, strengthen industrial cooperation and share promising, non-strategic technologies for mutual benefit.
- *Consider cooperation on a joint return manned vehicle:* ESA and EADS conducted a feasibility study concerning the development of a re-entry capsule for the ATV, an ATV Return Vehicle (ARV). It was envisioned as the basis for developing either a cargo return capacity or a manned version of the ATV, but never materialised. In 2011, ESA announced the possibility of collaborating with NASA on an ATV successor, involving the NASA MPCV capsule. In 2010, Japan, for the first time, began to study plans for a manned space vehicle. An improved version of HTV-R would serve as the platform for a manned Japanese spacecraft for the ISS. Such vehicles, however, are costly and complicated and require a clear strategic goal and political vision concerning the benefits. Given the success of the ATV and HTV and more recent ideas to build a return vehicle, both Europe and Japan should consider carefully the prospect of collaborating on a joint return man-rated spacecraft.
- *Contemplate the benefits of a backup agreement for government launches:* Currently, all government launches in Europe and Japan are conducted by domestic launch capabilities, on the Ariane 5 in Europe and on H-2A in Japan. Arianespace and MHI have in place a backup agreement for commercial missions. Taking the long view, Europe and Japan should consider the potential benefits of a back-up agreement for government launches. It would be especially relevant if both governments are contemplating man-rated rockets.

Space Exploration

- *Continue to strengthen cooperative efforts in space exploration:* The global space community is at a watershed, having to decide whether to truly pursue space exploration, and if so whether this would be in a coordinated or competitive fashion. By coordinating well Europe and Japan can help set the agenda for the long-term future in this domain.
- *Seek to forge a joint vision for space exploration and support the high-level international platform/forum established in November 2011 in Lucca, Italy:* Europe and Japan should seek common ways to maintain the positive momentum created by the Third International Space Conference and first high-level international platform/forum that took place in Lucca, Italy, in November 2011, including efforts to shape the policy issues for the next string of meetings.

- *Strengthen arguments for space exploration by including the benefits of such activity for the overall domestic and foreign policies of Europe and Japan:* Existing bilateral policy exchanges should include on their agenda a full evaluation of how space exploration promotes economic growth through scientific and technological progress, innovation and competitiveness. It should also explore how greater social prosperity can be advanced through joint space-related research and undertakings (including in the area of life sciences, joint robotic missions, etc.), and enhanced ISS cooperation, including joint space transportation. Space exploration is also an iconic human endeavour, with geopolitical significance (as demonstrated by the Chinese posture), and engenders all the scientific benefits of basic research.

Earth Observation (EO) and Related Applications

- *Promote EO-related cooperation that supports Europe's and Japan's broader policies, including at EU-Japan Summits:* Europe and Japan share many key policy priorities (identified, for example, in "Europe 2020" strategy and Japan's "New Growth Strategy" and "Comprehensive Partnership Policy") that involve use of Earth observation systems. These systems possess, in some cases uniquely, the capability of supplying continuous and comprehensive information about the Earth, including over extended periods. The priorities identified by the EU and Japan include space for societal and economic benefits, environmental protection, climate change monitoring/mitigation, and security (including disaster management). Enhanced EO-focused cooperation would strengthen support for EO utilisation and its greater commercialisation, and improve implementation of broader objectives such as innovation, competitiveness, environmental protection, sustainable energy and sustainable management of natural resources.
- *Promote strengthened position of Europe and Japan in multilateral EO-relevant venues:* Existing fora or venues, such as the Committee on Earth Observing Satellites (CEOS), the Group on Earth Observation (GEO) and its 10-year implementation plan (GEOSS), the ESA-EU "GMES Space Component" programme, ESA's Climate Change Initiative (CCI), International Charter Space and Major Disasters, and regional Sentinel Asia all seek to enable comprehensive monitoring and data collection. Gaps remain, however, between having access to unique EO-derived data (including environment and climate change-related) and the ability to effectively utilise it. Such international coordination, which seeks to, among other things, avoid duplication and redundancy, facilitate data sharing and raise awareness of EO potential in other communities, requires a special, sustained diplomatic and executive effort. Closer mutual coordination of Europe's and Japan's activities and priorities in these venues has the potential to bolster their role as international leaders in responding to environmental, climate change, and disaster management issues, to name only a few.
- *Advance commercialisation of EO/remote sensing through steady institutional support:* Although remote sensing has yet to become a fully viable commercial business, as the users become more familiar with the benefits of using space-derived data with other sources of geographic information, EO is poised for considerable growth in the coming years. Commercial data revenue alone is expected to increase more than threefold in the next 10 years.[2] A more robust commercial market will also result in improved decision-making processes for both governments and commercial users. Joint dialogue should involve issues ranging from how to bolster awareness of satellite observation capabilities, accelerate the transition of satellite use from research to operations, improve capacity-building investments in user communities, encourage investment in applications and services, and reduce the gap between users and suppliers of data.

Industry-to-Industry Cooperation

- *Level the playing field for investment and industrial involvement:* Space is, per definition, transcending borders. The benefits of globalisation experienced in many other fields should also increasingly be harvested in the space domain. Europe and Japan should be trail-blazers in allowing and fostering Europe/Japan cross-boundary investment in space industries, and should actively seek mutual engagement of European and Japanese industry in both commercial and governmental ventures.

[2] "Asia Pacific Satellite-based Earth Observation Market". 25 Mar. 2011. Frost & Sullivan 23 Feb. 2012 <http://www.researchandmarkets.com/reports/1803560/asia_pacific_satellite_based_earth_observation>.

- *Provide cooperative institutional support for space applications to enable greater utilisation of space:* High-level institutional dialogue can assist in shaping the strategies of both partners to advance their respective space-related industries. Given the large volume of official documents dealing with space policy, industry policy, science and technology policy, etc. it is often difficult to identify the relevant activities of both sides that warrant specific discussion, much less connect them. Commercialisation, closely connected with advancing space industries, needs to attract strong government support. Determining space objectives, enabled by collaboration, can drive innovation and competitiveness for each side's space industry. Joint pursuit of such objectives will strengthen the practical utilisation of space (e.g. offering international competitive space systems with improved performance, reduced costs and shorter development periods). There would also be benefits associated with better penetration of overseas markets and their respective domestic commercial markets. The improved integration of satellite communications, Earth observation and position, navigation and timing (PNT) could constitute promising areas for such enhanced industrial cooperation.

- *Stimulate innovation policies of Europe and Japan through space collaboration:* EU-Japan relations are already well-established through a number of existing fora. Innovation, a priority growth area for both sides, is closely linked to international collaboration and can address possible bottlenecks as observed by the EU's "Innovation Union" programme. Space activities require cutting-edge technologies that stimulate innovative ideas. Space-related research and development fuels open innovation for greater global competitiveness. A strengthened EU-Japan industrial partnership, beyond the current framework, can have broad, durable benefits, particularly in the areas of research and development, skill and knowledge transfer, sharing resources and information, and enhancing capability development.

- *Provide support for competitive European and Japanese space industries on the world market:* The space industry is a growing source of economic growth and competitiveness. The upstream industry is highly centralised in both Europe and Japan and presents challenges to the entrance of small and medium-sized enterprises (SMEs). This can be partially compensated for by the larger downstream industrial sector that can generate substantial revenues with lower barriers for the SME entrants. Accordingly, Europe and Japan should actively explore cooperation on specific, high-profile space projects that are emblematic of the large-scale contributions space assets can offer their respective societies, as well as stimulate the growth of the space industries of both sides (e.g. small satellites or space-based solar power).

Space Security

- *Add agenda item on space security into the broader foreign and security policy agendas of the EU and Japan:* Europe and Japan share a number of views on space policy as well as associated goals. They both view space as an important strategic asset and seek maximum autonomy in a number of space activities. With regard to space security, they actively participate in diplomatic exchanges on the future governance of space via various bilateral and multilateral mechanisms and initiatives (e.g. the UNCOPUOS, the International Code of Conduct for Outer Space Activities etc.). Space Situational Awareness (SSA) and the orbital debris issue area are also high on the space agenda. Indeed, both Europe and Japan are in the process of establishing more comprehensive space security policies. Good space governance requires clear guidance, informed decision-making, comprehensive management, and consistent policies. To achieve a predictable and stable space environment where all actors behave responsibly, there is a need to facilitate international cooperation, closer interaction between the private and public sectors, and the political will to address the degradation of the environment of Earth orbits due to space debris. Accordingly, adding the most pressing space security challenges to the broader bilateral foreign and security policy agenda would demonstrate heightened awareness and priority accorded this rapidly growing issue portfolio.

- *Pursue cooperative strategies for improved space debris mitigation and removal supported by upgraded Space Situational Awareness (SSA) and transparency and confidence-building measures (TCBMs):* The alarming increase of space debris in Earth's orbits has been recognised as one of the most challenging threats to secure space operations.

With the adoption of the IADC Space Debris Mitigation Guidelines at the UN in 2008, there is a continuing need for political endorsement of, and support for, these guidelines. Both Europe and Japan should strengthen further their existing engagement in various efforts to preserve space sustainability, including through space debris remediation efforts, SSA and transparency and confidence-building measures (TCBMs).

- *Increase cooperative opportunities for the EU and Japan in the area of crisis management:* Both sides are involved in various humanitarian and rescue undertakings, peacekeeping operations and crisis management. Enhanced cooperation can help fill existing gaps in crisis management operations, including through the establishment of more responsive multinational forces. Space assets are indispensable to the effective operations of such forces. Joint participation of Europe and Japan in crisis management exercises, actual missions and the sharing of space-based information, can improve prospects for mission success and more effective exploitation of the benefits of available space systems.

1. Introduction

The EU and Japan are the world's largest and fourth largest economies and account for 33% and 11% world GDP, and 17% and 6 % of world trade, respectively.[3] Both Europe and Japan share the basic principles of democracy and multilateralism and several other characteristics. At the same time, the full potential of the economic relationship leaves considerable room for new opportunities to be exploited.

The European Union (EU) identifies Japan as one of its "strategic partners" and recognises that Japan basically shares Europe's views on a number of key foreign policy issues (e.g. promoting effective multilateralism, the rule of law, etc.). EU–Japan relations date back to 1991, when both partners signed the "Joint Declaration between Japan and the European Community and its Member States".[4] The Declaration established common principles and shared objectives in the political, economic, cooperation and cultural areas and instituted a consultation framework for annual meetings between Japan and the EU. Subsequently, the basic structures of EU-Japan collaboration have been established. At the 10th EU-Japan Summit in 2001, a ten-year Action Plan set a number of cooperative objectives, including promoting peace and security, encouraging bilateral trade and investment partnerships, and coping with global and societal challenges.[5] Japan was later invited to participate in the EU's 6th and 7th Framework Programmes for Research. The 2001 "EU-Japan Action Plan" laid out ambitious goals, but needs to be populated with concrete implementation milestones.

At the 2010 EU-Japan Summit, a High-Level Group was established to examine jointly ways to strengthen and integrate the EU-Japan economic relationship. In May 2011, the 20th EU-Japan Summit took place in Brussels with the goal of deepening further political and economic relations between the two sides. During the meeting, the summit leaders agreed to launch negotiations on a Free Trade Agreement (FTA)/Economic Partnership Agreement (EPA) as well as a binding agreement that would address political and sectoral cooperation in a comprehensive manner. The annual Regulatory Reform Dialogue (RRD), where both sides present specific proposals for deregulation, has been in place since 1994. Other important issues are to be discussed at the next EU-Japan Summit scheduled for May 2012, including the potential launch of negotiations for a free trade agreement. Strong high-level commitment and firm leadership in Brussels and Tokyo will be key to building-out this important partnership.

Space-related systems and derived applications have the potential to advance and expand the bilateral dialogue as well as the broader strategies of both partners (i.e. "Europe 2020" strategy and related flagship initiatives, and Japan's "New Growth Strategy" and its "Comprehensive Partnership Policy"). Both partners need to develop a coherent strategy concerning their future space relations that can contribute to mutual political, economic and security interests. This should be accomplished in parallel with discussions on the goals of Europe's and Japan's respective space programmes as well as their approaches to the rapidly changing geopolitical environment of the 21st century. Understanding the character and context of each other's space efforts will aid the advancement of broader Europe-Japan collaboration.

This study addresses a range of views on Europe–Japan cooperation and evaluates opportunities for expanded space-related cooperation. The primary focus of the report is on four select areas of space activities and how these areas can be enhanced by joint undertakings, and, in turn, how such cooperation can advance broader common objectives of Europe and Japan. These include: access to space and space exploration; Earth observation and related applications; industry-to-industry cooperation; and space security. The study first provides an overview of the current status of space institutions, policies and budgets in the partner countries. The second section examines, in more specific terms, Europe's and Japan's priority space activities in the four areas referenced

[3] Sunesen, Eva et al. "Assessment of Barriers to Trade and Investment Between the EU and Japan: Final Report". DG Trade 30 Nov. 2009: 6. <http://trade.ec.europa.eu/doclib/docs/2010/february/tradoc_145772.pdf>.

[4] "Joint Declaration on Relations between the European Community and its Member States and Japan".

[5] "Shaping our Common Future: an Action Plan for EU-Japan Cooperation". European Union: Brussels (2001).

above and how collaboration could strengthen these activities. This section also reviews the nature of cooperative missions already undertaken and seeks to delineate the main factors that can shape successful collaboration. Chapter five of the study offers a set of recommendations germane to each of the four issue areas examined. Among the report's findings is the view that identifying common objectives with respect to space policy and implementation of same should be included as a more prominent agenda item for the broader bilateral relationship.

2. Space in Europe and Japan: Key Institutions, Policies and Budgets

The EU and Japan are both protective of their global stature and seek recognition for noble, far-sighted causes or policies. Space can serve as a powerful enabler of foreign policy objectives of both sides, including successful cooperation that touches on the overarching bilateral objectives of promoting peace and security, strengthening the economic and trade partnership, tackling global and societal challenges, and bringing together people and cultures as laid out in the 2001 Action Plan for EU-Japan Cooperation.

In the interest of providing a broader context in which to view cooperation between Europe and Japan, including in the four space-related areas addressed in this report, below is a brief overview of their institutional structures and actors involved in space policy decision-making, as well as noteworthy developments in this issue portfolio.

2.1 General Structure of Institutions Involved in Space

Europe

Europe undertakes its space activities through individual MS, ESA, Eumetsat and the EU. European nations, ESA, Eumetsat and the EU are all seeking to advance research and development of various space programmes to preserve, and further strengthen, their global space standing. For over four decades, ESA and its predecessors have engaged in space programmes for science, Earth observation, telecommunications, navigation, human spaceflight and exploration, and launchers. ESA–EU cooperation is based on a 2004 Framework Agreement which coordinates activities of ESA and the European Commission through a Joint Secretariat. The ESA/EU member states also meet at the ministerial level in the Space Council, prepared by the representatives of the Member States, ESA and the EU in the High-level Space Policy Group (HSPG). The High-level Space Policy Group consists of representatives of the 29 ESA and/or EU member states, ESA and the EU but not at the Ministerial level. It seeks to address issues concerning the practical implementation of the European space policy.[6]

With the entry into force of the Lisbon Treaty in December 2009, the EU was granted, for the first time, an explicit competence in the space domain. Its Article 189 formalised the status of space activities and stated that appropriate relations should be established with ESA. The task will now be to clarify how space can best be integrated into broader policy objectives of the EU.

In summary, Europe is now positioned to pursue and invigorate current space efforts for the benefit of mankind and Europe's overall global standing. Space is perceived as an engine and a sound space policy, together with robust international cooperation, can realise the overarching objectives of the EU.

Japan

There are two agencies that have been responsible for Japan's space policy: the Space Activities Commission (SAC) and the Council for Science and Technology Policy (CSTP). The SAC was established in 1968 under the Prime Minister's Office to plan Japan's comprehensive space policy. It produced Japan's national space policy, entitled "Outlines of Space Development Policy", in 1978, 1984, 1989 and 1996. The SAC's last space policy document, "Mid-to-Long Term Strategy for Space Development," was released in December 2000. In January 2001, the SAC was moved from the Prime Minister's Office to the Ministry of Education, Culture, Sports, Science and Technology (MEXT). Subsequently, the SAC's policy scope was limited to JAXA's space development and use. Still the SAC's "Japanese Long-Term Program for Space Activities", endorsed in June 2001, was considered a comprehensive national space policy.[7] The SAC was discontinued in 2012 and a space policy advisory panel of experts was created to support the Cabinet Affairs Office and Cabinet Ministers.

[6] The European Space Policy. Belgian High Representation for Space Policy. <http://www.bhrs.be/eu_en.stm>.
[7] Aoki, Setsuko. "Current Satus and Recent Developments in japan's National Space Law and its Relevance to Pacific Rim Space Law and activities". Journal of Space Law, Vol. 35 (2009): 372-373.

The CSTP, chaired by the Prime Minister, was a product of the 2001 central governmental reform, and given the mandate to create a comprehensive national science and technology strategy. The CSTP's members, a maximum of fourteen officials and experts, are appointed by the PM. The CSTP published in 2002 and 2004 documents entitled a "Basic Strategy of Space" addressing a comprehensive space policy as it related to science and technology to advance national goals. Accordingly, it can be said that the CSTP focuses on more immediate science and technology goals, while the SAC has focused on the long-term plans to advance scientific knowledge and innovative space technology. It is also useful to note that the CSTP is not authorised to request appropriations and does not supervise JAXA.[8]

Organisation of space activities in Japan changed in October 2003, when the Institute of Space and Astronautical Science (ISAS), the National Space Development Agency of Japan (NASDA), and the National Aerospace Laboratory of Japan (NAL), were merged to create the Japan Aerospace Exploration Agency (JAXA). JAXA is Japan's primary space research and development (R&D) organisation. The ISAS, founded in 1964, had managed scientific missions. NASDA, founded in 1969, was in charge of developing rockets and satellites, building the Japanese Experimental Module, and the training of Japanese astronauts. JAXA has a number of research centres across Japan. The ISAS is now a sub-unit devoted to science. The ISAS and NAL had been under the management of the Ministry of Education, while NASDA was under the auspices of the Science and Technology Agency (STA). The Ministry of Education and the STA were merged to form the present Ministry of Science, Culture, Sports, Science and Technology (MEXT) in January 2001.[9] MEXT is in charge of JAXA and controls approximately 60% of Japans total space budget.[10]

Besides MEXT there are three other main ministries involved in space-related research and development: METI, MIC, MLIT. The Ministry of Internal Affairs and Communications (MIC), as well as the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), have been conducting space development and utilisation activities with JAXA. As of April 2009, JAXA has operated under the supervision of MEXT for all its activities and the MIC retains limited control over certain of those activities. The Ministry of Internal Affairs and Communications (MIC), through its National Institute of Information and Communications Technology (NICT) manages the development of space communications, in cooperation with JAXA. The NICT designs, develops and operates Japan's advanced communications satellites. The MIC, together with MEXT, co-supervises JAXA with regard to its telecommunications activities. Besides the above-referenced ministries, there are also others relevant for space activities (see figure 1).

The Ministry of Economy, Trade and Industry (METI) plays a key role in promoting space industrialisation and is also involved in space research and development, mainly through its New Energy and Industrial Technology Development Organisation (NEDO) and its foundation, the Institute for Unmanned Space Experiment Free Flyer (USEF).

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) co-supervised, until August 2006, JAXA. The Meteorological Agency, which is part of the MLIT, used to develop and operate meteorological satellites in cooperation with NASDA/JAXA.

The Strategic Headquarters for Space Policy was established under the Cabinet Office in August 2008 in order to reorganise Japan's space management structure. The Prime Minister serves as the Chairman. The Chief Cabinet Secretary and the Minister of State for Space Policy serve as the Vice Director-Generals (see figure 2). In the spring of 2012, the Secretariat for the Strategic Headquarters for Space Policy was relocated to the Cabinet Affairs Office.

2.2 Space Policies: Latest Developments

Europe's Space Policy

The first European Space Policy (ESP) was formally introduced in April 2007 as a joint Communication from the European Commission to the European Council and Parliament and as a proposal from the ESA Director General to the ESA Council. It was formalised on 22 May 2007 in a Resolution on the European Space Policy adopted at the EU-ESA Fourth Space Council. It is considered an important milestone for Europe as it includes, for the first time, the EU in space policy decision-making. An EC Staff Working paper entitled "Preliminary Elements for a European Space Programme", and prepared in cooperation with the High-Level Space Policy Group, accompanied the ESP and outlined the first strategic guidelines for Europe's future activities in space.

[8] Ibid: 373-374.
[9] Ibid: 375-376.
[10] Kallender-Umezu, Paul. "Guest Blog: With Kan Canned, What's Next for Japan?" Space News 26 Aug. 2011 <http://www.spacenews.com/commentaries/110826-blog-kan-canned-what-next.html>.

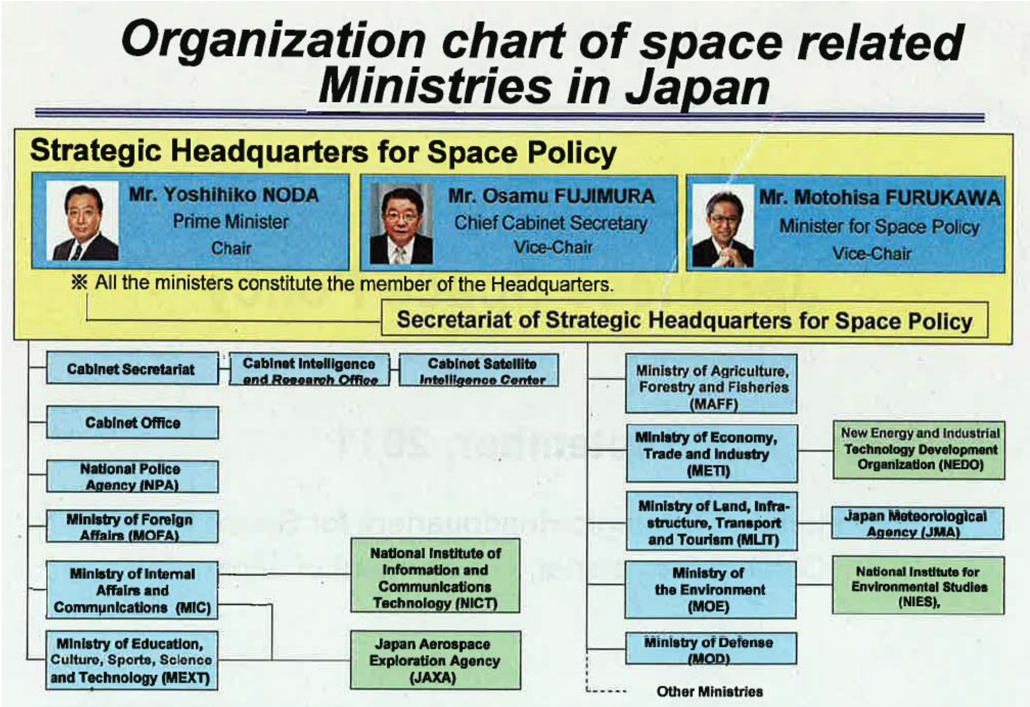

Figure 1: Japan's Space-Related Ministries (as of September 2011). (Source: Strategic Headquarters for Space Policy)

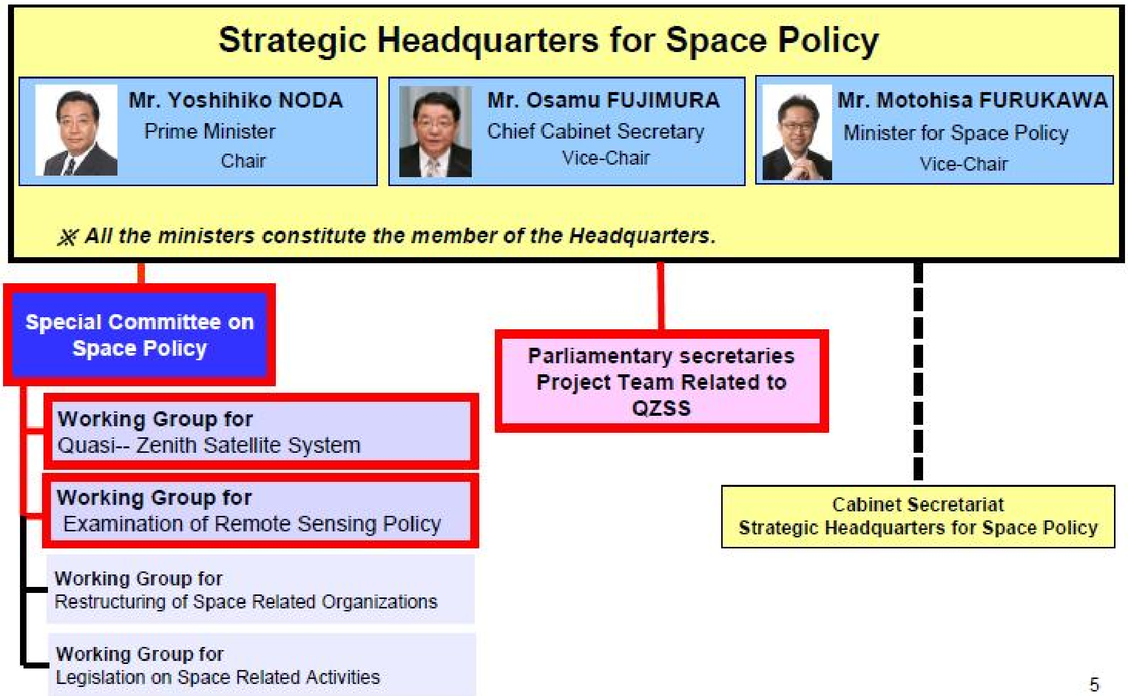

Figure 2: Organisational Chart of the Strategic Headquarters for Space Policy (Source: Strategic Headquarters)[11]

[11] Kunitomo, Hirotoshi. "Update on National Space Policy Development of Japan and Space Security." PPT Presentation at the Europe-Japan Space Workshop. ESPI, Vienna, Austria. 17 January 2012.

The May 2007 Resolution on European Space Policy emphasised, among other items, the contribution of space to CFSP and the EU's Sustainable Development Strategy, as well as Europe's standing as a major space-faring actor. Moreover, a decision was taken (under the Finnish Presidency) that a thematic area, "Space", was to be included in the EU's Seventh Framework Programme (FP7) for Research and Innovation for the period 2007–2013 with a budget of €1.43 billion over 7 years (out of some €50 billion for the entire FP7). Roughly 85% of the budget was earmarked for the GMES programme. The German Presidency followed up with another conference on GMES in 2007 to address the governance and operational funding issues.

With regard to Europe's position as a space-faring power, the ESP emphasises the direct connection between the space capabilities and the EU's ability to exercise influence regionally and globally. It asserts that if the EU wants to be a leading global actor, it has to possess credible space assets, educate top-tier engineers and scientists, and invest in space research and development to build a knowledge society. Moreover, a credible ESP can also advance Europe's objectives in other areas of interest (e.g. environment). Finally, space systems are a strategic asset for any nation, or group of nations, with global ambitions and can contribute substantially to Europe's autonomy and independence.

The ESP under the Lisbon Treaty still awaits a more defined work programme. There exist many space projects, but a clear, integrated and coherent space policy is still in the process of being developed. To accelerate this process, Europe is seeking to generate the proper amount of political will, long-term commitments, and financial, technological and other resources to realise its vision for space.

The current strategic objectives of the European Space Policy were defined by the 7th European Space Council (the first "Lisbon Treaty era" Space Council) of November 2010. The adopted resolution was entitled, "Global challenges: taking full benefits of European space systems". It describes the following elements of a space strategy for Europe: maintaining independent, reliable and cost-effective access to space; contributing to the monitoring of climate change with space systems; utilising space systems for security policies (space for security); development of an SSA capability (security for space); development of a European exploration strategy; and use of space to bolster the partnership with Africa.[12]

The European Commission adopted in April 2011 a Communication entitled "Towards a space strategy for the European Union that benefits its citizens". Three main imperatives driving the current space policy in Europe are: societal (benefits for citizens); economic (knowledge-building and driver for innovation); and strategic (Europe as a global actor). Space infrastructure is seen as critical infrastructure that needs to be protected from space-based threats. To that end, Space Situational Awareness (SSA) capability is seen as critical. This communication is seen as a first step toward an integrated space policy to be developed in conformity with the Lisbon Treaty.

In December 2011, the Council of the European Union adopted a resolution on "Benefits of space for the security of European citizens". The document highlights the role of the GMES as a tool for broader European policies, specifically for agriculture, environment, transport, energy, health, civil protection, humanitarian aid and security, as well as a major European contribution to the global efforts concerning climate change. It also acknowledges the need to enhance security, safety and sustainability in space and the need for effective European Space Situational Awareness (SSA), as well as importance of the draft Code of Conduct for Outer Space Activities. Concerning exploration, it takes into account the discussion of the third Exploration Conference in Lucca (Italy) in November 2011 and invites the European Commission, ESA, MS and international partners to pursue discussions about an exploration strategy beyond 2020.[13]

Japan's Space Policy

Japan enacted a "Basic Law on Space" in May 2008. The Basic Space Law is the first comprehensive national space law that seeks to regulate all space activities, public and private, and establishes the strategic direction for Japan's space programme.[14] The basic

[12] Robinson, Jana. Advancing Europe's Key Foreign Policy Objectives via Space. ESPI Report 30. Vienna: Springer. 2011: 18-19. <http://www.espi.or.at/images/stories/dokumente/studies/ESPI_Report_30_FINAL.pdf>.

[13] "Benefits of space for the security of European citizens." 6 Dec. 2011. Council of the European Resolution,30. Jan. 2011 <http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/intm/126591.pdf>.

[14] Schrogl, Kai-Uwe, Spyros Pagkratis and Blandina Baranes, Eds. "Yearbook on Space Policy 2009/2010: Space for Society". Springer WienNewYork/European Space Policy Institute: 56.

principles of the new law are: peaceful use of space; improvement of citizens' lives; improvement of human security and creation of a safe and secure society; improvement of national security; development of a human society through advanced space science and technology; promotion of international cooperation; enhancement of space diplomacy to advance Japan's national interests internationally; and protection of the outer space environment to achieve sustainable development and use of space.[15]

Measures to be taken to implement the basic principles of the Basic Space Law include: maintaining and improving of the space infrastructure, including satellite networks and autonomous launching capability; promoting space development and use to contribute to national and international security; promoting private space business; developing launching sites and other facilities; promoting rapid technology transfer to private space sectors; encouraging space commercialisation; financial measures to attract investments by private operators; facilitating international cooperation to preserve the space environment; and the development of detailed regulatory measures.[16]

The Basic Space Law also lifted the ban on the use of space technology for national security activities. The law implies that Japan interprets the peaceful use of outer space in accordance with the Outer Space Treaty as "non-aggressive", but within the limits of Article 9 of the 1946 Japanese Constitution. Accordingly, Japan's Self Defence Force (JSDF) can develop, manufacture, own and operate defence-related satellites to support its terrestrial operations, including ballistic missile defence, within the scope of individual self-defence.[17]

After the enactment of the Basic Space Law, the Strategic Headquarters for Space Policy was established at the Cabinet level, with the Prime Minister as Chairman, with a view to making the government space bureaucracy more efficient. The Strategic Headquarters released, in June 2009, the Basic Plan for Space Policy with the overarching goal of seeking to implement a comprehensive strategy for space.[18] It introduces a five-year strategy until 2013 prioritising nine projects: five systems for utilisation (i.e. Land and Ocean Observing Satellite systems to monitor Asia and other regions); environment monitoring and weather forecasts by meteorological satellites; advanced satellite telecommunications; navigation by the global positioning system; and national security satellite system; and four research programmes (i.e. the space science programme; the human space activity programme; the space solar power programme; and the small demonstration satellite programme).[19]

The Basic Plan represents a shift from research to civilian and military applications, including the development of high-resolution reconnaissance satellites and further research on sensors for a ballistic missile early warning satellite. The Japanese government likewise announced a determination to promote more private-sector space development by increasing spending for commercially-oriented programmes, as well as crafting a law to permit commercial launch services.[20]

The Basic Plan for Space Policy serves as Japan's fundamental space policy document for implementation of the Basic Space Law and provides a comprehensive roadmap for space activities. At the same time, the Japanese government continues administrative reorganisation of space activities with the above mentioned aim to consolidate authority under the Japanese Cabinet Office. Among other items, the new Basic Space Law stated the requirement to form a new space agency. Due to political reasons, the configuration of such an agency has not, as yet, been determined.

With regard to JAXA, the new Japanese space law potentially gives JAXA a bigger role in national security space activities. However, the legislation governing JAXA activities has not been modified and mainly focuses on civil space. Accordingly, JAXA continues to be guided by its March 2005 Vision 2025 plan that envisions JAXA to achieve world-class status in aeronautics and space science, security, infrastructure and industry.

Japan is active in a number of international space fora, including the UNCOPUOS; Committee on Earth Observation Satellites (CEOS); the Group on Earth Observation (GEO); or the International Charter "Space and Major Disasters". In Asia, the most important cooperation platform for Japan is the Asia-Pacific Regional Space Agency Forum

[15] Aoki, Setsuko. "Current Status and Recent Developments in Japan's National Space Law and its Relevance to Pacific Rim Space Law and activities". Journal of Space Law, Vol. 35 (2009): 386.
[16] Ibid: 388-389.
[17] Ibid: 387.
[18] "Wisdom of Japan Moves Space" June 2009. Secretariat of Strategic Headquarters for Space Policy, Tokyo 10 Oct. 2011 <http://www.kantei.go.jp/jp/singi/utyuu/keikaku/pamph_en.pdf>.
[19] "Basic Plan for Space Policy". Secretariat of Strategic Headquarters for Space Policy, Tokyo (June 2009): 3.
[20] "Non-European Space Expenditures: Japan". European Space Directory 2011, 26th Edition, ESD Partners: Paris (2011): 106.

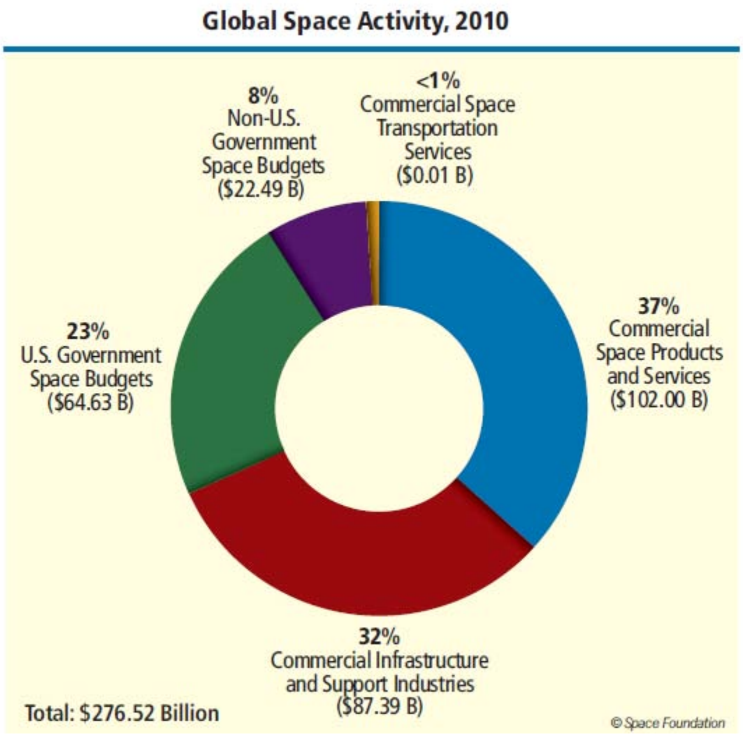

Figure 3: Global space economy in 2010 (Source: the Space Report 2011)

(APRSAF), established in 1993. In 2005, the annual APRSAF meeting established a voluntary initiative called Disaster Management Support System (DMSS), for the Asia-Pacific region. Its pilot project is called Sentinel Asia, followed by an Earth observation and communications system and, eventually, a comprehensive DMSS using regional satellites. Japan's contribution has been its remote sensing satellite ALOS-1 (Daichi) and the Wideband InterNetworking engineering test and Demonstration Satellite (WINDS, or Kizuna).

2.3 Space Budgets

Global Overview

Governments play a central role in space activities, as they fund a large portion of the research and development, are the largest purchasers of space products and services, and regulate private sector activities. A number of challenges exist in the space business, including the high cost of access to space, long development cycles, and high fixed costs in the upstream sector (i.e. launch services, satellite manufacturing, ground equipment and insurance), and the dual-use nature of many space technologies. The downstream sector (i.e. user end of the space market) produces the highest revenue share in the space economy. Satellite communications services are comprised of three applications: Direct Broadcasting Services (DBS), Fixed satellite Services (FSS) and Mobile Satellite Services (MSS). Remote sensing services offer three different products: Very high Resolution (VHR) optical imagery; Medium Resolution (MR) optical imagery; and Synthetic Aperture Radar (SAR) imagery. Navigation and positioning services are the third downstream market.[21]

In 2010, the global space economy grew by 7.7% and totalled $276.52 billion. Government spending accounted for $87.12 billion (32% of the global space economy). The U.S. government's spending amounted to $64.63 billion (74% of global government spending) and non-U.S. $22.49 billion. Commercial telecommunications, Earth observation and positioning products and services constituted the largest portion of expenditure amounting to $102 billion (a 9% increase from 2009). Commercial infrastructure and support industries amounted to $87.39 billion (a 13% increase from 2009). Commercial space transportation services totalled approximately $10 million (see figure 3).[22]

Although it is difficult to make precise calculations concerning the military space budgets,

[21] Venet, Christophe. "The Economic Dimension" in "Outer Space in Society, Politics and Law", Christian Brunner and Alexandr Soucek, eds., Studies in Space Policy, Vol. 8, SpringerWienNewYork (2011): 61-69.
[22] „The Space Report 2011". Space Foundation (2011): 32, 42.

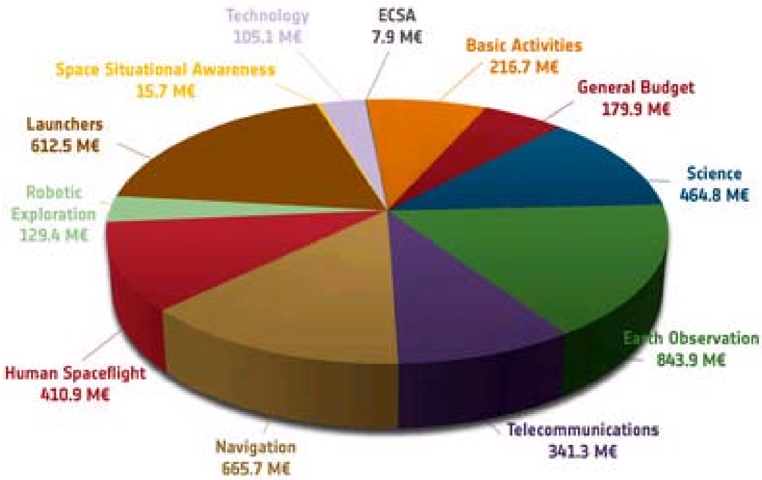

Figure 4: ESA 2011 Budget by Programme (Source: ESA)[23]

due to national security and dual-use nature of many space programmes, it is estimated that global military space spending amounted to $46 billion in 2010 with the U.S. accounting for approximately 95% of this total (i.e. $43.7 billion). The annual value of European military programmes, as indicated by European industry figures (with the exception of dual-use programmes), was $1.6 billion (€1billion) in 2008. [24]

Europe's Space Budgets

Government space activities in Europe are funded by ESA, the EU and individual European countries. ESA receives payments from its member states, the European Commission (EC) for their programmes managed by ESA (i.e. Galileo and GMES), and other organisations (e.g. Eumetsat) and so-called European Cooperating States. ESA's 2010 budget was about €3.7 billion. In 2011, fourteen of the ESA's then-18 member nations agreed to raise their contributions and the ESA's budget increased to approximately €3.99 billion, a 6.7% increase from 2010 (see figure 4). The 2012 budget is set at €4.02 billion (see figure 5 and 6).

The three largest funding targets are Earth observation (21% of the total 2011 budget), navigation (16.7% of the total 2011 budget), and launchers (15.3% of the total 2011 budget). From the member states, France and Germany are ESA's largest contributors. The EC's 2011 payment to ESA was about €778 million for 2011. The EU's budget for space averages about €750 million annually (€5.2 billion for the period 2007–2013).[25] The largest national civilian space budgets in 2011 include those of France with €720 million; Germany with €460 million; Italy with €400 million; and Spain €300 million.[26]

The EU activities are implemented by the EC. The EC's 2010 budget for space-related programmes was €1.33 billion, representing 0.9% of the EU's overall €141.5 billion budget for 2010. The budget includes the following areas: space research with a 2010 budget of €212.85 million; security research with an allocation of €215.05 million; and European satellite navigation programmes with a budget of €894.04 million. The 2010 combined appropriation of the first two areas increased by approximately 70% over the 2009 total.[27]

The area of space research supports the development of European space applications, including the Global Monitoring for Environment and Security (GMES) programme. The category of security research supports the development of space-related technology for civil safety and security applications (e.g. man-made and natural disasters, border control, crisis management, etc.). The category of satellite navigation funds the European Geostationary Navigation Overlay Service (EGNOS), non-autonomous infrastructure that improves GPS performance for European countries, and the deployment of the Galileo system, the planned fully autonomous infrastructure with global coverage.[28]

[23] "Funding: ESA Budget by Programme". ESA (2011). http://www.esa.int/esaMI/About_ESA/SEMNQ4FVL2F_1.html

[24] Ibid: 55.

[25] European Parliament. European Parliament resolution on Space and security. 2008/2030(INI) of 10 July 2008. Brussels: European Union. <http://www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=P6-TA-2008-0365&language=EN>

[26] Source: European Space Directory 2011. ESD Partners (Paris: 2011): 36-74.

[27] Ibid.

[28] Ibid.

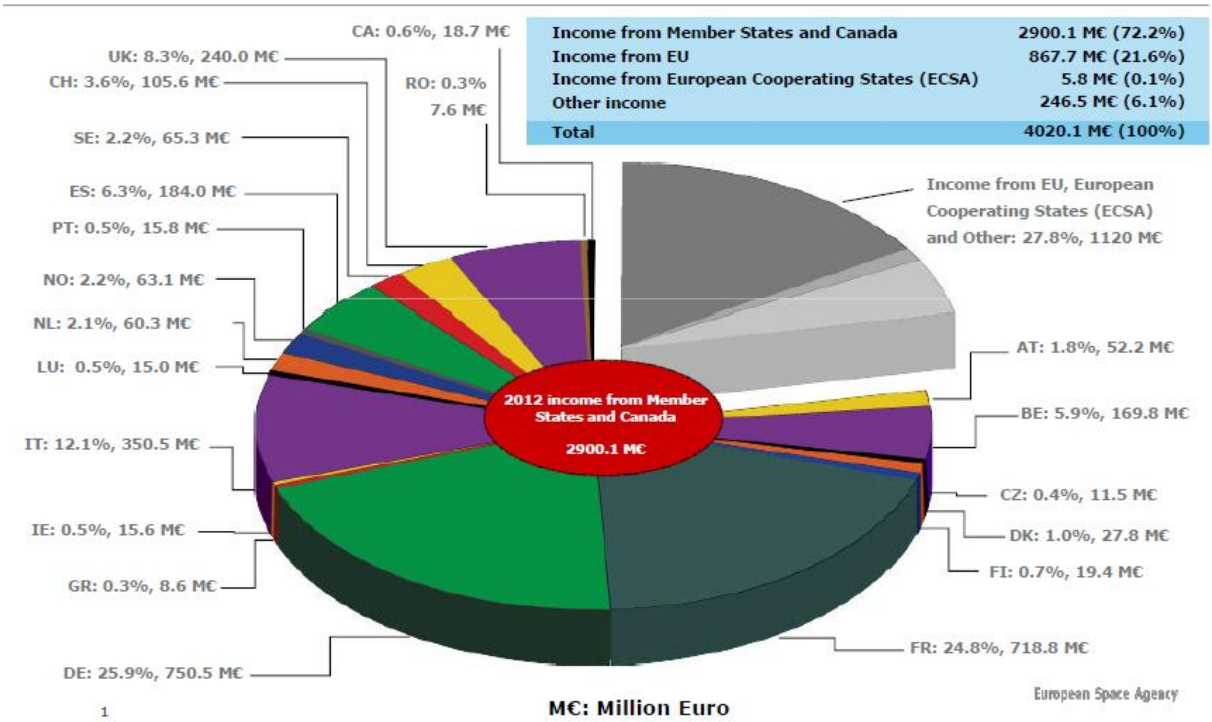

Figure 5: ESA's 2012 Budget (Source: ESA)

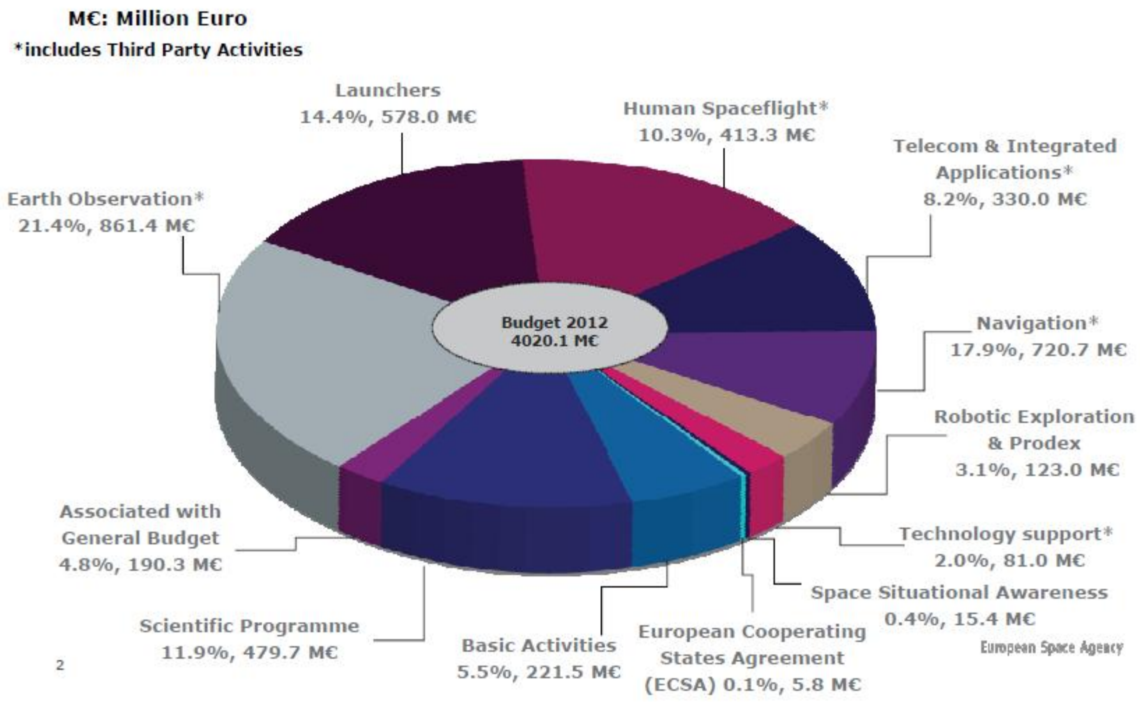

Figure 6: ESA 2012 Budget per Programme (Source: ESA)

Funding of EU space programmes has been a challenging political issue for some time, now exacerbated by the current financial crisis. Moreover, there are no specific indications in the Lisbon Treaty concerning industrial policy for space system-related contracts in Europe. ESA operates under the geographical return model and the EU is based on open "competitive dialogue". Accordingly, a vision for the funding of a sustainable long-term space programme remains in the process of being configured. The stable continuation of EGNOS/Galileo and the GMES programmes as operational systems beyond 2013 is closely connected with the establishment of the Multiannual Financial Framework (MFF) for the period 2014–2020, from which GMES is currently excluded.

Japan's Space Budget

Japan's FY 2010 national space budget was €3 billion (¥339 billion), a decrease of some 1.7% from the previous year's €3.05 billion (¥345 billion). The budget is distributed among several government ministries (see table 1) under the oversight of the Cabinet-level Strategic Headquarters for Space Policy.

JAXA, funded through the Ministry of Education, Culture, Sports, Science and Technology (MEXT), had a budget of €1.6 billion (¥180 billion), 53% of Japan's overall space spending. JAXA's request for a budget increase of €1.68 billion (¥190 billion) for the fiscal year 2011 was not successful as a government cost-cutting panel urged MEXT to keep the budget unchanged.[29]

Japanese Space Spending by Agency, 2010

Budget Information by Agency	FY 2010/2011 (Yen)	FY 2010/2011 (U.S. Dollars)	Percent of Total
Ministry of Education, Culture, Sports, Science and Technology	¥185.373 B	$2,094.31 M	54.69%
Japan Aerospace Exploration Agency	¥180.000 B	$2,033.61 M	53.10%
Cabinet Secretariat	¥63.638 B	$718.97 M	18.77%
Ministry of Defense	¥60.933 B	$688.41 M	17.98%
Ministry of Land, Infrastructure, Transport, and Tourism	¥10.954 B	$123.76 M	3.23%
Ministry of Economy, Trade, and Industry	¥9.130 B	$103.15 M	2.69%
Ministry of Internal Affairs and Communication	¥4.372 B	$49.39 M	1.29%
Ministry of the Environment	¥1.682 B	$19.00 M	0.50%
Ministry of Agriculture, Forestry, and Fisheries	¥1.110 B	$12.54 M	0.33%
Cabinet Office	¥0.801 B	$9.05 M	0.24%
National Police Agency	¥0.782 B	$8.83 M	0.23%
Ministry of Foreign Affairs	¥0.190 B	$2.15 M	0.06%
Total	**¥338.965 B**	**$ 3,829.56 M**	**100.00%**

Table 1: Japan's 2010 Space Spending (Source: the Space Report 2011)[30]

The main civilian space activities funded in 2010 included the Daichi Earth observation satellite, a Quasi-Zenith GPS augmentation system satellite, and the new Advanced Solid Rocket for launching small payloads. Defence-related expenditures included funding for Space Situational Awareness (SSA) development, a dedicated military telecommunications satellite, research on infrared missile warning sensor technology and microsatellites.[31]

In 2009, only six countries worldwide spent more than $1 billion on space (i.e. the U.S., China, Japan, France, Russia and Germany.[32] In 2010, governments spent approximately $87.12 billion on their space programmes, a third of the total global space economy (see table 2). The U.S. dominates the field by a wide margin in terms of total institutional space budgets of individual countries (i.e. 74% of global government space spending).[33]

[29] "Non-European Space Expenditures: Japan". European Space Directory 2011, 26th Edition, ESD Partners: Paris (2011): 106.
[30] "The Space Report 2011". Space Foundation, Colorado Springs (2011): 52.
[31] Schrogl, Kai-Uwe, Spyros Pagkratis and Blandina Baranes, Eds. "Yearbook on Space Policy 2009/2010: Space for Society". Springer WienNewYork/European Space Policy Institute: 57.

[32] Venet, Christophe. "The Economic Dimension" in "Outer Space in Society, Politics and Law", Christian Brunner and Alexandr Soucek, eds., Studies in Space Policy, Vol. 8, SpringerWienNewYork (2011): 63.
[33] "The Space Report 2011". Space Foundation (2011): 42, 43 and 54.

Government Space Budgets, 2010

Country/Agency	Budget (U.S. Dollars)	Source	Description
United States	$64.63 B	DOD, NRO, NGA, NASA, NOAA, DOE, FAA, NSF, FCC, USGS	Fiscal Year 2010 Request/Authorization
European Space Agency	$4.60 B	European Space Agency	Calendar Year 2010 Appropriation
European Union	$1.63 B	European Commission	Calendar Year 2010 Appropriation
Brazil	$0.18 B	Government of Brazil	Calendar Year 2011 Authorization
Canada*	$0.29 B	Government of Canada	Fiscal Year 2010/2011 Appropriation
China	$2.24 B	Futron estimate	Calendar Year 2010 Estimated Spending
France*	$0.92 B	*Space News*	Calendar Year 2010 Appropriation
Germany*	$0.64 B	Government of Germany	Calendar Year 2010 Appropriation
India	$1.25 B	Government of India	Fiscal Year 2010/2011 Allocation
Israel	$0.01 B	Futron	Calendar Year 2010 Estimated Spending
Italy*	$0.44 B	Government of Italy	Calendar Year 2010 Planned Spending
Japan	$3.83 B	Society of Japanese Aerospace Companies	Fiscal Year 2010/2011 Appropriation
Russia	$3.04 B	GlobalSecurity.org estimate	Calendar Year 2010 Planned Spending
South Korea	$0.21 B	Government of South Korea	Calendar Year 2010 Planned Spending
Spain*	$0.05 B	Government of Spain	Calendar Year 2010 Appropriation
United Kingdom*	$0.10 B	United Kingdom Space Agency	Fiscal Year 2009/2010 Appropriation
Emerging Countries	$0.74 B	i.e. Argentina, Australia, Chile, Indonesia, Malaysia, Mexico, Nigeria, Pakistan, South Africa, Taiwan, Thailand and Turkey	
Non-U.S. Military Space	$2.30 B	Futron	Futron estimate
Total	**$87.12 B**		

**Excludes ESA spending*

Table 2: Government space budgets in 2010 (Source: the Space Report 2011)

3. Europe–Japan Space Cooperation in Select Areas

This section of the report will seek to examine in some detail four select areas of space activities and how these areas could enhance Europe–Japan cooperation. These include: access to space and space exploration; Earth observation and related applications; industry-to-industry cooperation; and space security. It will review, in specific terms, Europe's and Japan's priority space activities in these areas, including the nature of the cooperative missions already undertaken and seek to understand better the main factors that can lead to successful collaboration.

3.1 Access to Space and Space Exploration

A prerequisite for space exploration are reliable launch systems. Launch-related activities include production of operational launch systems and launcher development. These include systems that are primarily relevant to the operations of the International Space Station (ISS) such as Europe's ATV and Japan's HTV. There are a variety of capable government launch systems from the U.S., Russia, Europe, Japan, China and India.[34] Of these countries, only Russia and China can presently transport humans to space. Besides the development of launchers by governments, privately developed space transportation systems (both unmanned and manned) are expected to become operational in coming years, contingent on sustained public and private funding for these ventures. The company Space X of the US, for example, is developing a launch vehicle called Falcon 9 and a reusable space capsule, Dragon. The company conducted the first flight of Falcon 9 in June 2010 and the first test flight of the Dragon spacecraft (attached to Falcon 9) in December 2010.

All major spacefaring nations, including Europe and Japan, have a strong interest in possessing indigenous launch capabilities and support their launcher industry. Russian, Chinese and Indian launchers also benefit from low-wage labour. Given continued government support and emergence of commercially-developed rockets, Europe and Japan will likely face increased competition in the launch market.

With regard to ISS-related human transportation, Russia's Soyuz capsules are the only means for astronauts to access the ISS for the foreseeable future. Concerning cargo, after the retirement of the U.S. space shuttle, international ISS partners have configured other means to deliver cargo to the space station with a range of smaller cargo-hauling vehicles from Europe, Japan and Russia. Beyond Europe's Automated Transfer Vehicle (ATV), Japan's H-2 Transfer Vehicle (HTV) and Russia's Progress cargo hauler, NASA supports the development of privately built cargo vehicles, including the Space X Dragon capsule and the Cygnus cargo module developed by Orbital Sciences. There have also been proposals to adopt a common transportation policy to advance space exploration. Under current financial constraints, it remains to be seen whether these countries would be open to such a proposal.[35]

Space exploration involves activities, manned and unmanned, that investigate the Universe in order to enhance human knowledge about the areas beyond Earth's atmosphere and employ this knowledge to advance humanity. Space exploration had captured peoples' imagination well before development of the first rockets that could enter space. Since 1957, satellites and robotic spacecraft have been gathering valuable information about our Sun and solar system, as well as the more distant Universe.

3.1.1 Launchers

The launching business is fiercely competitive. Globally, institutional demand is larger than that for commercial launches with the strongest demand coming from the U.S., Russia and China.[36]

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[34] Koudelka, Otto. "The Technical Dimension of Space" in Outer Space in Society, Politics and Law, Christian Brunner and Alexander Soucek, eds. ESPI Studies in Space Policy, Vol 8, Vienna: SpringerWienNewYork (2011): 53.

[35] Svitak, Amy. "Cooperative Kerfuffle: Europe Seeking Common Policy to Harmonize International Space Exploration Activities". Aviation Week&Space Technology (27 June 2011): 41.

[36] Veclani, Anna, Sartori, Nicolò and Rosanelli, Rosa. "The Challenges for European Policy on Access to Space." 22 Jul 2011. IAI Working Papers 1122. 7 Mar 2012 <http://www.iai.it/pdf/DocIAI/iaiwp1122.pdf>.

Suppliers compete to offer the best price, reliability and availability of service, as well as technology-related security. Beyond price considerations, reliability of the mission is a top priority. Availability and minimum delays are likewise important. In this connection, the ability to launch on short notice is increasingly important, especially for military customers. Successful integration of the payload with the launcher, and technology-related security is also essential.

With regard to the commercial market, the U.S. and Europe constructed robust commercial launch industries in the 1980s stimulated by the growth of the commercial communications satellite industry. The Soviet Union entered the commercial market in 1983. Europe, especially France, grasped the opportunity and established the Arianespace Corporation, a public-private corporation, to market Ariane launches to commercial customers. In the U.S., the government offered to transfer ownership of existing launchers (e.g. Delta, Atlas and Titan) to the private sector for commercial use and, at the same time, marketed the space shuttle (after its first four flights) as a commercial launcher.

After the 1986 Challenger accident, however, the space shuttle was prohibited from launching commercial payloads and the Delta, Atlas and Titan manufacturers, in competition with Arianespace, marketed the launchers to commercial customers (The Titan attracted an insufficient volume of commercial customers).

In the 1990s, various multinational commercial launch services emerged, including the International Launch Services (ILS), a U.S. company founded in 1995 by Lockheed Martin to market Proton and Atlas launch services for commercial and civil satellite programs (which since 2006 has sold only Proton launches and in 2008 became a subsidiary of Khrunichev); Starsem, a European-Russian entity established in 1996 by Astrium, Arianespace, the Samara Space Center (TsSKB Progress) and the Russian Federal Space Agency to market the Soyuz commercial launch services; and Sea Launch, founded in April 1995 as a consortium of four companies from Norway, Russia, Ukraine and the U.S. (i.e. Aker Solutions, RSC-Energia, SDO Yuzhnoye/PO Yuzhmash, and Boeing Commercial Space). The company declared bankruptcy in 2009, but returned to business after it emerged from Chapter 11 in October 2010.[37]

Other commercial launch companies began operations between 2000 and 2010, including the United Launch Alliance (ULA), Orbital and Space X in the U.S. The ULA, a joint venture established in 2006 by Lockheed Martin and Boeing, dominates the U.S. institutional market. It launches, on Delta II, Delta IV and Atlas V, the U.S. government's heavy- and medium-weight launches. Accordingly, the company does no longer compete for commercial launches (although it launched nine commercial missions in its five-year existence).[38] Yet Boeing retains the right to market Delta IV commercially, as does Lockheed Martin for Atlas V.

China entered the commercial launch market in 1985 and India conducted its first commercial launch in 2007. Japan's H-2 launcher was considerably more expensive than counterpart vehicles, impeding Japan's competitiveness. Japan was eventually able to enter the commercial market with its more successful and less expensive H-2A launcher in 2008.[39] Chinese entities now compete with Europe's Ariane 5 and America's Atlas V and Delta IV. The ability of India, Brazil and South Korea to penetrate the commercial market is currently limited.

Unduly optimistic projections regarding the growth of the telecommunications satellite industry resulted in an oversupply of launch services in the 1990s. Some 23 commercial launches worldwide in 1997 declined to 12 launches in 2003, despite launch capacity of almost 60. Demand today still lags behind supply.[40]

In 2010, 118 payloads were carried to space on 74 orbital launches (51 non-commercial launches and 23 commercial launches), representing a 5% decrease from 2009 (see figure 7). It is estimated that total launch expenditures totalled some $7.35 billion (with launches to ISS amounting to some $1.98 billion). Russia, with 13 commercial launches (57% of launches) remained the leader of the global commercial launch market, followed by Europe with six Ariane 5 launches (26% of the global commercial market) and the U.S.

[37] Logsdon, John. "Commercial Launch Industry". Encyclopedia Britannica online <http://www.britannica.com/EBchecked/topic/332323/launch-vehicle/272750/Commercial-launch-industry>.

[38] "United Launch Alliance Marks Five Years of Mission Success with 56 Launches in 60 Months". Space-travel.com 8 Dec. 2011 <http://www.space-travel.com/reports/United_Launch_Alliance_Marks_Five_Years_of_Mission_Success_With_56_Launches_in_60_Months_999.htm>.

[39] Logsdon, John. "Commercial Launch Industry". Encyclopedia Britannica online <http://www.britannica.com/EBchecked/topic/332323/launch-vehicle/272750/Commercial-launch-industry>.

[40] Logsdon, John. "Commercial Launch Industry". Encyclopedia Britannica online <http://www.britannica.com/EBchecked/topic/332323/launch-vehicle/272750/Commercial-launch-industry>.

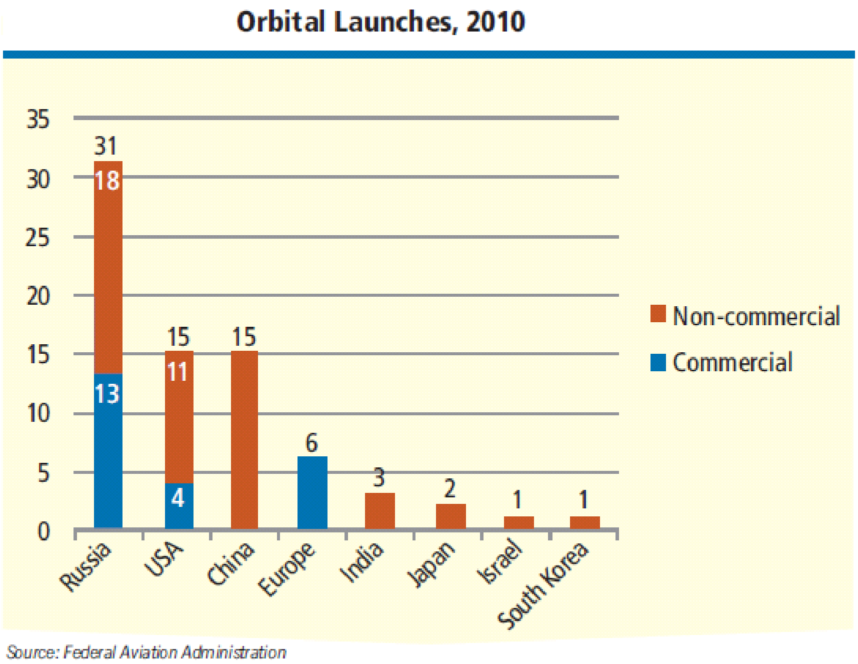

Figure 7: Orbital launches in 2010 (Source: the Space Report 2011)

with 4 launches (17% of the global commercial market).

In the commercial launcher sector, European launch provider Arianespace is the largest actor in the field with revenues of more than $ 1 billion (42% of the total launch revenues) and won more than 50% of the commercial launch contracts worldwide over the past two years. Arianespace's CEO Jean-Yves Le Gall announced at the beginning of 2012 that the company's backlog stands at a record €4.5 billion ($5.9 billion) for Ariane 5 and the Soyuz vehicle. It includes €2.5 billion in orders for commercial launches aboard the Ariane 5, €1 billion for government launches aboard the Ariane 5, and €1 billion in back orders for Soyuz launches.[41]

Status of Europe's Launchers

The development of launchers in Europe originated with the creation of intergovernmental entities, the European Launcher Development Organization (ELDO) in 1962 and the European Space Research Organisation (ESRO) in 1964. After the merger of ELDO and ESRO into a newly-established European Space Agency (ESA) in 1975, the Ariane launcher was developed with an inaugural launch in 1979. Arianespace (a French company) was then established to manage and commercialise the launcher. The Ariane launcher family, with five different rockets, Ariane 1–5, has been for more than thirty years the symbol of Europe's autonomy for a variety of institutional and commercial missions, for both civilian and military purposes (see figure 8).[42]

The Ariane-5 rocket now competes in the global market. As referenced above, in 2008 and 2009, for example, Arianespace, won more than 50% of the commercial launch contracts worldwide.[43] Arianespace also markets the Russian-built Soyuz rocket launched from Europe's spaceport in French Guiana, as well as the smaller Vega launcher.

Ariane 5, a heavy-lift launcher operating since 1999, has two configurations, one for launches to geostationary transfer orbit (GTO) with the launch capacity of 10 tons and another for launches to low-Earth orbit (LEO) with the launch capacity of 20 tons. The latter configuration is used for the launch of the Automated Transfer Vehicle (ATV) cargo spacecraft to the ISS. Ariane 5 is capable of providing a single launch or a double-launch (i.e. two satellites launched simultaneously).[44]

[41] Selding, Peter B. de. "Arianespace Expects to Post 2011 Profit". Paris: Space News 5 Jan. 2012 <http://www.spacenews.com/launch/120105-arianespace-expects-profit.html>.

[42] Veclani, Anna, Nicolo Sartori, and Rosa Rosanelli. "The Challenges for European Policy on Access to Space". IAI Working Papers 11/22, Instituto Affari Internazionali (July 2011): 4. <http://www.iai.it/pdf/DocIAI/iaiwp1122.pdf>.
[43] Schrogl, Kai-Uwe, Pagkratis, Spyros, and Blandina Baranes. "Yearbook on Space Policy 2009/2010: Space for Society". SpringerWienNewYork, European Space Policy Institute (2011): 90.
[44] Veclani, Anna, Nicolo Sartori, and Rosa Rosanelli. "The Challenges for European Policy on Access to Space". IAI Working Papers 11/22, Instituto Affari Internazionali (July 2011): 4. <http://www.iai.it/pdf/DocIAI/iaiwp1122.pdf>.

Additionally, a decade ago the European Space Agency (ESA) began the diversification of launchers through the development of the Vega small launcher and the adaptation of the Russian Soyuz launchers to ESA's launch site in Kourou, French Guyana. These activities took place under the auspices of the ESA-Russia agreement of 2005.[45] The Vega programme is an optional new small launcher programme of ESA that began in 1998, initiated by Italy. It is designed to place 300–2500 kg satellites in LEO orbits. Vega's maiden flight took place in February 2012 from ESA's French Guyana spaceport. What separates Vega from most other small launchers is that it will be able to handle a range of payloads, from a single satellite to one main satellite plus six microsatellites. It will have strong competitors in Orbital Sciences' Pegasus, the Minotaur series, and the Russian Kosmos 3M).

In 1996, Europe and Russia founded the Starsem company to market commercial launches with the Russian Soyuz, a medium launcher. The launches were originally conducted from the Baikonur Cosmodrome in Kazakhstan and later Soyuz launch facilities were constructed at the Guyana Space Centre. The European version of the Russian launcher Soyuz was adapted to launch satellites up to 3.2 tons into medium-Earth orbit (MEO) and LEO, including a constellation of two or more satellites. Soyuz-ST was launched for the first time in October 2011 from the Guiana Space Centre.

The European Space Agency (ESA) manages the development and production of the Ariane and Vega launchers. Arianespace is responsible for operating the launchers and their commercialisation. The European space industry is concentrated in a relatively small number of companies, including in the launcher sector, where EADS Astrium Space Transportation is the prime contractor for Ariane. Safran leads development of the propulsion system. There are approximately 40 other European suppliers, 25 of which are highly dependent on Ariane business.[46] In the case of Soyuz, the Russian Federal Space Agency is responsible for operating the launchers and for Vega it is the Italian company, European Launch Vehicle (ELV)[47]. EADS-Astrium and ELV are among the shareholders of Arianespace.

Europe is presently debating a successor for the Ariane 5, known as the Next-Generation Launcher (NGL). The issue to be resolved is whether to build another heavy-lift launcher for double launches or a medium-lift launcher for single launches. The decision on the type and funding of the NGL is to be made at the next ESA Ministerial Council in 2012. Meanwhile, Europe is developing the Ariane 5 Mid-life Evolution (ME) featuring a new, re-ignitable upper stage that would increase the payload-carrying capacity by about 20%. This would enable the launch of two extra tons to geostationary orbit, the destination of most telecommunications satellites. The GEO market is crucial for the current Ariane 5 to maintain financial stability. The Ariane 5 ME programme received initial funding in 2008 and it is envisioned that the cost will not exceed that of today's Ariane 5 ECA, the latest version of the Ariane 5 launcher. The cost of the first qualification flight of the ECA version was €185 million (2003 e.c.), involving launch vehicle manufacturing (€130 million) and operations and other costs (€55 million).[48] The first launch is currently planned for 2016-2017 provided that funding is secured at the 2012 ESA Ministerial Council.

Figure 8: Ariane launchers (Source: ESA)

Like other countries, Europe faces challenges concerning its future independent access to space, including the need for launcher modernisation and the ability to compete with traditional, as well as emerging, rivals in the sector. Germany is, together with France, the largest investor in Europe's launchers. Germany currently favours funding an upgrade of the Ariane 5 ME programme over work on its successor rocket as it also wishes to ensure that it will receive the maximum value for its investment in the ISS, in which it holds a 38% share.[49] France, on the other hand, is

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45 Morring, Frank. "Aligning the Axis: France, Germany agree on ESA launcher and ISS strategy as both unveil ambitious agendas". Aviation Week and Space Technology, Vol. 173, No. 5 (7 February 2011): 35.

46 Hayward, Keith. "The Structure and Dynamics of the European Space Industry Base". ESPI Perspectives 55. Vienna: European Space Policy Institute (December 2011): 3.

47 The company is owned 30% by the Italian space agency ASI and 70% by Avio.

48 "Access to space today and tomorrow: what does Europe need?" 16 May 2003. European Space Agency. 8 Mar. 2012 <http://www.esa.int/esaCP/SEMHQYR1VED_index_0.html>.

49 de Selding, Peter B. "DLR Chief Sees Battles Ahead on Station, Ariane". Space News 14 December 2011

pushing for the next-generation rocket envisioned to be operational by 2025.[50]

With regard to ISS-related transportation, ESA developed a highly capable expendable, unmanned resupply spacecraft called the Automated Transfer Vehicle (ATV). It is designed to deliver propellant, water, air, payload and experiments to the ISS. Two ATV vehicles, "Jules Vernes" and "Johannes Kepler", have successfully flown to the Space Station (see figure 9). ESA's second Automated Transfer Vehicle (ATV) was launched from Kourou, French Guiana, to the ISS in February 2011. The ATV-2 was a vital part of the Station's post-shuttle era supply chain, together with Japan's H-2 Transfer Vehicle (HTV) and Russia's Progress. The third ATV, named "Edoardo Amaldi", is to be launched to the ISS in the first half of 2012.[51] Two more ATVs are expected to be flown by 2015. As Europe is currently not contemplating its own manned spaceflight capability, it is looking for best ways of capitalising on their investment in the ATV.

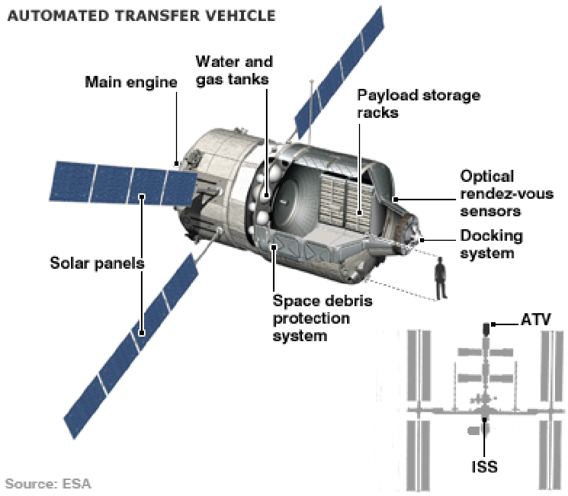


Figure 9: Automated Transfer Vehicle (Source: ESA)

With regard to reusable launch vehicle development (RLV), the French space agency CNES proposed a Hermes spaceplane for the first time in 1975. In 1985, France offered to develop Hermes under the auspices of ESA as part of a manned space flight programme (to be launched on Ariane 5). Although the project was approved in 1987 and the pre-development phase took place in 1988-1990, the project was cancelled in 1992 due to the funding issues. ESA established in the spring of 2000 a working group on RLV development due to the "fragmented" nature of previous European efforts in this area. The group proposed a "Program for European Advanced Reusable Launchers" (Pearl) to coordinate the various efforts into a joint programme.[52]

Status of Japan's Launchers

The Japanese launcher program was originally closely linked with that of the U.S. which provided Japan, based on a 1969 Exchange of Notes between the two countries, access to U.S. technology in exchange for control over its use. Accordingly, Japan's launch vehicles N-1 (1975-1982), N-2 (1981-1987), and H-1 (1986-1992) were developed through licenses of American technology and served as Japan's primary platforms until the mid-1980s. A decision was made to develop the next generation vehicle, the H-2, indigenously with an ability to bring a two-ton payload to a geostationary orbit. Accordingly, whereas the H-1 was a license-built version of the U.S. Delta rocket, the H-2, H-2A, and H-2B are entirely Japanese in design and construction.[53]

The first solely Japanese rocket, the H-2, was successfully launched in 1994. It turned out to be costly and experienced a high failure rate when launched during the 1990s.[54] Due to these technical issues, the H-2 was abandoned in 1999 for the development of a much more capable version, the H-2A, launched for the first time in 2001. The H-2A serves as Japan's current launch vehicle. The rocket can carry up to four tons to geosynchronous orbit. Although the core vehicle is similar to the H-2, the H-2A uses new boosters (solid and liquid) to improve payload performance. In 2007, H-2A rockets were transferred from JAXA to Mitsubishi Heavy Industries (MHI) which successfully conducted its first commercial launch of a private communications satellite, Superbird-7, in August 2008. In January 2009, MHI concluded a contract for the commercial launch of a Korean satellite, the Kompsat-3. Although the production and management of the H-2A rocket has been privatised, the government is active in the development and use of the new launcher, the H-2B (see figure 10).

<http://www.spacenews.com/civil/111214-dlr-chief-battles-iss-ariane.html>.

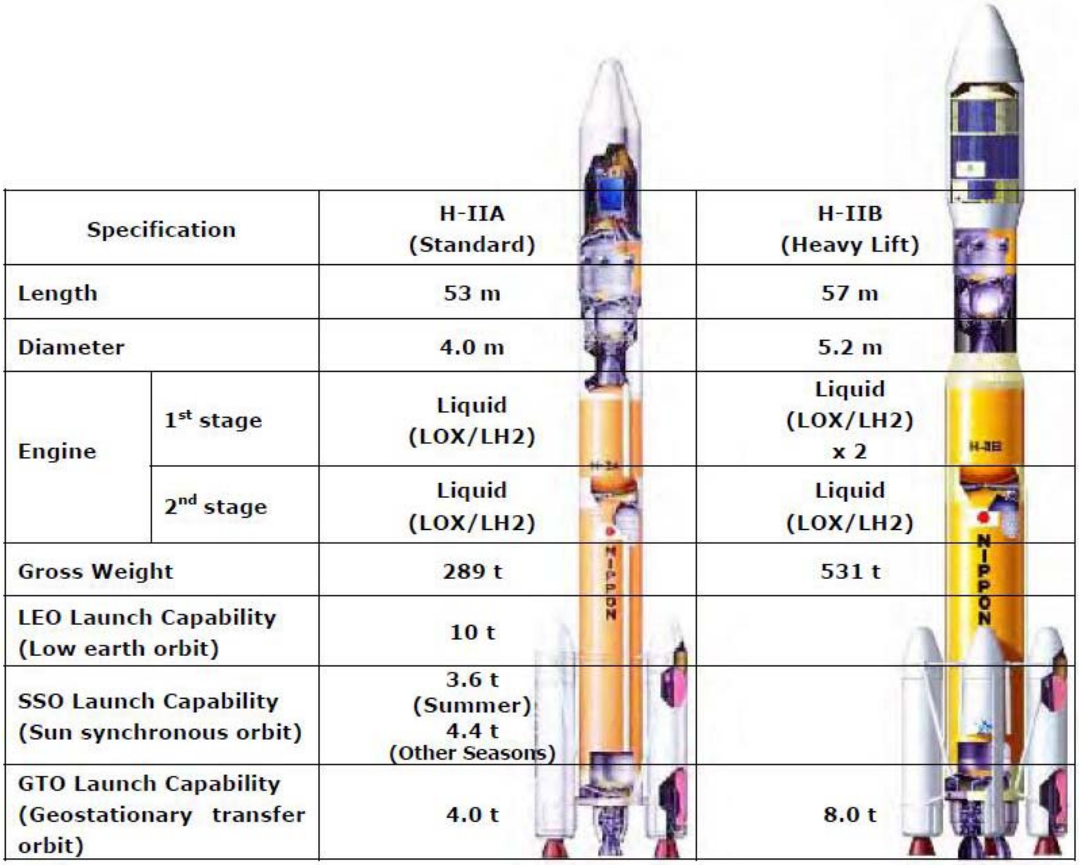
[50] de Selding, Peter B. "Fance Undecided on Ariane 5 Investment Question". Space News 8 December 2011 < http://www.spacenews.com/civil/111208-france-undecided-ariane5.html>.

[51] "ATV-3: Edoardo Amaldi". ESA Website. <http://www.esa.int/esaMI/ATV/SEMIZP6K56G_0.html>.

[52] Morring, Frank. "Europe and Japan Have RLV Research Plans". Aviation and Space Technology, Vol. 155, No. 16 15 October 2001.

[53] "H-2 Series (Japanese Rockets)". The Encyclopedia of Science <http://www.daviddarling.info/encyclopedia/H/H_series.html>.

[54] Two successive missions failed in 1998 and 1999 and launch costs were high.



Specification		H-IIA (Standard)	H-IIB (Heavy Lift)
Length		53 m	57 m
Diameter		4.0 m	5.2 m
Engine	1st stage	Liquid (LOX/LH2)	Liquid (LOX/LH2) x 2
	2nd stage	Liquid (LOX/LH2)	Liquid (LOX/LH2)
Gross Weight		289 t	531 t
LEO Launch Capability (Low earth orbit)		10 t	
SSO Launch Capability (Sun synchronous orbit)		3.6 t (Summer) 4.4 t (Other Seasons)	
GTO Launch Capability (Geostationary transfer orbit)		4.0 t	8.0 t

Figure 10: Japan's Launch Vehicles H-2A and H-2B (Source: Society of Japanese Aerospace Companies[55])

The H-2A's successor, the H-2B, uses a larger first stage than the H-2A and is also equipped with larger propellant tanks. The H-2B rocket was built to carry Japan's expendable cargo transporter to the ISS. Both systems were built by MHI. The Japan Aerospace Exploration Agency (JAXA) and MHI plan to upgrade the H-2A and H-2B rockets to improve their performance and enhance their competitiveness on the commercial launch market. The first launch of the so-called H-2A Upgrade is planned for early 2013. The launcher upgrade corresponds with the Basic Plan for Space Policy that calls for improved commercial competitiveness and better performance and safety of the H-2A.[56]

JAXA's Epsilon space transportation development program, conducted by IHI Aerospace, is due for an initial launch in 2013. It is designed to be a successor to the M-5 rocket. The M-5 (also known as Mu-5) was a solid-fuel rocket designed to launch scientific satellites operating in the years 1997–2006. It was developed by the Institute of Space and Aeronautical Science (ISAS). The first two successful launches were conducted in 1997 and 1998, with a third failed launch in 2000. This was followed by three more successful flights (including a launch of Hayabusa in 2003). The initial version, known as E-X, is estimated to cost some ¥21 billion ($270 million) to develop and ¥3.8 billion to launch. In comparison, the M-5 cost approximately ¥8 billion per launch. The E-X is slated to launch 1.2 metric tons to LEO and its improved version, the E-1 (with a first flight currently scheduled for 2017) should carry 100 kg more than the E-X (see table 3). The estimated development cost for the E-1 is about ¥10 billion.[57]

[55] „Data Information of Aircraft and Space". Society of Japanese Aerospace Companies: 30. <http://www.sjac.or.jp/common/pdf/hp_english/09.pdf>.

[56] Kallender-Umezu, Paul. "Japan Plans Launcher Upgrades To Attract Commercial Customers". Space News (7 March 2011) <http://spacenews.com/civil/110307-japan-plans-launcher-upgrades.html>.

[57] Perrett, Bradley. "Cost Conscious: Japan's New Solid-Rocket Program Should Make Launches Dramatically More Affordable". Aviation Week&Space Technology 173/28 8 August 2011.

イプシロン諸元等 /Epsilon Specifications		基本形態 Standard Configuration	オプション形態 Optional Configuration
		固体3段式 Three-staged Solid Propellant Launch Vehicle	固体3段式+小型液体推進系 Three-staged Solid Propellant Launch Vehicle +Compact Liquid Propulsion System
諸元 /Specifications	全長/Length(m)	24	
	質量/Mass(ton)	91	
打ち上げ能力 /Launch Capacity	地球周回低軌道 (LEO)	1200kg (250km x 500km)	700kg (500km circle)
	太陽同期軌道 (SSO)	-	450kg (500km circle)

Table 3: Epsilon Launch Vehicle Launch Capacity (Source: JAXA[48])

Figure 11: Japan's HTV (Source: JAXA)

Japan's H-2 Transfer Vehicle (HTV) is an unmanned cargo transfer spacecraft about 10 meters long and 4.4 meters wide that can deliver supplies to the ISS weighing up to 6,000 kg.[59] The HTV is launched from the Tanegashima Space Center on an H-2B launcher. Unlike the automated cargo vehicles of Russia and Europe which can dock automatically at the ISS, the HTV has to be grabbed by the robotic arm "Canadaarm 2", the Space Station Remote Manipulator System (SSRMS) which berths it to the ISS (see figure 11). JAXA spent approximately $680 million to develop the HTV spacecraft.[60] The first HTV (HTV-1) arrived at the ISS in September 2009 delivering five tons of cargo.

[58] http://www.jaxa.jp/projects/rockets/epsilon/design_e.html
[59] "HTV (H-II Transfer Vehicle)". Mitsubishi Heavy Industries website. <http://www.mhi.co.jp/en/products/detail/h-2_transfer_vehicle.html>.

[60] Malik, Tariq. "Japan's First Space Cargo Ship Ready to Fly". Space News (7 September 2009) <http://www.spacenews.com/civil/japan-first-space-cargo-ship-ready-fly.html>.

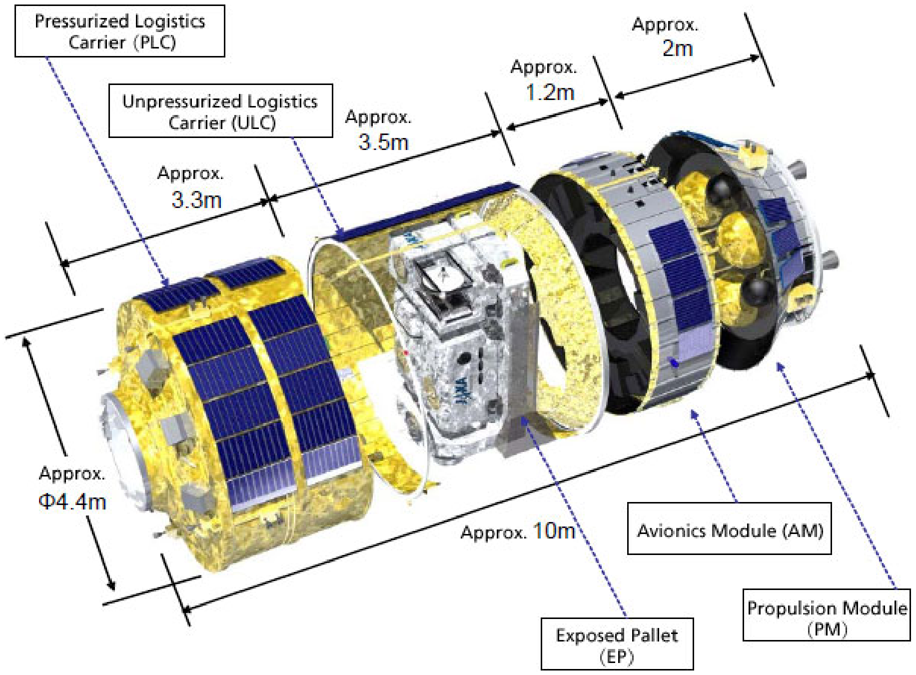


Figure 12: HTV Components (Source: JAXA[51])

The HTV-2, also called Kounotori-2 was successfully launched in January 2011.[62]

Among the unmanned cargo-carrying spacecraft (i.e. Russia's Progress and ESA's ATV), the HTV is the only vehicle capable of carrying both pressurised and unpressurised cargo (see figure 12). The Unpressurized Logistic Carrier (UPLC) has an Exposed Pallet that can be directly taken out to space and replace used experiment devices. The HTV's cargo capacity is smaller than that of the ATV, but has a larger (square) 1.2x1.2 m^2 hatch and can, therefore, carry larger objects.[63] (e.g. experiment devices).[64]

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Japan also studied reusable launch vehicle (RLV) concepts and the Japan's former space agency, NASDA, initiated the H-2 Orbiting Plane (HOPE) program. The programme was moved through a series of developmental steps and progressed though two major test beds, the HYFLEX (Hypersonic Flight Experiment), which consisted of a lifting body aircraft used to study hypersonic flight following launch from a rocket booster, and the ALFLEX (Automatic Landing Flight Experiment), which consisted of a 1:3 model of the HOPE space plane performing automated landing tests. The Japanese government, however, cut the HOPE budget significantly in 1997 and Mitsubishi Heavy Industries, the prime contractor for the Hope-X, dropped most of its research in the field of RLV development in 2001, and focused on preparing the then-new H-2A expendable launch vehicle for its first flight.[67]

JAXA has explored other designs for an unmanned cargo return vehicle capable of returning supplies from the ISS. Three different designs are being contemplated: equipping the HTV with a small capsule; equipping the HTV with a 2.6 meter diameter capsule similar to Soyuz return spacecraft; or remodelling HTV's cargo are to create a large capsule of

[61] "Overview of the Kounotori(HTV)". Japan Aerospace Exploration Agency website. <http://www.jaxa.jp/countdown/h2bf2/overview/htv_e.html>

[62] "KOUNOTORI2/H-IIB F2 successfully launched". JAXA website 22 Jan. 2011. <http://www.jaxa.jp/projects/rockets/h2b/index_e.html>.

[63] The ATV has a round hatch with 0.8 m in diameter.

[64] Overview of the HTV". Japan Aerospace Exploration Agency (JAXA) website. <http://www.jaxa.jp/countdown/h2bf1/overview/htv_e.html>

[65] The ATV has a round hatch with 0.8 m in diameter.

[66] "Overview of the HTV". Japan Aerospace Exploration Agency (JAXA) website. <http://www.jaxa.jp/countdown/h2bf1/overview/htv_e.html>

[67] Morring, Frank. "Europe and Japan Have RLV Research Plans". Aviation Week& Space Technology, 155/16 15 October 2001.

measuring 4x3.8 meters. The two latter options would have an advantage of the possibility of converting them into manned spacecraft. The first HTV-R could be launched between 2016 and 2018.[68]

Europe-Japan Space Transportation Cooperation

As evident by the referenced European and Japanese programmes in the area of space launchers, there have been a number of comparable programmes and goals, especially the Hermes–HOPE, Ariane 5–H-2A, and ATV–HTV. At the same time, there has been relatively little done to expand Europe-Japan cooperation at a governmental level.

Industry has been at the forefront of promoting better business relations in the launcher sector. Arianespace–Japan relations go back to the company's establishment of a Tokyo office in 1985 and launch of the first Japanese commercial satellite in 1989. That year, Arianespace offered Japan an Ariane-4/H-2 back-up agreement. Although Japan was not ready to accept such an undertaking at that time, a "commonality study" was launched under a general cooperation agreement between NASDA and CNES.

In 2003, Arianespace signed a mutual backup agreement for commercial satellite launches with Japan's MHI and Boeing Launch Services in the U.S. The agreement among Arianespace, Boeing Launch Services and MHI established the Launch Services Alliance (LSA) that involved the Ariane 5 launcher, the H-2A launcher and Sea Launch. Prior to this agreement, Arianespace had been negotiating compatibility issues with MHI since the 1990s to enable an equivalent mounting system and flight environment for Arianespace's clients. Such cooperation results in risk-reduction for both partners as it increases the launch provider's reliability. The backup agreement does not involve manufacturing.[69]

After the bankruptcy of the Sea Launch, in 2006 Arianespace and MHI signed an agreement which combines the satellite launch offerings for Ariane 5 and the H-2A and both companies can jointly propose launch services with the flexibility of launching a satellite on either of the two vehicles to guarantee launch dates for commercial satellites.[70] This was a step toward a genuine cooperative venture, as Arianespace would market the H-2A launchers and, in return, gain better mission assurance. Although no backup mission has, as yet, taken place, this agreement has been viewed as a useful model. From the beginning, both partners – Europe represented by Arianespace and Japan represented by NASDA – agreed that such cooperation is technically feasible and beneficial for both partners.

The European Space Agency (ESA), the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT), Arianespace and Japan's JAXA space agency have been working together to broaden this accord. Japanese companies have launched a number of satellites with Arianespace, including B-SAT Corporation, JSAT (the largest satellite operator in Asia), and the Space Communications Corporation (SCC). The main question is whether to extend a backup agreement for all missions, commercial and government. Although there were agreements between ESA and MEXT on the possibility of mutual launches under the condition that national launchers remain a priority, such launches never materialised due to availability of national launchers. Today, all government launches in Europe and Japan are conducted with domestic launch capabilities, on Ariane 5 in Europe and on H-2A in Japan.

Longer term, however, both Europe and Japan should consider the potential benefits of a major back-up agreement at a governmental level to take the existing agreement to a new level. Such a decision cannot be made by commercial entities, but must be based on high-level policy decisions in Europe and Japan.

Space development, including launcher technology, is a long-haul, costly endeavour. Accordingly, although privatisation of the launch business is viable, the development has, thus far, been lead by governments. There is also the reality that both Europe and Japan will most likely continue to seek autonomous launching capabilities. At the same time, both Europe and Japan are now debating their next generation launcher, the Ariane 6 in Europe and H-X in Japan. These debates inevitably include not only the launchers themselves, but also their operation and services (i.e. the launch site-related issues). This creates a common window of

[68] "JAXA Improving Plans for Unmanned Cargo Spacecraft To Bring Back Supplies from ISS [The Mainichi Daily News]". Space News 16 August 2010 <http://www.spacenews.com/commentaries/100816-jaxa-plans-cargo-spacecraft.html>.
[69] Unlike Japan's H-2A rockets, which are both manufactures and launched by MHI, Ariane-5 is built by various European companies with the prime contractor being Astrium.

[70] "Arianespace and Japan Continue to Build Long-Term Relationship". Space Travel 30 April 2007 <http://www.space-travel.com/reports/Arianespace_And_Japan_Continue_To_Build_Long_Term_Relationship_999.html>.

opportunity to consider bolder cooperative undertakings in the space transportation arena.

Relevant recommendations appear below:

- *More affordable human access to space through collaboration:* Europe is currently deciding on an Ariane 5 successor, known as the Next-Generation Launcher (NGL) or Ariane 6. Europe is also developing the Ariane 5 Midlife Evolution (ME). In Japan's case, JAXA and MHI plan to upgrade the H-2A and H-2B rockets to improve their performance and enhance their competitiveness on the commercial launch market. The first launch of the so-called H-2A Upgrade is planned for early 2013. The development of the Ariane 6 and Japan's next flagship launch vehicle, H-X, are going to be costly, long-term endeavours. Accordingly, Europe and Japan could contemplate to expand considerably cooperation with regard to the next launch vehicle of each side to reduce cost, strengthen industrial cooperation and share promising, non-strategic technologies for mutual benefit.
- *Consider cooperation on a joint return manned vehicle:* ESA and EADS conducted a feasibility study concerning the development of a re-entry capsule for the ATV, an ATV Return Vehicle (ARV). It was envisioned as the basis for developing either a cargo return capacity or a manned version of the ATV, but never materialised. In 2011, ESA announced the possibility of collaborating with NASA on an ATV successor, involving the NASA MPCV capsule. In 2010, Japan, for the first time, began to study plans for a manned space vehicle. An improved version of HTV-R would serve as the platform for a manned Japanese spacecraft for the ISS. Such vehicles, however, are costly and complicated and require a clear strategic goal and political vision concerning the benefits. Given the success of the ATV and HTV and more recent ideas to build a return vehicle, both Europe and Japan should consider carefully the prospect of collaborating on a joint return man-rated spacecraft.
- *Contemplate the benefits of a backup agreement for government launches:* Currently, all government launches in Europe and Japan are conducted by domestic launch capabilities, on the Ariane 5 in Europe and on H-2A in Japan. Arianespace and MHI have in place a backup agreement for commercial missions. Taking the long view, Europe and Japan should consider the potential benefits of a back-up agreement for government launches. It would be especially relevant if both governments are contemplating man-rated rockets.

3.1.2 Space Exploration

Prior to space travel and the technological tools to study it, scholars, searched the skies and stars to better understand our place in the universe. Galileo's discoveries by the use of a telescope, including identification of craters and mountains on the moon and spots on the surface of the Sun, constituted the beginning of "frontier research".[71] Space exploration, enabled by astronomy and space technology, is a driver for innovation, development of new technologies and source of new scientific discoveries. It requires high-level political support at a global level. The Apollo program succeeded in landing humans on another celestial body six times and paved the way for future such endeavours. The main discussion is how cooperation, unlike the competition of the Apollo days, can achieve the next milestones for future exploration, including human missions to the Moon, asteroids, Mars and beyond.

Space exploration, as agreed by many, needs to be an international undertaking given the required funds, expertise, technology and need for long-term vision and commitment. The United States has been at the forefront of space exploration since the beginning of the Space Age. More recently the U.S. civilian space programme had to face a number of challenges, including the retirement of the space shuttle and cancellation of the Constellation program. This stimulated a debate in Europe concerning potential downsides connected to reliance on any one country as the main decision-maker on future exploration undertakings.

Space exploration has also been symptomatic of the intense competition between national and commercial interests, ideologies and motivations. No human being has travelled beyond Earth orbits since the Apollo days. Accordingly, policy-makers worldwide face the challenge of making crucial decisions concerning the long-term destiny of human space travel. This involves deciding how they will distribute funds for the often rugged and uneven path of humans in space as well as robotic missions to advance space science.

The International Space Station (ISS), a 5-partner project, is the largest-ever space

[71] Lago, Maria Teresa. "Knowledge: Understanding Our Place in the Universe" in "Threats, Risks and Sustainability – Answers by Space", Schrogl, Kai-Uwe at al. Vienna: Springer (2009): 25-26.

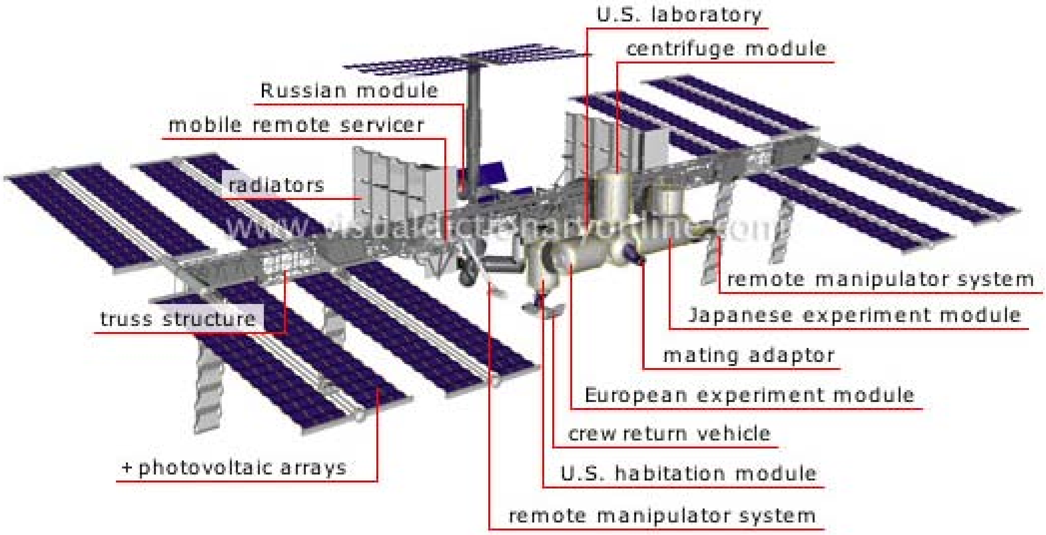

Figure 13: International Space Station (Source: Merriam-Webster[73])

cooperation programme that followed eight other space stations launched into a low Earth orbit since 1971.[72] In the middle of the last decade of the 20th century, some 500 people from 30 different countries had flown to space. At that time, the U.S. and Russia possessed human-rated launch capability. Today it is Russia and China. The ISS enables a range of research-related activities, including in the field of biomedical, psychological and sociological research; space science; solar and space physics; solar system exploration; exploration of the universe; microgravity research; and Earth observation. Participating countries are presently seeking the optimal use of the now-completed Station (see figure 13).

Beyond the ISS, international coordination now exists concerning key exploration priorities for the future. In 2006, fourteen major space agencies, ESA, Australia, Canada, China, Germany, France, India, Italy, Japan, Republic of Korea, Russia, Ukraine, United Kingdom, and the United States sought to map future robotic and human space exploration within the Solar System. They worked out a set of main space exploration themes that were introduced in a May 2007 document entitled “The Global Exploration Strategy: the Framework for Coordination”. The themes included: new knowledge in science and technology; sustained presence – extending human frontiers; economic expansion; a global partnership; and inspiration and education.

The document also called for the establishment of a voluntary, non-binding international coordination body, named the International Space Exploration Coordination Group (ISECG), which would facilitate the interaction on mutual interests, plans and objectives with regard to space exploration. The main purpose of this body is the overall improvement of both individual exploration programmes and collective initiatives.[74] Since its inception, the Group has been releasing Annual Reports outlining the main achievements of previous years, as well as highlighting the exploration activities of participating agencies. In 2008, the Group established an International Standards Working Group (ISWG), later renamed the International Architecture Working Group (IAWG), the task of which was to identify a lunar exploration architecture that would enable extensive international cooperation based on an “open architecture” environment.[75]

In 2010 the IAWG published a document entitled the “ISECG Reference Architecture for Human Lunar Exploration”. It lays out how space-faring nations can collaborate on complex human exploration scenarios that involve using assets of various space agencies. It has been recognised as a concrete step in materialising a Global Exploration Strategy where the Moon is a key destination for future human exploration and involves

[72] The ISS predecessors were the Salyut 1, Skylab, Salyuts 3, 4, 5, 6, and 7, and Mir.
[73] “International Space Station”. Merriam-Webster, visual dictionary online. <http://visual.merriam-webster.com/astronomy/astronautics/international-space-station.php>

[74] “International Space Exploration Coordination Group”. International Space Exploration Coordination Group website. <http://www.globalspaceexploration.org/>
[75] “The ISECG Annual Report 2008”. International Space Exploration Coordination Group website. <http://www.globalspaceexploration.org/documents>

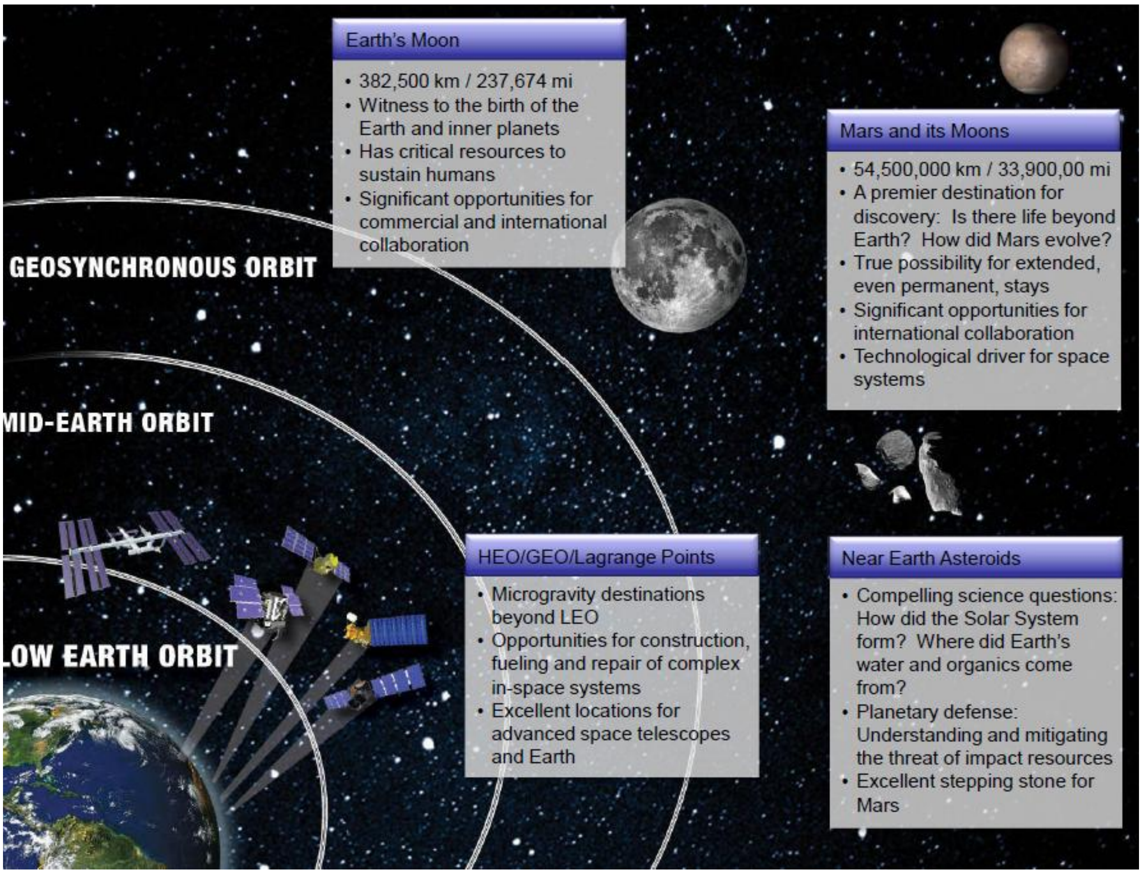

Figure 14: Exploration scenarios involving Lagrange Points, Moon, Near-earth Asteroids and Mars (Source: NASA[76])

continuous robotic and human exploration activity in multiple locations on that celestial body. The document also suggested that the Moon Architecture can also serve as a model for different destinations, including Near-Earth Objects (NEO), Lagrange points, and Mars and its satellites (see figure 14).[77]

In September 2011, the ISECG prepared a new Global Exploration Road Map. It builds on the Group's lunar architecture work. The evolving 25-year strategy lays out pathways to Mars via the Moon or a near-Earth asteroid (see figure 15).[78] The Road Map offers a framework for inter-agency discussions consisting of three main elements: common goals and objectives; long-range human exploration scenarios; and coordination of exploration preparatory activities. The latter is to facilitate understanding of how near-term decisions of individual agencies influence long-range exploration scenarios.[79]

The ISS serves as a model for the governance of the Global Exploration Road Map. International partners would be responsible for "critical path" hardware, now that the Obama Administration has cancelled the Constellation program. There are also ideas for the ISS serving as a test-bed for advanced life support and other technologies needed for exploration beyond the low-Earth orbit (LEO).[80]

Europe's Space Exploration Activities

Transatlantic cooperation drove the beginnings of human spaceflight activities in Europe with Spacelab, followed by the Co-

[76] Olson, John. "The Big Picture: Space Exploration&Operations Planning, Integration and Partnerships". PPT Presentation at the Human Space Exploration Community workshop, San Diego 14-16 November 2011. <http://www.nasa.gov/pdf/603234main_Olson-20111114%20Olson%20Workshop%20Big%20Pic.pdf>.
[77] "The ISECG Reference Architecture for Human Lunar Exploration: Summary Report". ISECG International Architecture Worksing Group July 2010 <http://www.globalspaceexploration.org/c/document_library/get_file?uuid=7cb7e62e-b2a5-4dfe-9da8-25043a4f5145&groupId=10812>.
[78] "About ISECG". International Space Exploration Coordination Group website <http://www.globalspaceexploration.org/about-isecg;jsessionid=A883540616CC32E8D4E685C8F0094254>.
[79] "The Global Exploration Roadmap". ISECG International Space Exploration Coordination Group (September 2011): 1. <http://www.globalspaceexploration.org/c/document_library/get_file?uuid=bd0428e8-9163-4483-976f-57208dc6507f&groupId=10812>.
[80] Carreau, Mark. "Heads Up: Moon Still Holds Sway for Potential Profits Missions, Despite Policy Changes". Aviation Week&Space Technology (21 November 2011): 66.

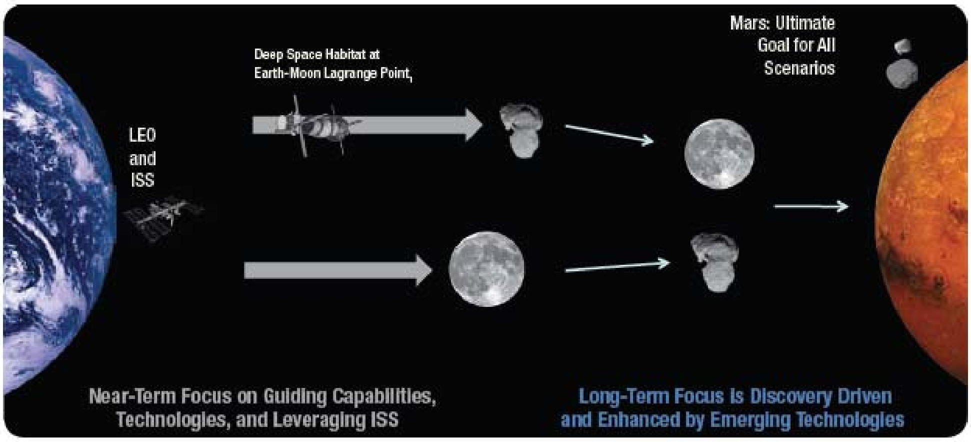

Figure 15: Optional Routes to Mars in an ISECG's Global Exploration Road Map (Source: ISECG)

lumbus Laboratory, the contribution of ESA to the Space Station Freedom and the International Space Station. Today, the debate in Europe focuses on how to promote exploration and human spaceflight through "interdependence and partnership".[81]

In the debate concerning why Europe should engage in space activities, including exploration, two main justifications can be distinguished: one anchored in pragmatism (also labelled "utilitarian"), and a more visionary and abstract one (also labelled "trans-utilitarian"). Pragmatic arguments focus mainly on tangible benefits, including economic progress, development of new technologies, job creation, and space applications. The trans-utilitarian debate involves the benefits of greater understanding of our solar system and the Universe, as well as conquering new frontiers. Often times, however, arguments from both sides a spectrum are required to inspire support and funding of space activities. This is also true for the human spaceflight.[82] Space systems not only enable expanding human knowledge about our planet and the Universe, but also contribute to human progress and enable new operational services for the benefit of people worldwide. It also enables scientific advances which drive the development of new technologies, thus supporting Europe's competitiveness in global markets.

Europe aspired to become the third one, after the U.S. and Russia, to gain the ability to send a human into space as evident by the plans adopted by ESA Council at Ministerial Level in 1985 and 1987 and participation in the International Space Station (ISS), and the development of Hermes and a Man-Tender Free Flyer (the latter two did not ultimately materialise).[83] In 2001, Europe's Aurora programme outlined the possibility of exploration of the Moon, Mars and the planetary system. The Aurora Programme is part of Europe's strategy for space exploration, technology innovation, and inspiration to encourage young students and scholars to study science and technology. The main target of the Aurora has been to establish a long-term European plan for exploration (robotic and human) of the solar system, as well as the search for life beyond the Earth.[84]

Although Europe does not possess an independent human space transportation capability, it trains a European astronaut corps and actively participates in the ISS with the Columbus module and the Automated Transfer Vehicle (ATV). Aurora involves two sizable missions, the ESA ExoMars programme and Mars sample return. ESA's highly successful Mars Express mission was launched in 2003 and will be operational until 2014. The scientific payload of the Mars Express comprises surface and subsurface instruments, atmospheric/ionospheric measurement devices, and High Resolution Stereo Camera delivering images of Mars. ESA also participated in an international study called "Mars500" that conducted full duration stimulation of a manned flight to Mars in 2010–2011.

Funding of space exploration projects is especially challenging at a time when European countries are dealing with the financial crisis.

[81] Agenda 2015: A Document by the ESA Director General". Paris: European Space Agency (November 2011): 11.
[82] Schrogl, Kai-Uwe. "The Political Context for Human Space Exploration" in Humans in Outer Space – Interdisciplinary Perspectives, Ulrike Landfester, Nina-Louisa Remuss, Kai-Uwe Schrogl, and Jean-Claude Worms (eds.). Vienna: SpringerWienNewYork (2011): 3-9.
[83] Schrogl, Kai-Uwe. "The Political Context for Human Space Exploration" in Humans in Outer Space – Interdisciplinary Perspectives, Ulrike Ladfester, Nina-Louisa Remuss, Kai-Uwe Schrogl, and Jean-Claude Worms (eds.). Vienna: SpringerWienNewYork (2011): 7-8.
[84] "European Space Exploration Programme Aurora". ESA website. < http://www.esa.int/esaMI/Aurora/index.html>.

Accordingly, European countries seek ways how to expand their existing cooperation, as well as how to better leverage international partnerships. Europe took the initiative to organise international conferences on exploration in 2009 in Prague and 2010 in Brussels, followed by a third conference in Lucca, Italy, in November 2011. The nature of the conferences evolved from being mainly Euro-centric to active involvement of international partners. Accordingly, the third conference sought to transform the proceedings into a high-level global discussion.

The Second International Conference on Space Exploration in Brussels in October 2010 was co-organised by the Belgian Presidency of the EU, the European Commission, Italy (as the Chair of the ESA Ministerial Council) and ESA. Many of the conference participants emphasised the need for Europe to take immediate steps to assure that Europe maintains a significant role in future space exploration. The main areas of discussion were: technologies as enablers for space exploration; space transportation for exploration (i.e. secure and reliable access to space); exploitation of the International Space Station (ISS) as a platform for further exploration; international high-level cooperation; and specific actions for Europe.[85]

In November 2011, representatives from 28 countries met in Italy for the Third International Conference on Exploration. The so-called "Lucca Declaration", endorsed at the meeting, emphasised that space exploration provides a direct benefit to humankind and that achieving sustainable space exploration will depend on the intensity of high-level, structured policy dialogue. The benefits include "fuelling future discoveries; addressing global challenges in space and on Earth through the use of innovative technology; creating global partnerships by sharing challenging and peaceful goals; inspiring society ...; and enabling economic expansion and new business opportunities".[86]

The Third Conference on Space Exploration in Lucca was called the First High-Level International Exploration Platform to demonstrate an evolution from deliberations that placed emphasis on Europe, to a global perspective. The Declaration emphasised the need for an international exchange that would support space exploration efforts worldwide, including the implementation of the ISECG's Global Exploration Roadmap.[87]

In March 2011, the ESA Council approved funding for the International Space Station (ISS) through 2020 in the amount of € 550 million for Europe's share of station operations, logistics and transportation using the Automated Transportation Vehicle (ATV). Overall, Europe is to spend some € 4 billion on the Station in the period 2008–2020.[88]

Europe was the lead advocate for extending ISS funding until 2020, in part, to gain an adequate return on its investment in the European Programme for Life and Physical Sciences (Elips) that takes advantage of microgravity for a variety of research projects. ESA receives 75 hours of crew time for science every six months and can expand it by 30-50% through collaboration with other partners. Europe has nine User Support & Operation Centers (USOCs) where scientists can oversee experiments on the ISS. The USOCs receive information through the Columbus Control Centre in Oberpfaffenhofen (Germany) which oversees the laboratory's operations.[89]

The European Commission (EC) stated in its 2011 Communication, entitled "Toward a Space Strategy for the European Union that Benefits its Citizens", that Europe "is not making the most of its potential because its actions are too piecemeal and because of the lack of linkage between space exploration and the political, economic and social challenges" that Europe faces. Accordingly, it emphasises: the development of critical technologies (cross-sectoral); working more

[85] Actions for Europe included: examining the feasibility of a European space exploration strategy building on existing competences, strengths and priorities; supporting the extension of ISS at least until 2020 and strive for its exploitation; initiating further reflection on an international common space exploration transportation policy; establishing in 2011 long-term roadmaps and associated programmes for technology , in particular in critical areas such as life support, automation and robotics, novel energy sources and storage and advanced propulsion; and on the basis of the proposed international high level space exploration platform, organising its first meeting by end 2011. (Conclusions of the Second International Conference on Space Exploration. <http://download.esa.int/multimedia/Conclusions_second_exploration_conference_21102010.pdf>)

[86] "Declaration of the Third International Conference on exploration and First meeting of High-level International Space Exploration Platform". Lucca 10 Nov. 2011 <http://www.congrex.nl/11A18/docs/11A18_exploration/declaration-final-lucca.pdf>.

[87] "Declaration of the Third International Conference on exploration and First meeting of High-level International Space Exploration Platform". Lucca 10 Nov. 2011 <http://www.congrex.nl/11A18/docs/11A18_exploration/declaration-final-lucca.pdf>.

[88] "ESA Council OKs ISS Funding". Aviation Week and Space Technology, Vol. 173, No. 10 21 March 2011.

[89] Morring, Frank and Amy Svitak. "European Continuity: ESA's ISS Utilization Has Roots in Spacelab, and a 10-year Track Record on the Station". Aviation Week&Space Technology (20 June 2011): 134.

closely on the International Space Station (ISS); assuring independent access to space; and the development a high-level international platform to facilitate international cooperation through strengthening the political dimension of this endeavour.[90] The Lucca Conference of November 2011 is a concrete manifestation of these efforts.

Japan's Space Exploration Activities

JAXA is guided by its 20-year plan released in March 2005 entitled "JAXA Vision 2025" that envisions world-class status for JAXA in aeronautics and space science, security, infrastructure and industry. It also places significant emphasis on lunar exploration. The U.S. has been Japan's leading space partner. Based on a decision by U.S. President George W. Bush to build a lunar base by about 2020 with the assistance of international partners and use it for the human exploration of Mars, Japan has actively engaged with other space-faring nations to develop an architecture for lunar exploration.

Like Europe, Japan wants to extend the utilisation of the ISS at least until 2020. JAXA controls 12.8% of the ISS capacity under the government-to-government barter arrangements that govern ISS operations. With the retirement of the Space Shuttle, also Japan depends on Russia's Soyuz crew capsules to deliver astronauts to the ISS. Currently, Japan's Kounotori, second H-2 Transfer Vehicle (HTV-2), can deliver cargo to the ISS. Over time, Japan may well wish to have its own capability to fly astronauts to space.[91]

The Japanese Kibo laboratory (meaning "hope" in Japanese), also called the Japanese Experiment Module (JEM), is the largest and most flexible module on the ISS, including an outside "porch" for exposed experiments, a robotic arm and airlock to move gear in and out of the pressurised volume, and an "attic" for storage. The Kibo laboratory was the first significant piece of Japanese hardware to be incorporated into the ISS. It was launched to the ISS by the Space Shuttle in 2008 and 2009 and can accommodate up to four crew members.[92]

Within Kibo, JAXA controls half of the resources and NASA the other half, based on U.S.-supplied services such as power from the Station's solar arrays. The Japanese module is equipped with four science racks inside and three more experiments racks outside on the exposed facility. It includes an astronomical camera called the Monitor of All-sky X-ray Image, an external mount to gauge the effects of the space environment on a variety of materials, hardware called the Space Environment Data Acquisition Equipment-Attached Payload, and a Superconducting Cub-millimetre-wave Limb-Emission Sounder which has already finished its observation and will be replaced by a high-energy space observatory. JAXA not only promotes scientific research in Kibo, but also in-orbit activities in the humanities and social sciences, including dance and visual art possible only in microgravity. Japan's government called Kibo the "gateway to ISS in Asia" and seeks to accommodate non-Japanese Asian participants through JAXA's "Kibo Utilization Office for Asia". The APRSAF has established a task force to plan joint ISS utilisation missions.[93]

The Japanese scientific gear on the ISS consists of: the Saibo Rack carrying the Cell Biology Experiment Facility and a clean bench for handling life-science materials; the Kobairo Rack with the Gradient Heat Furnace for materials processing; and the Ryutai Rack with the Fluid Physics Experiment Facility; the Image Processing Unit; the Solution Crystallization Observation Facility; and the Protein Crystallization Research Facility (PCRF). The last facility advances research on medications for Alzheimer's disease and influenza. Although Japan can carry its own materials to the ISS on the HTV, it relies on Russia to get its experiments back to Earth. To retrieve space-grown crystals from the PCRF to Earth, for example, Japan concluded a bilateral agreement with Russia to share its protein crystal growth equipment in exchange for transport to and from the station in Russian vehicles.[94]

Japan's space science programme focuses, among other activities, on lunar research and planetary science through the following projects: PLANET-C (a Venus exploration mission), BepiColombo (a Mercury exploration mission jointly planned with ESA), Hayabusa

[90] "Towards a Space Strategy for the European Union that Benefits its Citizens". Brussels: European Commission Communication COM (2011) 152 (4 April 2011):7-8. <http://ec.europa.eu/enterprise/policies/space/files/policy/comm_native_com_2011_0152_6_communication_en.pdf>.
[91] Morring, Frank. "Safety Check: Japanese Astronauts may fly commercial, but only after careful review by JAXA". Aviation Week and Space Technology, Vol. 173, No. 5 (7 February 2011): 34.
[92] "JEM (Japanese Experimental Module)". Mitsubishi Heavy Industries website. <http://www.mhi.co.jp/en/products/detail/japanese_experiment_module.html>.
[93] Morring, Frank and Amy Svitak. "Japanese Gem: Kibo Has Space for Experiments Inside and Out, With an Air-lock". Aviation Week&Space Technology (20 June 2011): 137-138.
[94] Morring, Frank and Amy Svitak. "Japanese Gem: Kibo Has Space for Experiments Inside and Out, With an Air-lock". Aviation Week&Space Technology (20 June 2011): 137-138.

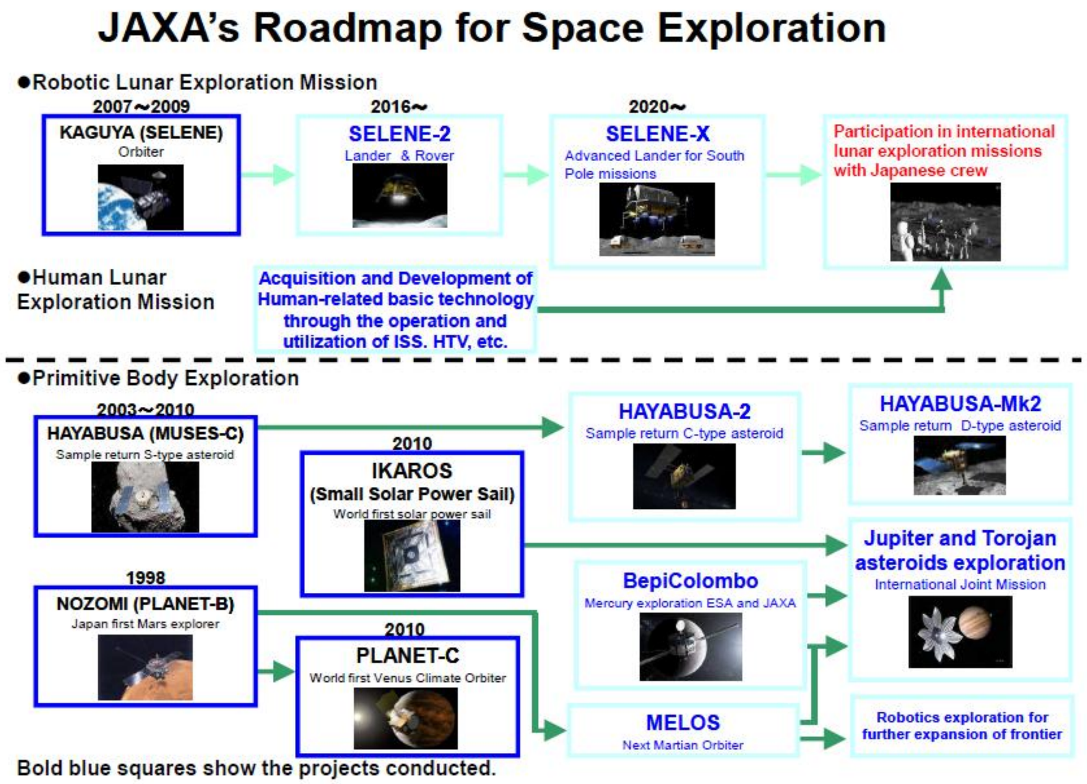

Figure 16: JAXA's Roadmap for Exploration (Source: JAXA)[95]

(an asteroid explorer), and Kaguya (a lunar explorer to acquire data necessary for the development of technology for future moon exploration). JAXA also conducts research on space plasma, X-rays and infrared rays, and various space technologies (e.g. electric propulsion, solar electric sail, lunar-planetary exploration rovers and reusable transportation systems) .[96]

Cooperation in Space Exploration

Exploring the universe requires highly reliable components and protection of delicate electronics and mechanics from the harsh space environment. For long-duration probes that can take years, or even decades, autonomous operations is an essential element. Europe and Japan, through the ESA–JAXA partnership, have demonstrated that both sides share similar visions for their research and development. These include, for example, the Rosetta and Hayabusa missions. The Rosetta Mission, approved in November 1993, represents the Planetary Cornerstone Mission in ESA's long-term space science programme. The goal is to rendezvous with Comet 67P/Churyumov-Gerasimenko in 2014. The mission is expected to be completed in 2015. On its 10-year journey to the comet, the spacecraft has passed close to two asteroids: 2867 Steins (in 2008) and 21 Lutetia (in 2010). The long mission duration has required the introduction of extended hibernation periods.[97] Japan's Hayabusa mission was launched to asteroid Itokawa in 2003, stayed three months at the 500-m large asteroid in 2005, and brought back the samples from the surface of the asteroid in 2010. JAXA hopes to launch a Hayabusa-2 asteroid sample-return mission in 2014 and would reach its target in 2019 and return to Earth in 2020. Hayabusa-2 is to visit 1999 JU3, a 920-meter-diameter object similar to Itokawa. The project is to receive $38 million (¥3 billion) budget for FY 2012.[98]

Decisions made during times of economic uncertainty will play a significant role in de-

[95] Sato, Naoki. "JAXA Status of Exploration and Human Space Program". PPT Presentation from the Human Space Exploration Community Workshop, San Diego 14-16 November 2011. <http://www.nasa.gov/pdf/605307main_JAXA-Status-%28Final%29-A-Sato.pdf>.
[96] "Space Science Research". JAXA website. <http://www.jaxa.jp/projects/sas/technology/index_e.html>.
[97] "Rosetta: Summary". ESA website. <http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=2279>
[98] Kallender-Umezu, Paul. "NEC Corp. Tapped to Build Another Asteroid-bound Hayabusa Probe". Space News (25 January 2012). <http://www.spacenews.com/civil/120125-nec-corp-tapped-build-another-asteroid-bound-hayabusa-probe.html>.

termining the future of space exploration. Many people assert that international cooperation in space exploration is essential and Europe and Japan have a number of opportunities to engage in close dialogue concerning possible future joint endeavours.

BepiColombo is a joint mission of ESA and JAXA, executed under ESA's leadership. The project was re-affirmed in November 2009 by the Science Program Committee (SPC) which sets Europe's space science agenda based on the ESA budget. The project received reaffirmation despite much larger costs for ESA than originally envisioned. BepiColombo is a mission to Mercury planned for departure in 2014 and arrival in 2020. The mission is comprised of two spacecraft: the Mercury Planetary Orbiter (MPO) and the Mercury Magnetospheric Orbiter (MMO).

Astro H, an X-ray astronomy mission initiated by the Institute of Space and Astronautical Science of JAXA, will provide unique measurements in a number of fields such as the structure of the Universe and its evolution, extreme conditions of the Universe, dark matter and dark energy. Astro-H is the sixth X-ray astronomy mission developed by ISAS/JAXA. Astro-H is to be launched in 2014 on H-2A launcher. JAXA invited ESA to appoint three European members to the Astro-H Mission Science Working Group (SWG) which will provide guidance through the mission execution. This mission can also be perceived as a precursor to the International X-ray Observatory/Athena mission proposed in the framework of ESA's Cosmic Vision program.[99] Space science cooperation is one of the areas that has a strong foundation and will continue in the future. A joint ESA-JAXA mission (SPICA), a JAXA-led astronomical missions with ESA contribution (through the provision of the cryogenic telescope assembly), is currently being discussed (see figure 17).

Space exploration will always have a strong human dimension. In the near term, ESA and JAXA can explore new angles of bilateral cooperation with respect to ISS operation and utilisation. Moreover, active exchanges of information and coordination of architectural studies for future space exploration should be pursued. ESA and Japan can also explore ways to develop the robotic possibilities. Robotic missions to other planets deliver precise in-situ data and can reach far-away destinations. Certain dimensions of exploration, however, can only be delivered by humans.

A debate needs to be stimulated at a senior policy level concerning the prospects of expanded cooperation on a non-scientific project such as human space exploration. Arguably, for the best results, Europe and Japan would decide to enhance their coordination on key positions prior to multilateral and other gatherings as their joint interventions could prove more persuasive than uncoordinated solely national positions. Another benefit of a more unified position on select priority issues would likely improve the possibility of placing such items on the agendas of relevant official and other fora.

Relevant recommendations appear below:

- *Continue to strengthen cooperative efforts in space exploration:* The global space community is at a watershed, having to decide whether to truly pursue space exploration, and if so whether this would be in a coordinated or competitive fashion. By coordinating well and early Europe and Japan can help set the agenda for the long-term future in this domain.
- *Seek to forge a joint vision for space exploration and support the high-level international platform/forum established in November 2011 in Lucca, Italy:* Europe and Japan should seek common ways to maintain the positive momentum created by the Third International Space Conference and first high-level international platform/forum that took place in Lucca, Italy, in November 2011, including efforts to shape the policy issues for the next string of meetings.
- *Strengthen arguments for space exploration by including the benefits of such activity for the overall domestic and foreign policies of Europe and Japan:* Existing bilateral policy exchanges should include on their agenda a full evaluation of how space exploration promotes economic growth through scientific and technological progress, innovation and competitiveness. It should also explore how greater social prosperity can be advanced through joint space-related research and undertakings (including in the area of life sciences, joint robotic missions, etc.), and enhanced ISS cooperation, including joint space transportation. Space exploration is also an iconic human endeavour, with geopolitical significance (as demonstrated by the Chinese posture), and engenders all the scientific benefits of basic research.

[99] "The Astro-H Mission" <http://www.isdc.unige.ch/astroh/about>.

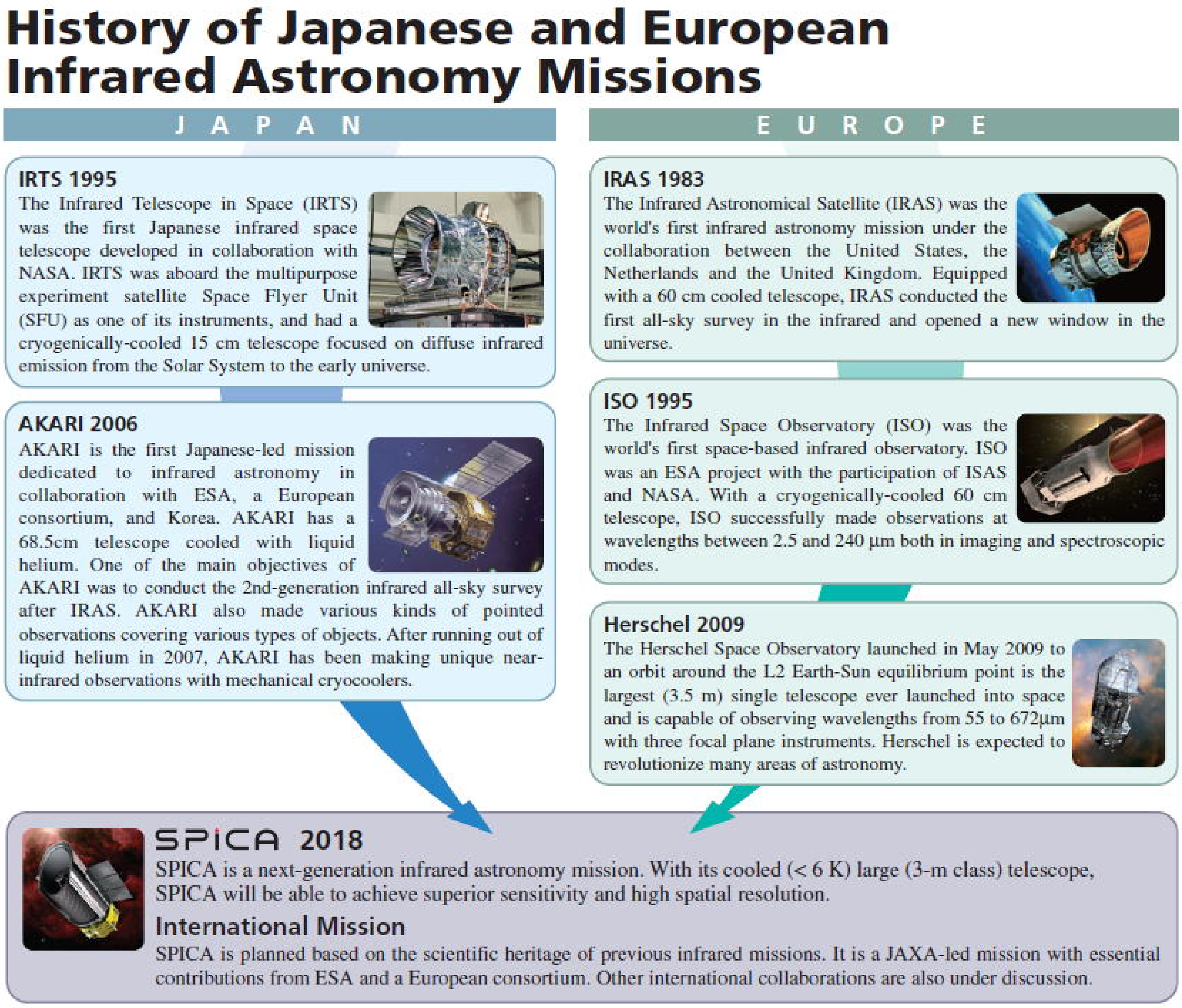

Figure 17: History of Japanese and European Infrared Astronomy Missions (Source: JAXA)[100]

3.2 Earth Observation and Related Applications

Space-based Earth observation (EO) is capability increasingly recognised as having global importance. For example, during the devastating 3/11 earthquake of 2011 in Japan, 14 different countries were able to deliver as many as 5,000 images of the affected areas from 27 different satellites, which provided crucial information to accelerate rescue and recovery missions.[101]

The following section of the report will focus on EO as it relates to the environment, including climate change monitoring and disaster management. It will also review briefly commercial EO-related activities.

Space-based assets have been recognised as indispensable in providing essential data for environmental research, disaster management, security and related political decision-making. EO satellites play a special role in cooperation as evidenced by the existence of EO-related organisations such as the Committee on Earth Observation Satellites (CEOS) and the Group on Earth Observation (GEO). Other efforts include, the European Space Agency's (ESA) Climate Change Initiative (CCI) and the International Charter, "Space and Major Disasters" (initiated by ESA and CNES after UNISPACE III in 1999). The CCI seeks to take advantage of data from ESA and Member State (MS) EO space assets to analyze long-term global records of essential climate variables. The International Charter seeks to provide a unified system of space data acquisition and delivery on a timely basis to areas affected by man-made disas-

[100] <http://www.ir.isas.jaxa.jp/SPICA/SPICA_HP/ippan-3_English.html>

[101] "Friendship on the Final Frontier: Space Agencies Work Together to Understand our Earth". Japan Now 7/5 (6 October 2011), Washington: Japan Embassy in the U.S. <http://www.us.emb-japan.go.jp/jicc/japan-now/EJN_vol7_no5.html>.

ters.[102] The CCI and Charter's mechanism is described in more detail below, as well as in section 3.4. of this report.

The Committee on Earth Observation Satellites (CEOS) was established in 1984 and involves 28 space agencies and 20 other national and international organisations. The Committee coordinates and plans civilian satellite missions for EO. Its mission is to make the best use of EO satellites internationally and coordinate the procedures of calibration, validation, data management and information systems for EO. It undertakes the complex task of meeting the needs of mission operators (space agencies) that involve national interests, costs and schedules, and those of the end-users of the data. The goal is to avoid duplication and secure all important measurements. ESA, EUMETSAT and the European Commission (EC) became members of CEOS in 1984, 1989 and 1994, respectively. Japan joined in 1984 though MEXT/JAXA.

The Group on Earth Observation (GEO) joins 88 governments (as of September 2011) and the EC in a voluntary partnership with a goal of developing a Global Earth Observation System of Systems (GEOSS). Another 64 organisations (international, intergovernmental and regional) with an EO mandate have the status of Participating Organisations. The Executive Committee consists of 13 representatives from the Americas (three), Asia (three), Europe (three), Africa (two), and the CIS (one). The Russian Federation is part of its Executive Committee, where it represents the CIS countries. The committee oversees GEO's activities when the Plenary (i.e. the Members and Participating Organisations) is not in session. It likewise steers the Secretariat. At the GEO Summit in Tokyo on 16 February 2005, a 10-year implementation plan was approved for the development of a coordinated and sustained architecture to achieve a better understanding of Earth systems. The document was signed by 47 countries and more than a dozen international organisations (e.g. ESA, UN, EUMETSAT, EC, ISCU, WMO, etc.). Europe's GMES constitutes its contribution to the GEOSS Plan.

The purpose of GEOSS is to improve observation of the Earth's atmosphere, oceans, land, ecosystems and their functions on a "comprehensive, coordinated and sustained" basis. It targets nine "Social Benefit Areas". Information derived from these observations can improve the decision-making on key issues related to sustainable development, prevention and mitigation of disaster-induced damage, improved resource and energy management, climate change-related forecasting, improved weather forecasting, conserving biodiversity and other key issues.

Commercial EO has been slow to develop due to the fact that there was a substantial secrecy surrounding intelligence-gathering satellites during the Cold War and there were limits on the capabilities that could be offered on a commercial basis. Governments have, however, generally encouraged greater understanding of the benefits derived from multispectral observation sponsored by private investment for some time. In 1986 France launched the first of its SPOT remote-sensing satellites and created a marketing organisation, Spot Image, to promote use of its imagery. In the 1990s, when some of the technology used for reconnaissance satellites was declassified, commercial remote sensing satellites began to be launched. The first commercial high-resolution satellite, Ikonos 1, was launched in 1999.

Major customers for high-resolution imagery are governments, many of which lack their own reconnaissance satellites. Although remote sensing has yet to become a fully viable commercial business, as the users become more familiar with the benefits of using space-derived data with other sources of geographic information, there is the opportunity for significant commercial success.[103] In 2010, Earth observation-related global revenue, constituting data sales and value-added services (i.e. new products and services generated from existing raw satellite data), amounted to $2.01 billion (a 6% increase from 2009) and was driven mainly by government requirements (civilian and military). This number is expected to increase to $7.7 billion per year by 2019.[104]

3.2.1 Europe's Key Earth Observation-Related Activities

Earth observation (EO) has been recognised as a priority space activity in Europe as it can generate high socio-economic returns on investment. Among the areas for which EO is especially beneficial are the environment and security (including disaster management). The EU's environment policies have been structured around so-called Environmental Action Programmes (EAP). The latest of them, the 6th EAP, provides a framework for

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[102] Robinson, Japan. "Enabling Europe's Key Foreign Policy Objectives via Space". ESPI Report 30. Vienna: European Space Policy Institute (February 2011): 6.

[103] Logsdon, John M. "Space Applications". Encyclopedia Britannica. <http://www.britannica.com/EBchecked/topic/557348/space-exploration>

[104] "The Space Report 2011". Space Foundation (2011): 38.

environmental policies in the period 2002–2012. The 6th EAP also represents an environmental dimension of the Europe 2020 strategy.

The Living Planet Programme

ESA's Living Planet programme constitutes an important contribution to understanding and addressing global environmental challenges. Five of the missions are displayed in figure 18. Three of the missions have already been launched. The Gravity field and steady-state Ocean Circulation Explorer (GOCE), the first of a series of Earth Explorer satellites launched in March 2009, is designed to provide information on critical variables of the Earth system. Gravity and its variation in space are fundamental for every dynamic process on the Earth's surface and in its interior. A better understanding of how gravity affects the interaction among these processes can offer valuable knowledge.[105] ESA's Soil Moisture and Ocean Salinity (SMOS) mission, launched in October 2009, examines how climate change may be affecting evaporation patterns over land and sea. The CryoSat-2, launched on 8 April 2010, measures the thickness of floating sea-ice in order to detect seasonal and multi-annual variations. It will likewise observe the surface of continental ice sheets for elevation change detection. For example, it will determine the contribution of the Antarctic and Greenland ice sheets to mean global sea level rise.[106]

Figure 18: ESA's Earth Explorer missions (Source: ESA)

The monitoring of wind and other variables can serve as another example of the benefits of space-based assets. Wind is a global transportation system for heat, moisture and airborne particles. Since over 70% of the Earth is covered by water, the interaction between the ocean and atmosphere is a complex, but critical, part of our climate. Surface ocean circulation, coastal currents, waves and swell are primarily driven by the wind. Meanwhile, ocean circulation plays an important role in the distribution of heat and water vapour in the atmosphere. Monitoring the wind and other variables, such as air pressure, air temperature and water vapour, gives us valuable information about how the ocean and atmosphere interact to produce changes in our weather and climate. ESA's Earth Explorer Atmospheric Dynamics Mission (ADM-Aeolus), to be launched in 2013, will seek to provide global observations of three-dimensional wind fields to improve atmospheric modelling and analysis techniques for operational weather forecasting and climate research.[107]

The Climate Change Initiative (CCI)

ESA has repeatedly demonstrated the usefulness of long-term satellite data for better understanding and managing climate change, including through its Climate Change Initiative (CCI). The CCI seeks to take advantage of data from ESA and MS EO space assets that go back three decades to analyze long-term global records of essential climate variables. These data, together with new missions, produce new information on GHG concentrations, sea-ice extent and thickness, sea-level rise, sea-surface temperature and salinity, etc.

Due to the complexity of the climate system, the only tools that provide quantitative estimates of future climate change are sophisticated numerical models. Climate models, or "general circulation models" (GCMs), are simplified, mathematical representations of the climate system. The ESA Sea Level CCI Project, for example, will advance the preciseness of climate models used for sea-level projections. Another project, ESA's Fire CCI, will seek to provide quality evaluations of burned areas globally to fine-tune climate-vegetation models for better assessment of global vegetation and atmospheric conditions related to fire. These examples demonstrate how ESA works to improve climate model predictions through satellite datasets.[108]

Satellite systems offer unique capabilities for climate change research and management. They can provide sound data on the state of the environment. Earth observation and meteorological satellites have contributed significantly to scientific understanding of the environment. EO satellites can monitor global

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[105] Looking into the Forces that Shape Our Planet. European Space Agency Website. <http://www.esa.int/SPECIALS/GOCE/SEM3Q2VHJCF_0.html>

[106] Earth Explorers Overview. European Space Agency website. <http://www.esa.int/esaEO/SEM9JP2VQUD_index_0_m.html>.

[107] Aeolus: Wind Monitoring. Astrium-EADS website. http://www.astrium.eads.net/en/programme/aeolus.html

[108] Climate Scientists Highlight ESA Climate Change Initiative. European Space Agency Website 6 December 2010 <http://www.esa.int/SPECIALS/Space_for_our_climate/SEMIOGOR9HG_0.html>.

EM-DAT Disasters* and Charter activations per year and per type
(only the EM-DAT based disasters according to Charter hazard types are reported).

Charter Activations

Years/types	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Earthquakes		3	1	3	6	3	2	4	4	4	5	35
Floods		4	8	5	6	13	15	19	23	19	24	136
Ice Jams								1				1
Industrial Accidents		3	2		1		4	3			2	15
Slides	1		2	1			1	1		2	4	12
Snowfalls											1	1
Volcanoes		1	1	2	1	2	1	2	3	3	2	18
Wave / Surges					3			1		1	1	6
Wild Fires				5	1	2		4	2	4	1	19
Wind Storms			1	2	3	5	2	10	8	7	11	49
Total	1	11	15	18	21	25	25	45	40	40	51	

EM-DAT disasters*

Years/types	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Earthquakes	31	25	36	40	30	25	23	18	22	22	23	295
Floods	158	158	173	159	127	199	227	148	166	146	182	1843
Industrial Accidents		2	2	1	1		2	2				10
Slides	29	21	19	21	16	12	19	13	14	31	29	224
Volcanoes	5	6	7	2	5	8	11	6	7	1	6	64
Wave / Surges			1		13		1	3				18
Wild Fires	30	14	24	12	8	14	7	16	5	9	7	146
Wind Storms	102	113	114	86	133	123	76	96	111	84	83	1121
Total	355	339	376	321	333	381	366	302	325	293	330	

*source EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be, Université Catholique de Louvain, Brussels (Belgium)

Table 4: Charter Activations Statistics (Source: EM-DAT)

stratospheric ozone depletion, including at the Earth's poles, and detect tropospheric ozone (e.g. ERS 2, Envisat, etc.). They generate synoptic weather imagery and assimilate data for numerical weather prediction (e.g. MetOp weather satellite, etc.). They help discover the dynamics of ice sheet flows in Antarctica and Greenland (e.g. ERS-1, ERS-2, Envisat, etc.). They can also detect mesoscale variability of ocean surface topography and its importance in ocean mixing and observe the role of the ocean in climate variability (e.g. Topex/Poseidon, ERS-1, ERS-2, Envisat, etc.).[109]

The International Charter "Space and Major Disasters"

As referred to above, the International Charter was initiated by ESA and the French Space Agency (CNES) based on their proposal during the UNISPACE III gathering in 1999. The Charter reflects international cooperation among space agencies which make their resources available to emergency and rescue operations. Its objectives are:

- To support, by means of space assets and the associated information and services, the organisation of emergency assistance or subsequent operations
- To provide a unified and coordinated system of space data acquisition and data delivery to those affected by disasters
- To promote cooperation between space agencies and space system operators in the field of disaster management

The Charter is open to space agencies and space system operators who participate on a voluntary basis with no exchange of funds. The members commit to make satellite resources (including acquisition planning) available without delay during period of crisis (with the exception of those restricted by provider's data policy) and supply emergency organisations with coordinated and free access to space systems and derived data and information.

In 2003, the United Nations' Office for Outer Space Affairs (OOSA) was accepted as a coordinating body for the Charter. The OOSA established a 24/7 hotline in July 2003 through which various UN agencies can request data through the Charter to address emergency situations.

In 2011, the Charter was activated by Japan a number of times, including the September flood and landslide in the Kinki and Shikoku regions (as a result of a typhoon) and July floods in the Niigata and Fukushima prefectures in Japan. One of the future goals for improving the scope of the Charter's work is to make it accessible to more countries (including in Africa) and investigate options to make the offered space-based solutions sup-

[109] Space Technologies and Climate Change: Implications for Water Management, Marine Resources and Maritime Transport. Organisation for Economic Cooperation and Development. 2008: 73.

porting disaster management activities more efficient.

The Global Monitoring for Environment and Security (GMES)

The GMES programme represents an effort on the part of the EU to ensure the provision of reliable and sustainable Earth observation data and services over the long term by seeking to: provide better access to existing assets; strengthen existing capabilities; and accelerate the development of operational services. GMES has been recognised as the European contribution to building the Global Earth Observation System of Systems (GEOSS) developed within the framework of the Group on Earth Observation (GEO). The programme was launched in 1998 by the European Commission (EC), ESA, and a number of national space agencies. In 2005, the EU declared GMES a flagship programme along with the Galileo satellite navigation system. The EU has the overall programme management responsibility. ESA offers multi-mission facilities and ground segment operations, as well as the GMES space component (the Sentinel satellites). MS provide contributing missions, both in situ and from space.

The programme has, in the period of 1998–2013, been allocated approximately € 3.2 billion to be used for development and initial operations of services, space and in-situ infrastructures (see table 5). For the period of 20142020, an estimated budget of € 5,841 million (€ 1,091 million for the services, € 350 million for the in situ component, and €4,400 million for the space component) is envisioned for the full deployment, maintenance, evolution and upgrades.[110]

In the European Commission Communication, "A Budget for Europe 2020" of June 2011, it was proposed that GMES be financed outside the EU's Multiannual Financial Framework (MFF) 2014–2020 through a specific GMES fund. This fund would be managed by the Commission, with financial contributions from all 27 EU Member States based on their gross national income (GNI).[111] An agreement to that effect would have to be ratified by the 27 MS, as the EC plan would shift the burden of GMES operations funding to individual member states.[112] Over the upcoming six months, intense discussions will take place among European countries on whether GMES will be funded within, or outside, the EU's MFF 2014-2020. Adopting a long-term view on an investment such as GMES will be key to supporting this forward-looking initiative.

GMES funding	Years 1998–2013
EU funding for the service component	€520 million
ESA funding for the service component	€240 million
EU funding for the space component (FP7 and GMES Initial Operation)	€780 million
ESA funding for the space component	€1,650 million

Table 5: GMES funding for the period 1998–2013.

The GMES is designed to build upon existing scientific research based on EO from space and to advance environmental research and climate change studies, including at an international level. As the thematic areas within the so-called "GMES service components" include climate change information, beyond coordinating the current efforts of individual actors, it will offer new capabilities. One of the functions of the GMES programme, which will integrate Earth observation (EO) satellites and ground-based sensors, is to support the EU's external actions. It will also be able to assist in the prevention and mitigation of disasters such as flooding, forest fires and oil spills that all require timely and precise information. The GMES Space Segment will deliver land, sea and atmosphere data from space.[113] GMES has a number of pre-operational services, including the following projects: Geoland2, MyOCEAN, SAFER-security oriented system, GMOSAIC, and MACC (see figure 19).

The space segment of Europe's GMES comprises existing satellites (i.e. Spot and Cosmo-Skymed), as well as new satellites (the Sentinel series). ESA has funded most of the R&D work on the dedicated Sentinel satellites. Specifically, ESA is developing five families of Sentinel missions specifically for the GMES space component. The first is to be launched in 2013 (provided funding for its operations and maintenance is secured beyond mid-2014). A preoperational phase of

[110] Communication for the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the European Earth monitoring programme (GMES) and its operations (from 2014 onwards). COM (2011) 831, Brussels (30 November 2011): 4.
[111] Ibid. 5.
[112] Svitak, Amy. "Flagging Flagship: Europe's Showcase Environmental-Monitoring Project Twisting in the Wind". Aviation Week&Space Technology (7 November 2011): 35.
[113] GMES: Observing Our Planet for a Safer World. European Commission. http://ec.europa.eu/gmes/index_en.htm

Figure 19: GMES Pre-operational Services (Source: General Secretariat of the EU Council[114])

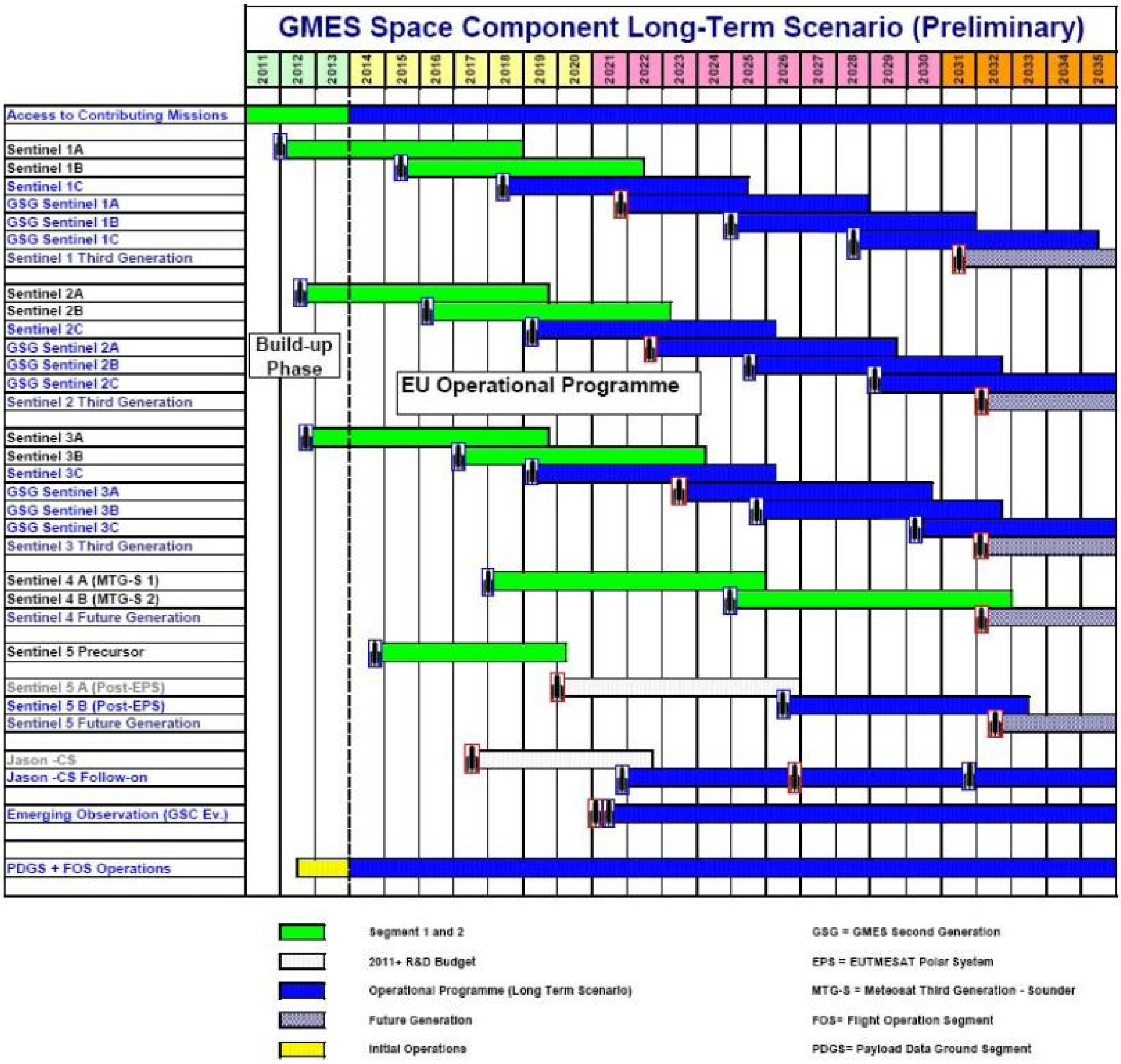


Table 6: Preliminary Launch schedule of the Sentinel Satellites (Source: EC COM(2009)589 final[115])

[114] Burianek, Jiri. "Japan-EU Cooperation in Space: Earth Observation and Related Applications." Presentation.Europe-Japan Space Workshop. European Space Policy Institute, Vienna, Austria.17 January 2012.
[115] Communication from the Commission to the European Pariament, the Council, the European Economic and Social Committee and the Committee of the Rregions "Global Monitoring for Environment and Security (GMES): Challenges and Next Steps for the Space Component". Brussels: European Commission (28 October 2009): 49.

GMES was launched in 2008 and initial operations are expected to begin by 2014 (see table 6).

The GMES programme has substantial potential to advance Europe's key policy objectives, including in the areas of environment and security (see table 7). Advanced optical and radar sensors of the remote sensing satellites can produce accurate analyses of the Earth environment and human development. They can also offer a permanent global perspective and upgrade continuously Geographic Information Systems (GIS).

EC Strategic Policy Priority	GMES Policy Domain
The European Union as a global partner (External policies)	Climate Change Mitigation and Adaptation Global environment protection and sustainable development Development and Aid Common Foreign and Security
Preservation and management of natural resources	Natural resources (agriculture, fisheries) Biodiversity and ecosystem management European environmental protection Risk and civil protection (from natural and technological disasters)
Sustainable growth ▪ Competitiveness for growth and employment ▪ Cohesion for growth and employment	Cross cutting issues including: ▪ Lisbon Agenda ▪ Efficient delivery of public services ▪ Support to strategic industries ▪ Regional policy
Citizenship, freedom, security and justice	Security, Border Control

Major issue	Wider benefit
Global environment	Climate change Desertification Development and aid Humanitarian aid and food security
Security	Common Foreign & Security Policy Border surveillance
Natural resources	Agriculture Biodiversity and ecosystem services Fisheries
European environmental protection	Air quality, Water quality, Land use and regional policy, Urban environment and spatial planning, Marine and coastal environment protection
Risk and civil protection	Floods, Forest fires, Urban subsidence, Landslides, Earthquakes, Industrial accidents
Sustainable growth	Competitiveness

Table 7: EC's Policy Priorities in the Context of GMES Services (Source: EC COM(2009)589 final) [116]

[116] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIALCOMMITTEE AND THE COMMITTEE OF THE REGIONS "Global Monitoring for Environment and Security (GMES): Challenges and Next Steps for the Space Component". Brussels: European Commission (28 October 2009): 49.

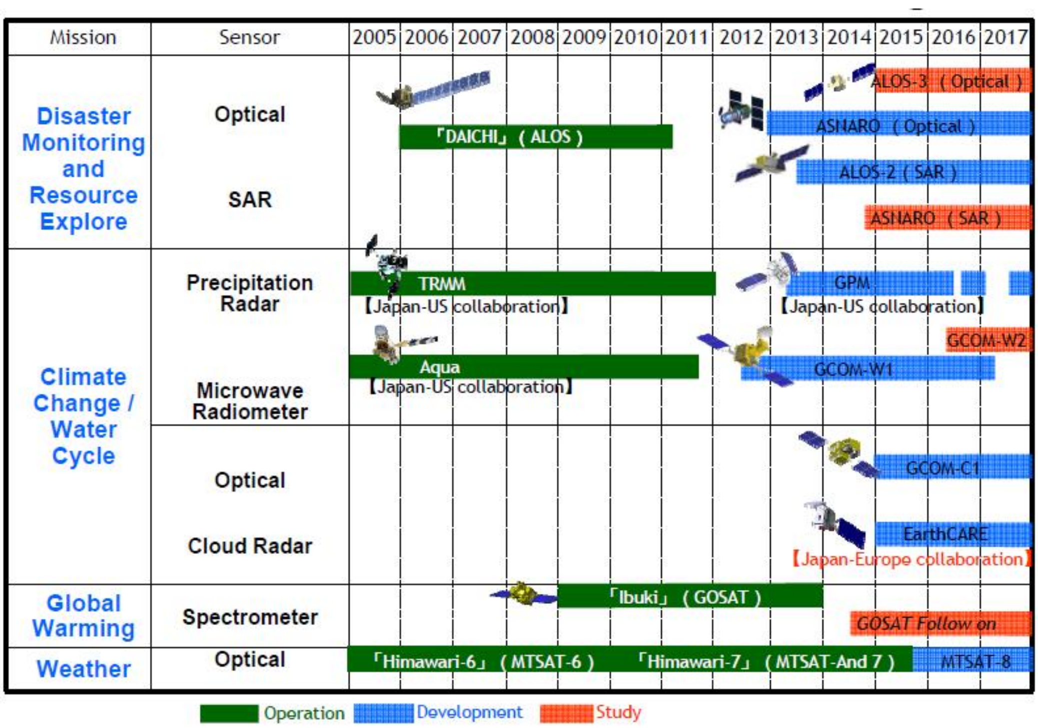


Figure 20: Japan's Earth Observation Programme (Source RESTEC[117])

3.2.2 Japan's Earth Observation-Related Activities

Japan had been involved in remote sensing activities since the 1970s with initial focus on scientific research. Japan launched its first satellite, the Marine-Observation Satellite Momo-1, in 1987. Based on the Basic Plan for Space Policy of June 2009, Japan now considers Earth observation capabilities as an indispensable element in its social and economic development, as well as environmental preservation. Concerning the latter, it provides essential information concerning global warming worldwide and its potential impact on Japan. Earth observation is also considered an essential element of national security. Since the Taepodong-1 missile launch by North Korea in 1998, Japan had sought to acquire independent remote sensing capabilities for national security. In March 2003, Japan launched its first two reconnaissance satellites.

Japan has a distinguished tradition of Earth observation activities. Its first observation satellites were Marine Observation Satellites MOS-1a and MOS-1b launched in 1987 and 1990. Subsequently the Japanese Earth Resource Satellite-1 (JERS-1, also known as Fuyo) and the Advanced Earth Monitoring satellite (ADEOS, also called Midori) were developed, followed by the Advanced Land Observing Satellite ALOS (also called Daichi). In 2006, the Japan Meteorological Agency started to use microwave radiometer sensors (including the AMSR-E the Japanese sensor aboard the NASA satellite Aqua for the global numerical prediction model). JAXA also provided the Light Particle Telescope (LPT) for the 2008 Jason-2 satellite of the French Space Agency (CNES).[118]

Currently, the "Global Change Observation Mission" (GCOM) is to establish and demonstrate a global, long-term satellite system to measure essential geophysical parameters for better understanding of world climate change and water cycle mechanism. The GCOM system will be comprised of two satellites and three consecutive generations are foreseen to sustain a 13-year observation period. GCOM-A1 was launched in January 2009, together with the Greenhouse Gasses Observing satellite (GOSAT, also known as Ibuki), and several microsatellites.[119]

After JAXA terminated efforts in May 2011 to recover the Advanced Land Observing Satellite (ALOS) that operated for five years after being launched in January 2006, Japan is planning the launch of ALOS-2 (with radar L-band) to sun-synchronous orbit in 2012 and ALOS-3 (a multispectral, high resolution satellite) in 2013. With regard to weather satellites, Japan launched the Multi-Functional Transport Satel-

[117] Matsuura, Naoto. "Japan's Earth Observation Activities". Presentation. Europe–Japan Space Workshop. ESPI, Vienna. 17 Jan 2012.

[118] 2011 European Space Directory. Paris: ESD Partners (2011): 106-107.

[119] Ibid:107

lite 1R (MTSAT-1R) in February 2005 and MTSAT-2 in February 2006 (see figure 20).[120]

The Basic Space Plan prioritises six "Basic Pillars", five Systems and four Programs. Earth observation is especially relevant for the first three pillars: 1) "rich, secure and safe life"; 2) "security through utilisation of space", and 3) "space diplomacy". EO satellites contribute to: societal needs (pillar 1); national security (pillar 2); and protecting humans from natural threats (pillar 3). Two of the five systems are "Land and Ocean Satellite System to contribute to Asia and other regions" (see figure 21) and "Global Environmental Change and Climate Observing Satellite System" (see figure 22). The priorities delineated for Earth observation activities are, as in other areas, emblematic of a shift from research to utilitarian applications.

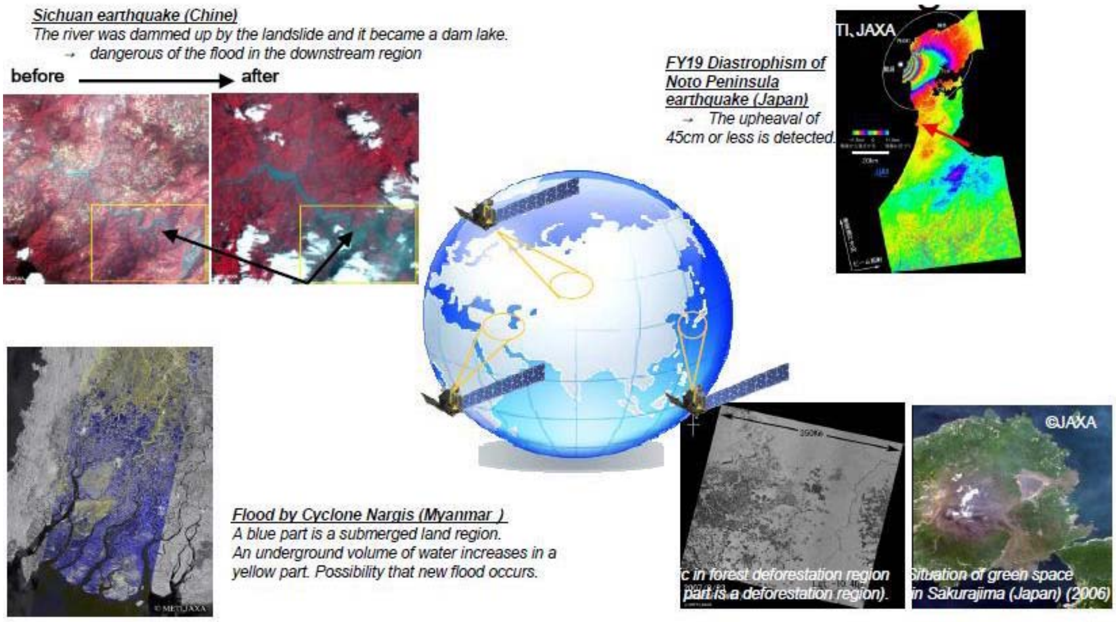


Figure 21: Land and Ocean Observing Satellite System to contribute to Asia and other regions (Source: Japan' Strategic Headquarters for Space Policy[121])

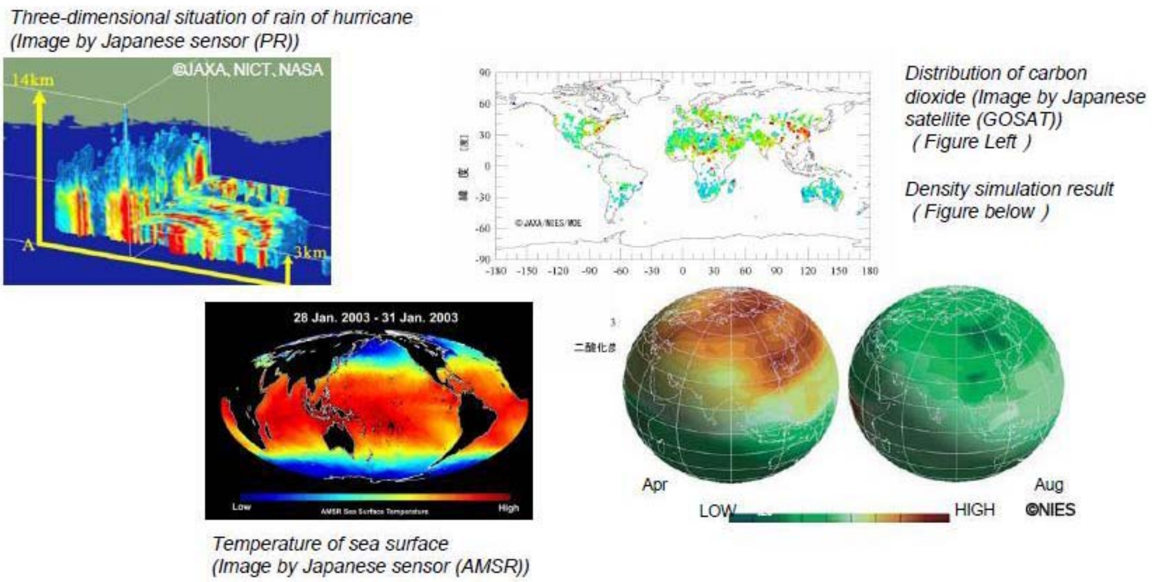


Figure 22: Global Environmental Change and Climate Observing System (Source: Japan' Strategic Headquarters for Space Policy[122])

[120] Ibid.
[121] Kunitomo, Hirotoshi. "Update on National Space Policy Development of Japan and Space Security". Presentation. Europe-Japan Space Workshop. ESPI, Vienna. 17 Jan 2012.
[122] Ibid.

Japan is actively involved in all of the main EO-relevant international fora, including the CEOS, GEO/GEOSS (see figure 23), and International Charter "Space and Major Disasters".

Based on international activities concerning the need for a global coordinated Earth observation system (GEOSS), Japan's Council for Science and Technology Policy (CSTP) issued the "Earth Observation Promotion Strategy" in December 2004 to lay out Japan's general policy concerning Earth observation. The Council stated that an integrated observation and monitoring system represents a key national technology.[123] Japan places emphasis on global warming, climate change and natural disasters (see figure 24).

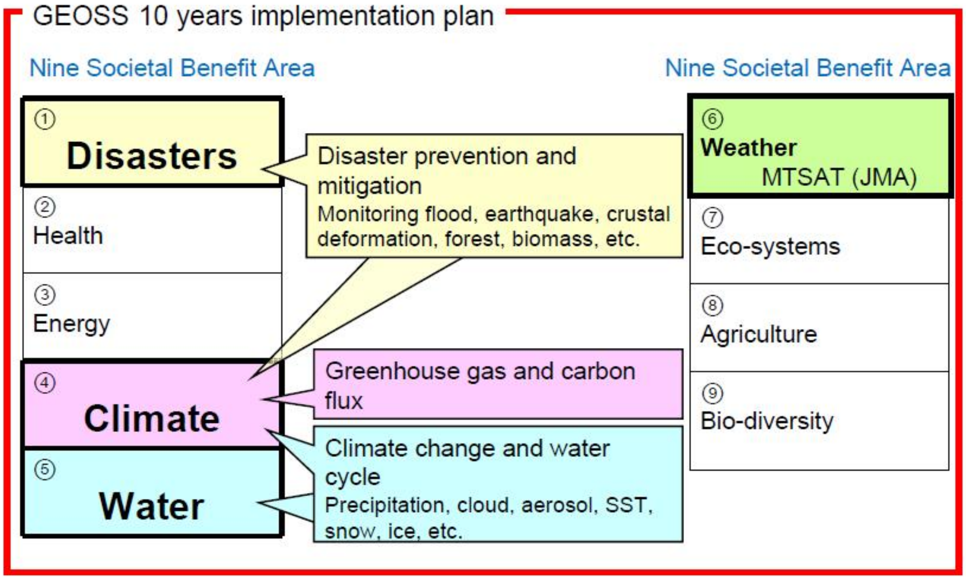


Figure 23: Japan's main Earth observation capabilities for GEOSS (Source: RESTEC[124])

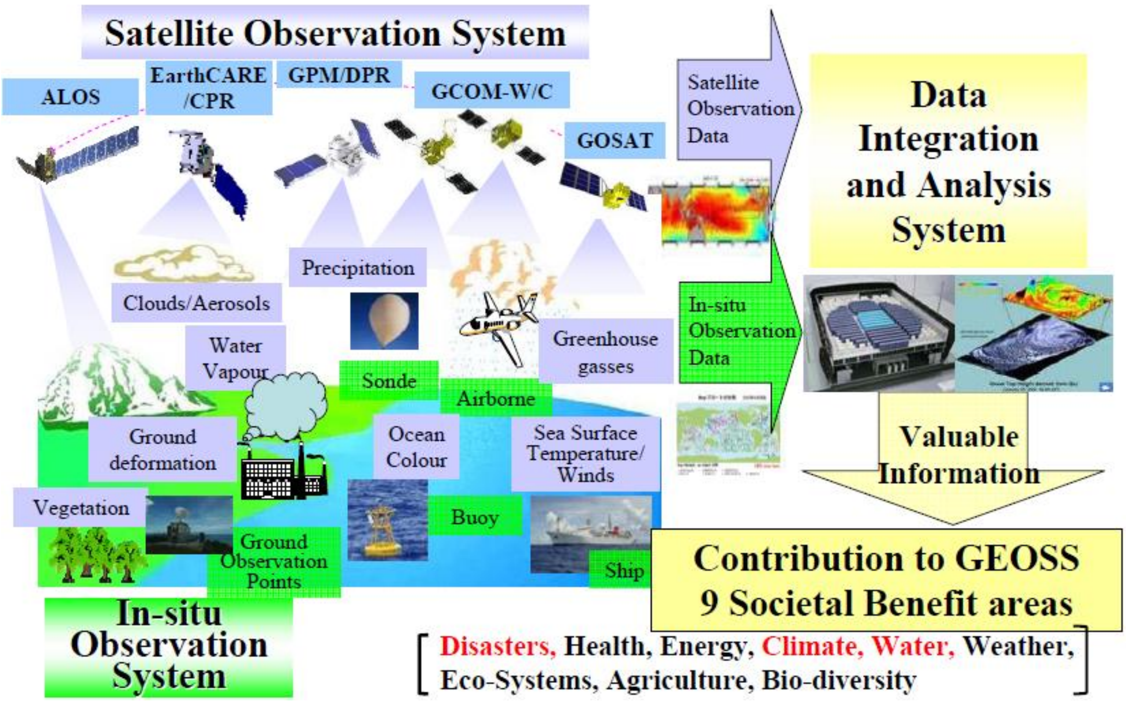


Figure 24: Japan's Contribution to the 9 GEOSS Societal Benefit Areas (Source: RESTEC[125])

[123] "Japan's Earth Observation Satellite Development Plan and Data Utilization Strategy". Special Subcommittee on Earth Observation of the Space Activities Commission (July 2005): 2.
[124] Matsuura, Naoto. "Japan's Earth Observation Activities". Presentation. Europe–Japan Space Workshop. ESPI, Vienna. 17 Jan 2012.
[125] Ibid.

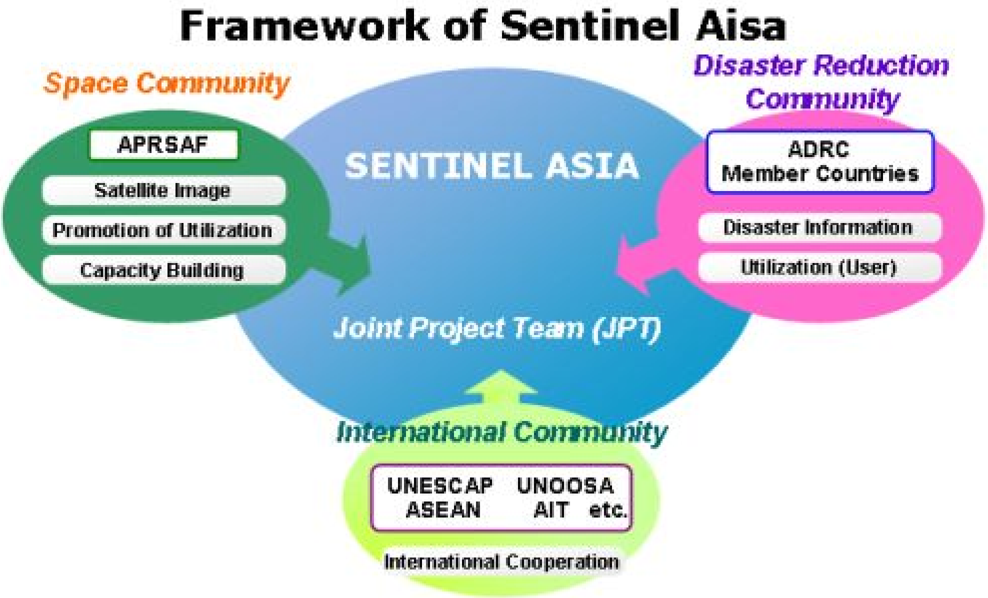


Figure 25: Framework for Sentinel Asia (Source: Sentinel Asia website)

The International Charter, "Space and Major Disasters", is a prime example of international cooperation in the field of natural disasters. In February 2005, JAXA joined the International Charter during the third Earth Observation Summit.

At a regional level, Japan has been instrumental in launching the Sentinel Asia initiative, a voluntary activity led by the APRSAF (Asia-Pacific Regional Space Agency Forum) to support disaster management activity in the Asia-Pacific region by use of the WEB-GIS technology and space based technology, including EO data (see figure 25). There are three main steps to establish a comprehensive dissemination system that include: "implementation of the backbone 'Sentinel Asia' data dissemination system and associated Nodes, to showcase the value and impact of the technology using standard internet dissemination systems (February 2006 - December 2007); expansion of the dissemination backbone with new Satellite Communication Systems (2008–2012); and establishment of a comprehensive DMSS (2013 and onwards)".[126]

3.2.3 Europe-Japan Cooperation in the Field of Earth Observation

Europe and Japan share many key policy priorities that involve use of Earth observation satellites and derived information. These include, space for societal and economic benefits, environmental protection and climate change monitoring, and security (including disaster management).

Societal and economic benefits, as well as security, including through international cooperation, will be derived from Europe's GMES and Japan-initiated Sentinel Asia Project. Climate change is one of the four priorities delineated in the EU's 6th Environmental Action Plan (EAP). The 5th Space Council recognised climate change as a new priority area within the European Space Policy. The third pillar of Japan's Basic Space Plan calls for "utilisation of space for diplomatic policy" to protect humans from the threat of climate change, disasters, etc. Internationally, both Europe and Japan have been actively involved in the goals of the UN Environment Programme (UNEP) and the UN Framework Convention on Climate Change (UNFCCC), which provides an overarching structure for intergovernmental efforts to deal with climate change.

Thanks to the large amount of available environmental data generated on a daily basis by space-based and other sensors, international environmental conventions, and similar gatherings, can be supported by more informed decision-making. At the same time, due to the complex mechanisms driving global climate change, international cooperation on making reliable predictions concerning the long-term consequences of climate change for human development is essential. Moreover, international conventions and other environmental-related agreements can be successful only when backed by solid verification and compliance.

In this connection, space-based systems are an invaluable source of information for better

[126] "About Sentinel Asia". Sentinel Asia website. <https://sentinel.tksc.jaxa.jp/sentinel2/MB_HTML/About/About.htm>

understanding and managing of our fragile planet as well as for verification purposes. Closer mutual coordination of their activities and priorities can advance Europe's and Japan's role as international leaders in responding to climate change.

Active engagement of both Europe and Japan in Earth observation-related endeavours is based on solid foundations they have each developed nationally. Both sides also have pursued opportunities to cooperate on a bilateral basis. Concrete cooperative ventures include endeavours such as JAXA's sensor contribution to the CNES' ADEOS-2 satellite and the ESA-JAXA cooperation on the EarthCARE mission.

Japan provided two sensors for the Advanced Earth Observing Satellite-2 (ADEOS-2) of the French Space Agency, CNES. The satellite acquired data to better understand the nature of global environmental changes (including global warming) and to support meteorology and fishery activities. The JAXA sensors include: Advanced Microwave Scanning Radiometer (AMSR) for quantitatively observing various geophysical data concerning the water cycle; and GLobal Imager (GLI) for observing oceans, land and clouds with high accuracy. ADEOS-II was launched in December 2002 by the H-2 launcher from Tanegashima Space Center and was lost the following year in October 2003.[127] JAXA also provided the Light Particle Telescope (LPT) for the 2008 Jason-2 satellite of CNES.[128]

A prime example of cooperation is ESA's cloud, aerosol and radiation mission, "EarthCARE". EarthCARE is the largest and most complex of ESA's Earth Explorer missions and is being developed as a joint venture between ESA and JAXA. The mission, scheduled for launch in 2015, will seek to gain insights with regard to the role clouds and aerosols play in reflecting incident solar radiation back into space and trapping infrared radiation emitted from Earth's surface. This knowledge is required to improve climate predictions and weather forecasts.[129]

Another cooperative venture involves the ALOS satellite. Based on an ESA-JAXA agreement, ESA became responsible for the ALOS European data Node (ADEN) and has been delivering data from the ALOS EO satellite to users in Europe and Africa. Within the ADEN network, ESA, JAXA and other partners cooperated in producing a wide range of environmental datasets. Its Phased Array type L-band Synthetic Aperture Radar (PALSAR) acquired 24/7 all-weather observations. PALSAR data also complemented ESA's radar missions, such as Envisat and ERS-2, and the European National X-band missions, such as the German TerraSAR-X and Italian Cosmo Skymed constellation. The Panchromatic Remote-sensing Instrument of Stereo Mapping (PRISM) onboard ALOS could observe selected areas in three dimensions, down to a high 2.5-metre spatial resolution. The Advanced Visible and Near Infrared Radiometer type-2 (AVNIR-2) charted land cover and vegetation in visible and near infrared spectral bands. Applications of the observations include the domains of forestry, global carbon monitoring, oceanography, sea-ice monitoring, agriculture and vegetation monitoring, topography and disaster mitigation. ALOS was launched in January 2006 and ESA was supporting ALOS through its ground infrastructure and expertise to acquire, process and distribute data from the satellite to its user community (so called 'Third Party Mission').[130] Its mission was completed in 2011.

With regard to the International Charter Space and Major Disasters, given the trend that reveals an increased number of natural disasters such as floods, droughts, landslides, fires, earthquakes and tsunamis and the effects of climate change, the need for a flexible response system will most likely continue to grow. The International Charter is currently a voluntary regime. In the future, support for a more binding instrument could prove beneficial. The GEO could also become an entity providing operational support for delivering timely EO-related information.

To support ongoing cooperation between Europe and Japan as well as to strengthen Europe's and Japan's standing in international efforts utilising Earth observation capabilities and derived products, both sides should consider including Earth observation in the proceedings of the annual EU-Japan Summits and other fora. These debates can include discussion on the ways both sides engage in GEO and identify opportunities for Europe to engage actively in the regional APRSAF. An indirect step in this direction was taken at the 2011 EU-Japan Summit which introduced space into its deliberations, specifically satellite navigation and the draft Code of Conduct for Outer Space Activities. Accordingly, the

[127] "Orbitography". French Space Agency website. <http://smsc.cnes.fr/POLDER/GP_satellite.htm>.
[128] 2011 European Space Directory. Paris: ESD Partners (2011): 106-107.
[129] "ESA Call for EarthCARE Mission Advisory Group Members". European Space Agency website (14 Nov 2011). <http://www.esa.int/esaLP/SEMN9YVWVUG_LPearthcare_0.html>.
[130] "ESA awarded by Japan Aerospace Exploration Agency". ESA News (23 January 2009). <http://www.esa.int/esaEO/SEMJP5WPXPF_index_0.html>.

doors have been opened for expanding space-related dialogue under the framework of these summits.

The overarching goal is not just to gain more data, but rather to advance the coordination of existing capabilities and data at an international level. Using EO-derived information effectively and efficiently offers fertile ground for enhancing key foreign policy objectives via bilateral and multilateral cooperation.

Relevant recommendations appear below:

- *Promote EO-related cooperation that supports Europe's and Japan's broader policies, including at EU-Japan Summits:* Europe and Japan share many key policy priorities (identified, for example, in "Europe 2020" strategy and Japan's "New Growth Strategy" and "Comprehensive Partnership Policy") that involve use of Earth observation systems. These systems possess, in some cases uniquely, the capability of supplying continuous and comprehensive information about the Earth, including over extended periods. The priorities identified by the EU and Japan include space for societal and economic benefits, environmental protection, climate change monitoring/mitigation, and security (including disaster management). Enhanced EO-focused cooperation would strengthen support for EO utilisation and its greater commercialisation, and improve implementation of broader objectives such as innovation, competitiveness, environmental protection, sustainable energy and sustainable management of natural resources.
- *Promote strengthened position of Europe and Japan in multilateral EO-relevant venues:* Existing fora or venues, such as the Committee on Earth Observing Satellites (CEOS), the Group on Earth Observation (GEO) and its 10-year implementation plan (GEOSS), the ESA-EU "GMES Space Component" programme, ESA's Climate Change Initiative (CCI), International Charter Space and Major Disasters, and regional Sentinel Asia all seek to enable comprehensive monitoring and data collection. Gaps remain, however, between having access to unique EO-derived data (including environment and climate change-related) and the ability to effectively utilize it. Such international coordination, which seeks to, among other things, avoid duplication and redundancy, facilitate data sharing and raise awareness of EO potential in other communities, requires a special, sustained diplomatic and executive effort. Closer mutual coordination of Europe's and Japan's activities and priorities in these venues has the potential to bolster their role as international leaders in responding to environmental, climate change, and disaster management issues, to name only a few.
- *Advance commercialization of EO/remote sensing through steady institutional support:* Although remote sensing has yet to become a fully viable commercial business, as the users become more familiar with the benefits of using space-derived data with other sources of geographic information, EO is poised for considerable growth in the coming years. Commercial data revenue alone is expected to increase more than threefold in the next 10 years.[131] A more robust commercial market will also result in improved decision-making processes for both governments and commercial users. Joint dialogue should involve issues ranging from how to bolster awareness of satellite observation capabilities, accelerate the transition of satellite use from research to operations, improve capacity-building investments in user communities, encourage investment in applications and services, and reduce the gap between users and suppliers of data.

3.3 Industry-To-Industry Cooperation

The space industrial base is comprised of three primary segments: space (satellites and other spacecraft), launch and ground systems. Industry supports civilian governments, the military and commercial markets. The development and manufacturing sector and space operations constitute the "upstream" sector, and a wide variety of service-related business activities constitute "downstream" activities. Although the downstream segment represents a much larger source of revenues, that and the upstream segment are linked at a technology and commercial level. Development and manufacturing can create new applications and the market helps guide investment into the upstream sector.[132]

These markets are described in the Space Foundation's Space Report as the global

[131] "Asia Pacific Satellite-based Earth Observation Market". 25 Mar. 2011. Frost & Sullivan 23 Feb. 2012 <http://www.researchandmarkets.com/reports/1803560/asia_pacific_satellite_based_earth_observation>.
[132] Hayward, Keith. "The Structure and Dynamics of the European Space Industry Base." ESPI Perspectives 55. Vienna (December 2011):1.

space economy divided as follows: commercial satellite products and services ($ 102 billion), commercial infrastructure and support industries ($87.39 billion), U.S. government space budgets ($64.63 billion), non-U.S. government space budgets ($22.49 billion), and commercial human space transportation services ($0.01 billion). The total value of the global space economy is estimated to be some $276.52 billion.[133]

The Satellite Industry Association data show a continued, but somewhat slower, growth of the satellite industry worldwide. In 2010, the world satellite industry revenue amounted to approximately $168 billion, up 4.5% from 2009. Most of the revenue was derived from satellite services (60%), ground system equipment (31%), satellite manufacturing (6%) and launch services (3%).[134]

Governments play a key role in the development of space products and services. Accordingly, the space business is influenced significantly by governments and other institutional actors. Over 80% of global space activities involve public institutions as investors and operators. Governments also control market access and space technology transfers.[135] The U.S. continues to spend the most in space (its space budget is nearly 10 times the size of European institutional spending). Its export control regime (i.e. the International Traffic in Arms Regulations (ITAR) and the Export Administration Regulations (EAR)), which also applies to commercial products, has proven, however, to have an adverse impact on the U.S. industrial base.

Export controls constitute one of the foremost obstacles to foreign space markets for the U.S. companies, especially affecting smaller firms. At the same time, as the U.S. governmental space activities are closed to non-U.S. suppliers, it has a competitive advantage and technology developed for military programmes that have often proved the foundation for commercial space applications. During the Cold War, the U.S. government primarily operated satellites to serve its needs. Gradually, it has started to offer services directly to the public (e.g. GPS, remote sensing products and services). Public free access stimulated the development of the associated commercial market.[136] The inverse is generally true for Europe.[137]

Technology transfer programmes and business incubators initiated by governments also stimulate development of space products, services and spin-offs. ESA's Technology Transfer Programme (TTP), for example, seeks to identify industrial needs and space technology spinoffs that could meet those needs. Subsequently, the European space incubator activities support the creation of start-up companies that can commercialize the technology. Governments also promote development of new commercial space products and services by serving as the major purchasers or tenant customers of the product, guaranteeing financing (e.g. through export credit agencies), as well as space-related regulations supporting the required level of transparency and due-diligence. Advancing new ideas is also stimulated by cash prizes and competitions. The European Satellite Navigation Competition of 2010, for example, incentivized contestants by offering a grand prize of €20,000 to offer new uses of the satellite positioning, navigation, and timing systems and received 357 submissions.[138]

This following will cover spacecraft manufacturing and operations and space applications. Launchers are covered in section 3.1.1. of this report.

3.3.1 Europe's Space Industry

The EU is the largest single market comprising some 499.8 million people (as of January 2009[139]) and its gross domestic product (GDP) in market terms amounting to about €12 trillion in 2010[140], exceeding that of the U.S. Europe maintains the world's second-largest aerospace industry. European companies (mainly Thales Alenia Space, EADS Astrium and, more recently, German OHB), together with the U.S. companies (Space Systems/Loral, Lockheed Martin, Boeing, Orbital Sciences), constitute the largest satellite manufacturing firms.

133 "The Space Report 2011: The Authoritative Guide to Global Space Activity." The Space Foundation (2011): 6.
134 "State of the Satellite Industry Report". Satellite Industry Association (June 2011).
135 Hayward, Keith. "The Structure and Dynamics of the European Space Industry Base." ESPI Perspectives 55. Vienna (December 2011):2.

136 "The Space Report 2011: The Authoritative Guide to Global Space Activity." The Space Foundation (2011): 28-30.
137 Ibid.
138 Ibid.
139 "The EU Population Continues to Grow: Population Statistics in Europe 2008, First Results". Eurostat 31 (2009). <http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-QA-09-031/EN/KS-QA-09-031-EN.PDF>.
140 "European Union Economic Report: GDP Data and GDP Forecasts; Economic, Financial and Trade Information; EU and population Overview." Global Finance. <http://www.gfmag.com/gdp-data-country-reports/631-the-european-union-gdp-economic-report.html#axzz1kGpywsrX>.

The two main markets for the European space industry are the institutional domestic market (civil and military), and the external commercial and export market, the former of which represented half of the space manufacturing industry's final sales in 2009. The main institutional customers were ESA (worth €1.8 billion sales), space agencies (worth €0.5 billion), and military agencies (worth €0.35 billion). The total value of military systems sold exceeds the value of sales to military entities due to the fact that military systems can be procured by certain civilian customers (e.g. civil agencies such as CNES, DLR and ASI as well as private operator Paradigm, etc.). The main commercial and export sales were linked to commercial satellite operators (€1.26 billion), primarily those in geosynchronous (GEO) orbit, and launch service providers that procure launch systems from industry (€800 million). Export sales include a share of institutions and governmental bodies outside Europe. Satellite applications represent one sector of European industry that has significantly grown in the past twenty years.[141]

As operations in space require specific and reliable technologies and transportation that are expensive, companies have high fixed costs. Accordingly, reliability and a good reputation play a significant role in selecting suppliers. The globalisation of the supply chain and ownership that increasingly characterizes the aerospace sector is less common in the space sector. Small and medium enterprises (SMEs) constitute less than 5% of European space manufacturing employment but they are important as they are part of a complex knowledge transfer chain and innovation network. At the same time, the SME participation in the space sector may have only limited influence on strengthening European space industry competitiveness.[142]

Spacecraft Manufacturing

The European space manufacturing industry is part of the broader aerospace and industrial complex. The industry is highly concentrated and vertically integrated. The four largest industrial holdings are EADS, Finmeccanica, Safran and Thales together representing some 70% of total space industry employment. The space manufacturing industry is distributed across all Europe. The major industrial sites are located in France, Germany, Italy, and on a smaller scale, in the UK, Spain and Belgium. The core space manufacturing activity is the design, development and manufacturing of satellites for operational applications (€3 billion), launchers (€1 billion), scientific activities (€0.8 billion), and ground systems and activities (€0.4 billion).[143]

In 2009, European manufacturers seized 50% of the accessible market for satellites. Telecommunications applications constituted two-thirds of the satellite sales and the commercial market reflects the cyclical nature of the demand for telecommunications. European space manufacturing generates only a modest profit. Over the past ten years, only 23% of space activities in Europe led to a profit of over 3%. Nineteen companies declared zero profits or experienced a loss. This same pattern occurred at the global level as low returns accompanied by long-term risks are often considered too risky for many private investors. Accordingly, institutional funding will continue to play a major role in assuring a viable space industry.[144]

Satellite Operations and Services

Some eleven companies engage in satellite operations in Europe, including major companies such as Inmarsat, Eutelsat, and SES. The majority of space-based services are in the telecommunications field that is highly profitable. The Earth Observation (EO) services are only marginally developed, as fragmentation of EO services decreases the level of competitiveness in the higher value EO market. However, there is an increasing interest on the part of upstream companies to engage in EO-related business due to better opportunities to deliver integrated services accompanied by improved economies of scale.[145]

Satellite operations are more profitable than space manufacturing. Value added activity in this sector is double that of space manufacturing. The European satellite operator sector enjoys direct employment of some 4,000 workers with a turnover of over €3 billion (from which €1.5 billion is traded outside the EU). The barriers to entry are less significant than in space manufacturing. The UK's start-up, Avanti Communications, a regional UK satellite operator, for example, raised more than 70% of its funding in the UK and received the remainder from public sector R&D investment. Avanti's first satellite, called

[141] European Space Directory 2011. ESD Partners, 26th Edition, Paris (2011), pp. 30-31.

[142] Hayward, Keith. "The Structure and Dynamics of the European Space Industry Base." ESPI Perspectives 55. Vienna (December 2011):2-3.

[143] The numbers cited are from Eurospace 2009 survey. More information at www.eurospace.org.

[144] Hayward, Keith. "The Structure and Dynamics of the European Space Industry Base." ESPI Perspectives 55. Vienna (December 2011):4.

[145] Hayward, Keith. "The Structure and Dynamics of the European Space Industry Base." ESPI Perspectives 55. Vienna (December 2011):4.

HYLAS 1, was launched on 26 November 2010 and is the first superfast broadband satellite launched in Europe. Avanti's second satellite, called HYLAS 2, is fully funded and will be launched in second quarter of 2012. It will extend Avanti's coverage to Africa and the Middle East.[146]

Institutional Considerations

At an institutional level, national, intergovernmental and supranational entities all shape space policy and the funding of space programmes. Although Europe's space industry is heavily influenced by national government decision-making, European-level public policy is playing an increasingly important role in shaping the industry with the EU and ESA at the forefront of this dynamic. Some 40% of the funding is derived from individual governments and most of the remaining funds come from ESA. The European Commission (EC) seeks enhanced coordination of European space actors (i.e. member states, ESA, EUMETSAT and the EU).

This is to be accomplished by a proposal for an EU space program linked to the EU's multi-year budget. The industry views this EC initiative overall as positive. However, there are concerns over the level of funding the EU will be able to provide given the tough budget environment. The EC backs the Galileo positioning, navigation and timing system and debates are ongoing concerning the funding of the Global Monitoring for Environment and Security (GMES) effort (described in more detail in section 3.2.2. of this report). Europe is seeking to reconcile the needs of a complex, long-term programme with EU funding procedures. The EC also seeks to address the gap in Europe concerning its military and civilian space activities, although defence-related issues are outside the powers of the EC.

The main concerns for Europe in shaping long-term space programmes is to establish a comprehensive strategy and "vision" for space and understanding the commercial needs of emerging markets (e.g. in the EO field). Moreover, the policies need to reflect the special nature of the space market where international competition is largely influenced by non-commercial factors.[147]

Horizon 2020, Europe's new instrument for implementing research and innovation policy, is also relevant for space-related activities. Research and innovation are a key element of the Europe 2020 strategy which seeks Europe's global competitiveness without compromising environmental and social objectives. Horizon 2020 was adopted to simplify RTD funding and to integrate more effectively sectoral policies to improve transformation of knowledge into innovation.[148] With regard to the space industry, the EC calls for a space industry policy that "fully reflects the specific needs of each subsector" and promotes global competitiveness, non-dependence in strategic sub-sectors (e.g. launching), and the development of market for space products and derived services.

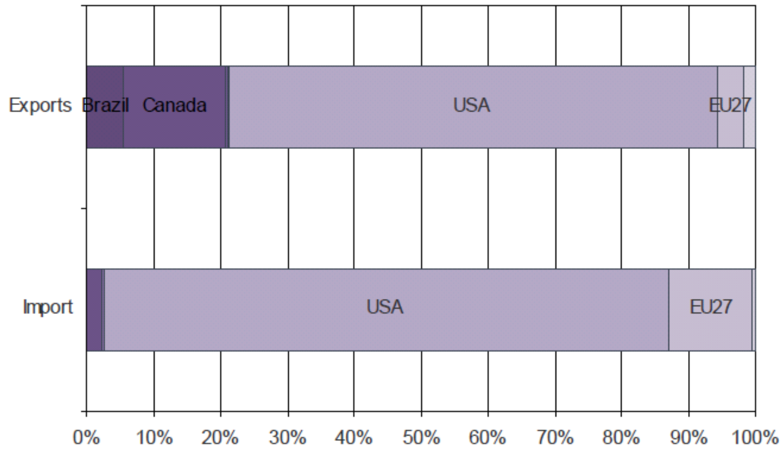
Horizon 2020 has funding of €80 billion and is divided in four parts: excellent science, industrial leadership, societal challenges and direct actions (non-nuclear) of the Joint Research Centre (JRC). Space is included in part two (including innovation of SMEs). The Horizon 2020 strategy and international cooperation are designed to: strengthen Europe's competitiveness, non-dependence and innovation in space activities; enable advances in space technologies; enable more effective exploitation of space data; and support European research to facilitate international space partnerships. Implementation of these goals is to be guided by the space policy direction identified in the EC's Communication "Towards a space strategy for the European Union that benefits its citizens" (COM(2011)152).[149]

The above mentioned document is Europe's space strategy. With regard to the space industry, the policy calls for a firm technological base for competitiveness of the space industry. The influence of the EU space industrial base is envisioned to be enhanced by innovation. Such innovation is, in turn, to be driven by determining ambitious space objectives.[150]

3.3.2 Japan's Space Industry

Japanese trade relations are concentrated among a few main partners (see figure 26). They include (as at 2007): the U.S. (around 85% of imports and 73% of exports), the EU (contributes around 12% to Japanese imports

[146] "Welcome to Avanti". Avanti Communications website. < http://www.avantiplc.com/home>
[147] Hayward, Keith. "The Structure and Dynamics of the European Space Industry Base." ESPI Perspectives 55. Vienna (December 2011):5.
[148] "Horizon 2020 – A Common Strategic Framework for EU Research and Innovation Fund". PRO INNO EUROPE (25 August 2011). <http://www.proinno-europe.eu/inno-grips-ii/article/horizon-2020-common-strategic-framework-eu-research-and-innovation-funding>.
[149] Burianek, Jiri. „Japan-EU Cooperation in Space: Earth Observation and Related Applications". Presentation at the Europe–Japan Space Workshop. Vienna: ESPI (17 Jan 2011).
[150] Stone, Christopher. "Collective assurance vs. independence in national space policies". The Space Review (16 May 2011). <http://www.thespacereview.com/article/1843/1>.



	Import	Exports
Other	28	34
EU27	568	82
USA	3868	1468
South Africa	0.4	0.03
Russian Federation	4	0
India	0	0.3
China	3	10
Canada	109	303
Brazil	0.2	110
Australia	0.4	2

Figure 26: Japan's Exports and Imports shares and values by main trade partners in 2007, in million Euros (Source: Ecorys)

and receive 4% of exports), and Canada (its share on Japanese exports constituted 15% and of imports a mere 2.4%).[151]

The Japanese aerospace industry is dominated by four companies: Mitsubishi Heavy Industries (MHI), Kawasaki Heavy Industries (KHI), Ishikawajima-Harima Heavy Industries (IHI) and Fuji Heavy Industries (FHI). These companies do not only specialize in aerospace field but are diversified across many segments such as automobiles, shipbuilding, industrial machinery and power systems. Generally space products make up some 15–20% of total sales (see figure 27).[152]

The Japanese space budget is about $4 billion annually. Two-thirds of the budget comes from the MEXT and is transferred to JAXA and the remainder comes from eight other government ministries.[153] JAXA's current budget is about one-tenth of that of NASA and one-half of ESA's budget (see figure 28).[154]

Japanese space activities currently involve: launch vehicles, H-2 Transfer Vehicles (HTV), services, space science, communications satellites, and Earth observations satellites. Its path has been, however, more gradual. There is limited capital invested in comparison with, for example, the U.S., Russia and Europe. This reality is visible in the high cost of domestic spacecraft in relation to foreign products. To remedy this situation, Japan seeks to establish itself as a technologically independent and self-sustained industrial base through the implementation of the 2009 Basic Plan for Space Policy[155], as well as recovery from some of the impediments of the past.

[151] "FWC Sector Competitiveness Studies - Competitiveness of the EU Aerospace Industry with focus on: Aeronautics Industry Within the Framework Contract of Sectoral Competitiveness Studies – ENTR/06/054". Munich: Ecorys (15 December 2009): 268-269.
[152] Ibid.
[153] Selding, Peter. „Japanese Government Seeks To Reorient Space Spending" Space News (28 September 2010). <http://www.spacenews.com/civil/100928-japan-reorient-space-spending.html>
[154] Mamiya, Kaoru. „Industry-to-Industry Cooperation". Presentation. Europe-Japan Space Workshop. ESPI, Vienna, Austria. 17 Jan 2012.
[155] Japan's Aerospace Industry Prospects and Challenges". The Society of Japan Aerospace Industries: IIST World Forum (21 December 2009). < http://www.iist.or.jp/wf/magazine/0723/0723_E.html>

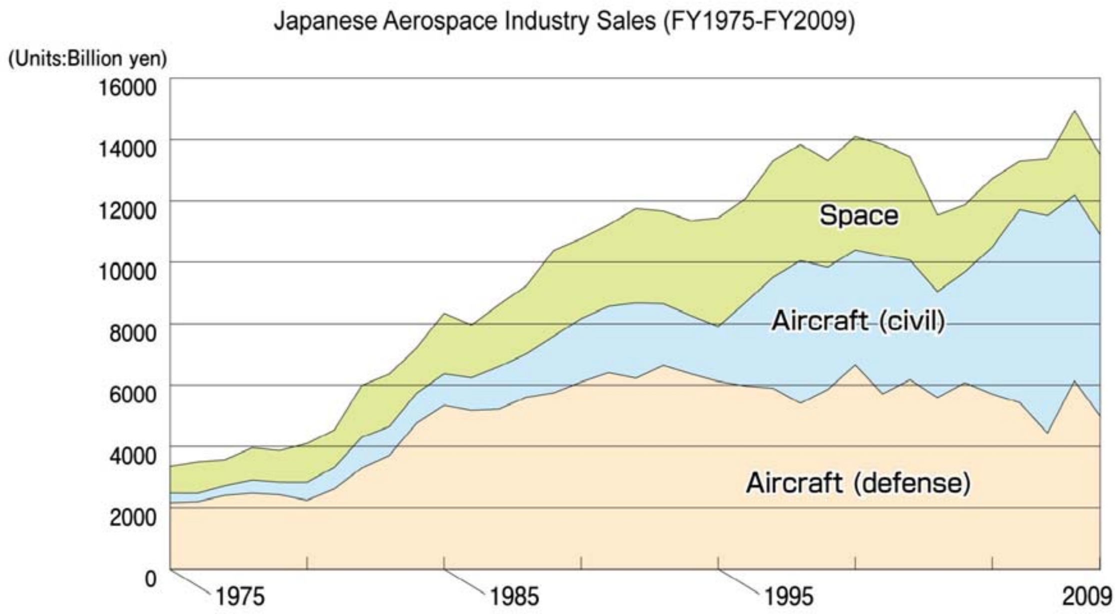


Figure 27: Japanese Aerospace Industry Sales FY1975-2009 (Source: SJAC)[156]

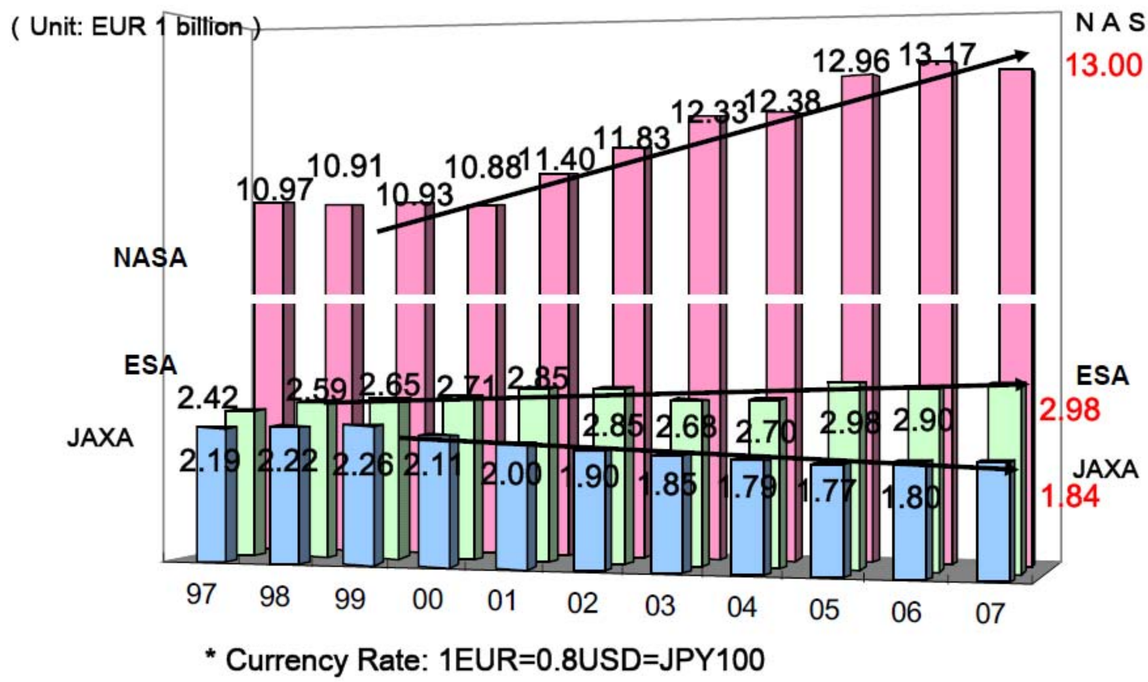


Figure 28: Comparative table of NASA, ESA, JAXA budget (source: JSF)

[156] <http://www.bciaerospace.com/malaysia/images/stories/progconfpresentations/sjac_jun_ono.pdf>

The U.S.–Japan Satellite Procurement Agreement of 1990, stemming from trade friction between the U.S. and Japan, for example, required Japan to open its non-R&D satellite procurement to foreign (mainly U.S.) satellite manufacturers which stifled the indigenous Japanese satellite industry. As a result, Japan procured most of the satellites from the U.S., and invested more resources into "R&D" satellites. That is why, in many respects, Japan still has a strong space science presence, but fledgling space commercialization.[157] A change began with the need to acquire independent satellite capability for national security reasons, including intelligence-gathering satellites (IGS) and a legal change of the 1969 Diet resolution restricting strategic implementation of space activities. This ultimately led to the new 2008 Basic Space Law and 2009 Basic Plan for Space Policy opening new opportunities for Japanese industry.

Space Manufacturing

Japanese space industry sales totalled ¥269 billion for FY 2009 (approximately $3.26 billion, €2.56 billion) and employed 6300 workers. There has been an increase in sales for two consecutive years as Japan elevated supplies for the ISS and national launchers. Most of the sales, therefore, have been driven by domestic demand. In comparison, the European space industry is more exposed to international markets as commercial and export sales represent almost 50% of revenues. 2009 revenues amounted to €5.5 billion (approximately $7.5 billion) with 31,369 employees.[158]

Satellite Communications Sector

As referenced above, satellite communications and broadcasting is the most profitable commercial space market. Revenues are generated mainly through the sales of capacity (i.e. leasing of satellite's transponders) and added value services. The bulk of business is derived from television. Direct broadcast satellite (DBS) services have penetrated Japan (as well as South Korea) and users can now subscribe to satellite services and watch TV on their mobile phones.[159]

In 2005, Japan received its first commercial contract to manufacture a communications satellite. Mitsubishi Electric Corp (Melco) entered a contract with a Japanese satellite communications services company, the Space Communications Corporation (which was later purchased by SkyPerfect JSAT Corp.), to build a communications satellite, Superbird-7 (renamed Superbird-C2 on orbit). It was the first commercial order of a Mitsubishi DC-2000 type satellite. It was launched on Europe's Ariane-5 ECA rocket in 2008. The satellite provides television and telecommunications broadcasts mainly for Japan.

Japan now operates the Wideband InterNetworking engineering test and Demonstration Satellite, Kizuna, which performs demonstrations that will enlarge the capacity of information networks. Kizuna was jointly developed by JAXA and the National Institute of Information and Communications Technology. It was launched in February 2008. Besides establishing ultra-high speed Internet network, the goal is also to construct international Internet access with other Asia-Pacific nations.[160] Japan has also developed the Engineering Test Satellite series (Kiku, meaning chrysanthemum in Japanese) with the aim of acquiring highly capable satellite communications technology. Japan also operates the KODAMA data-relay satellite which performed successfully inter-satellite communications experiments with the Earth observation satellite Daichi, Kibo and Europe's Envisat.

Institutional Aspect

The adoption of the Basic Space Law in 2008 and subsequent adoption of the Basic Plan for Space Policy in 2009 have been positive developments for Japanese industry as the government places significant emphasis on the practical utilisation of space, international cooperation and scientific research and development. As the space industry plays an important role in Japan's national space program, the government seeks to strengthen Japanese industrial competitiveness. One of the six pillars in the Basic Plan is "fostering strategic industries for the 21st century" (see figure 29). In terms of spacecraft develop-

[157] Aoki, Setsuko. "Current Status and Recent Developments in Japan's National Space Law and its Relevance to Pacific Rim Space Law and activities". Journal of Space Law, Vol. 35 (2009): 367-368.

[158] The Space Economy at Glance. OECD, Directorate for Science, Technology and Industry (22 July 2011). <http://www.oecd-ilibrary.org/sites/9789264111790-en/03/01/index.html?contentType=/ns/Chapter&itemId=/content/chapter/9789264113565-9-en&containerItemId=/content/book/9789264111790-en&accessItemIds=&mimeType=text/html>

[159] The Space Economy at Glance. OECD, Directorate for Science, Technology and Industry (22 July 2011). <http://www.oecd-ilibrary.org/sites/9789264111790-en/03/02/index.html?contentType=/ns/Chapter&itemId=/content/chapter/9789264113565-10-en&containerItemId=/content/book/9789264111790-en&accessItemIds=&mimeType=text/html>

[160] JAXA website. http://www.jaxa.jp/projects/sat/winds/index_e.html

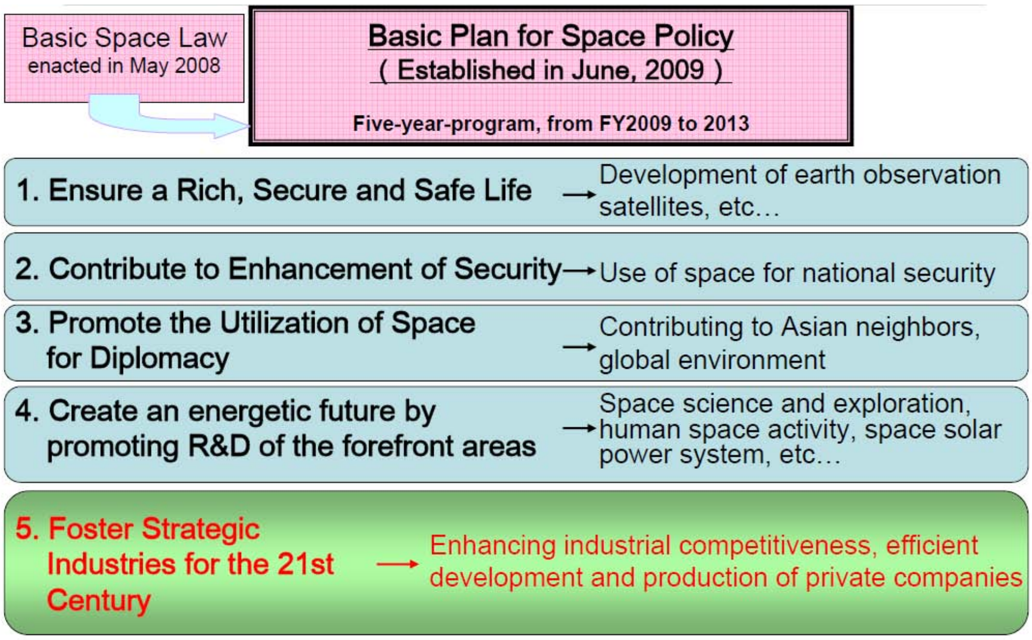


Figure 29: Basic Plan for Space Policy and Industry (Source: JSF)

ment, this involves creating internationally competitive space systems with improved performance, reduced costs and shorter development periods, as well as promoting business in overseas markets and the domestic commercial market. In remote sensing, the focus is on greater utilisation of EO-derived information and services, growth of the satellite data market and development of data applications (e.g. in energy and mineral resources).[161]

Under the new Basic Space Law, the main responsibility for Japan's space strategy, including relevant programmes and projects, has been transferred from JAXA (focused mainly on R&D) to the to the Strategic Space Headquarters for Space Policy, chaired by the Prime Minister. This creates new opportunities to continue improvements in R&D while also advancing the commercialization of space technologies by Japanese companies. This will create better international competitiveness of the space industry. According to Futron Corporation (a U.S. consulting firm), Japan ranks fourth (after the U.S., Europe and Russia) in terms of its overall space competitiveness. Japan outperformed China due to greater transparency within civil and military space organizations. This positive trend shows the potential for a robust Japanese space industry.[162]

[161] Kaneko, Shuichi. "Policies on Japan's Space Industry". Ministry of Economy, trade and Industry (METI).
[162] "Space Industry in Japan". GlobalTrade.net. (13 March 2011) < http://www.globaltrade.net/f/market-research/text/Japan/Aerospace-Space-Industry-in-Japan.html>.

3.3.3 Europe-Japan Space Industry Cooperation

The industrial dialogue between the EU and Japan has been conducted through various venues. The goal of these dialogues has been to establish a transparent, open and stable business environment and contribute, through better cooperation between the EU and Japan, to stronger economic relations with third countries.

Unlike Europe, Japan is mainly an importer of aerospace products and services and does not rely much on aerospace exports.[163] Companies in Japan that seek to expand their space industry business require imports to complement their own technology. Accordingly, imports for the Japanese space industry have been rising (according to the Society of Japanese Aerospace Companies). North America and Europe are the major exporters to Japan. In 2008, 98% of Japanese imports were spacecraft out of which 72% were satellite-related.[164]

The success or failure of any cooperative endeavour depends, in large part, on capable industry. This needs to be accompanied by shared understandings concerning the prac-

[163] "Trade". The Space Economy at Glance 2011. http://www.oecd-ilibrary.org/sites/9789264111790-en/06/03/index.html?contentType=/ns/Chapter&itemId=/content/chapter/9789264113565-32-en&containerItemId=/content/book/9789264111790-en&accessItemIds=&mimeType=text/html
[164] "Space Industry in Japan". GlobalTrade.net. (13 March 2011). <http://www.globaltrade.net/f/market-research/text/Japan/Aerospace-Space-Industry-in-Japan.html>.

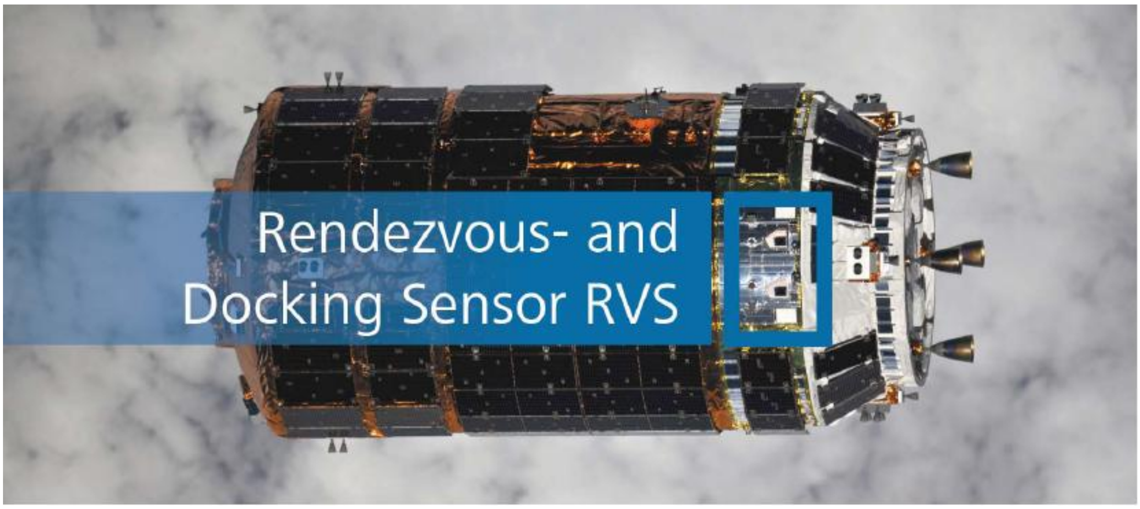


Figure 30: Rendezvous- and Docking Sensor RVS (Source: Astrium)

tices, culture and methodology of the partner. A successful partnership has been ongoing, for example, through the partnership between Mitsubishi Electric Corporation (MELCO) and Astrium which began with an exchange of engineers in the 1980s (each staying for a period of 1–2 years). Their cooperation was further stimulated by the partnering of the then parent companies in 1995 (i.e. Daimler-Benz and Mitsubishi). Although facing a number of security requirements with regard to military and dual-use projects, the engineer exchange programme is still ongoing.[165]

Another example is represented by a joint decision by ESA and JAXA to develop a Rendezvous- and Docking Sensor (RVS) for ATV and HTV (see figure 30). Jena-Optronic served as a contractor and MELCO and Astrium as industrial customers. In 2008, Jena-Optronic received a contract from MELCO for the delivery of an additional 12 RVS flight models. In large part due to this successful cooperation, the HTV successfully docked to the ISS in September 2009 and, again, in January 2011. The RVS, with its application to enable fully automated approach, berthing and docking of unmanned supply vehicles to the ISS, also enhanced technologies for future space missions.[166]

Other cooperative missions of Astrium include Jena-Optronic Star Sensors for Japanese customers (for ALOS-2, Jaxa's QZSS, and Turksat), BepiColombo, EarthCare, for the supply of subsystems or equipment for commercial satellite programs, and critical equipment for institutional programmes. Numerous Japanese companies are standard suppliers for Astrium commercial satellites and vice versa.[167]

As evident from these examples, European and Japanese companies are already engaged in various institutional and commercial programmes and both partners can provide excellent technical quality and management skills. Accordingly, industry representatives of both Europe and Japan are well-positioned for enhanced cooperative undertakings as their programme characteristics, capabilities and competencies match well. Both the EU and Japan are in the pursuit of new space policies and are in the process of determining the ultimate vision for space within their domestic and foreign policy objectives. Industry is the backbone of these pursuits.

The EU and Japan created a Business Roundtable (BRT) in 1999 where some 50 CEOs and senior executives from European and Japanese firms meet annually to review business cooperation between them. They also propose policy recommendations to the European Commission (EC) and Japanese government, representatives of which participate in the roundtable, particularly concerning trade promotion and regulatory means. The EC and the Japanese government, in turn, submit a Progress Report on the level of BRT implementation of recommendations of the previous year. The working parties (WP) of the BRT prepare the annual meeting. The WP currently are on: "Multilateral & Bilateral Trade Relations, Investment and Regulatory Cooperation"; "Life Sciences & Biotechnology; Healthcare & Well-Being", "Innovation; Information & Communication Technologies"; "Financial Services; Accounting & Taxation"; and "Energy, Environment and Sustainable

[165] Lindenthal, Andreas. "Industrial Cooperation Europe-Japan." Presentation. Europe-Japan Space Workshop. ESPI, Vienna, Austria. 17 January 2012.
[166] Ibid.
[167] Ibid.

Development".[168] Venues such as the Europe-Japan Business Roundtable (EU-Japan BRT) and the broader EU-Japan Summit can serve as important platforms for promoting the space industries of both sides.

In the process of seeking to expand industry-to-industry relations, it will be important to determine what level of access that foreign suppliers of space equipment and technology have to the space infrastructures of Europe. Similarly, European suppliers will likely seek reciprocal treatment should Europe allow such market opening. The strategic and technology-sensitive nature of national space programs complicates expanded space-related trade, but with active communications and the building of greater trust such relationships can become more frequent and durable. The EU-Japan Mutual Recognition Agreement of January 2002[169], the Agreement on Cooperation and Anti-competitive Activities of June 2003[170], the Agreement on Cooperation and Mutual Administrative Assistance[171] and the Science and Technology Agreement of November 2009[172] are important steps in this direction.

Relevant recommendations appear below:

- *Level the playing field for investment and industrial involvement:* Space is, per definition, transcending borders. The benefits of globalisation experienced in many other fields should also increasingly be harvested in the space domain. Europe and Japan should be trail-blazers in allowing and fostering Europe/Japan cross-boundary investment in space industries, and should actively seek mutual engagement of European and Japanese industry in both commercial and governmental ventures.
- *Provide cooperative institutional support for space applications to enable greater utilisation of space:* High-level institutional dialogue can assist in shaping the strategies of both partners to advance their respective space-related industries. Given the large volume of official documents dealing with space policy, industry policy, science and technology policy, etc. it is often difficult to identify the relevant activities of both sides that warrant specific discussion, much less connect them. Commercialisation, closely connected with advancing space industries, needs to attract strong government support. Determining space objectives, enabled by collaboration, can drive innovation and competitiveness for each side's space industry. Joint pursuit of such objectives will strengthen the practical utilisation of space (e.g. offering international competitive space systems with improved performance, reduced costs and shorter development periods). There would also be benefits associated with better penetration of overseas markets and their respective domestic commercial markets. The improved integration of satellite communications, Earth observation and position, navigation and timing (PNT) could constitute promising areas for such enhanced industrial cooperation.
- *Stimulate innovation policies of Europe and Japan through space collaboration:* EU-Japan relations are already well-established through a number of existing fora. Innovation, a priority growth area for both sides, is closely linked to international collaboration and can address possible bottlenecks as observed by the EU's "Innovation Union" programme. Space activities require cutting-edge technologies that stimulate innovative ideas. Space-related research and development fuels open innovation for greater global competitiveness. A strengthened EU-Japan industrial partnership, beyond the current framework, can have broad, durable benefits, particularly in the areas of research and development, skill and knowledge transfer, sharing resources and information, and enhancing capability development.
- *Provide support for competitive European and Japanese space industries on the world market:* The space industry is a

[168] "EU-Japan Business Roundtable". EU-Japan Business Roundtable website. <http://www.eu-japan-brt.eu/index.php?content=round-table>.
[169] Commission of the European Communites. Council Decision of 27 September 2001 concerning the conclusion of the Agreement on Mutual Recognition between the European Community and Japan. 2001/747/EC of 27 September 2001. Brussels: European Union 8 Mar 2012 <http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2001:284:SOM:en:HTML>.
[170] Commission of the European Communities. Agreement between the European Community and the Government of Japan concerning cooperation on anti-competitive activities. 22003A0722(01) of 22 July 2003. Brussels, European Union 8 Mar. 2012 <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:22003A0722(01):EN:NOT>.
[171] Commission of the European Communities. Agreement between the European Community and the Government of Japan on cooperation and mutual administrative assistance in customs matters. 22008A0306(01) of 6 March 2008. Brussels, European Union 8 Mar. 2012 <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:22008A0306(01):EN:HTML>.
[172] "The Science and Technology Agreement between the EU and Japan". 9 Jul. 2010. EU News 200/2010 8 mar. 2012 <http://www.deljpn.ec.europa.eu/modules/media/news/2010/100709.html>.

growing source of economic growth and competitiveness. The upstream industry is highly centralized in both Europe and Japan and present challenges to the entrance of small and medium-sized enterprises (SMEs). This can be partially compensated for by the larger downstream industrial sector that can generate substantial revenues with lower barriers for the SME entrants. Accordingly, Europe and Japan should actively explore cooperation on specific, high-profile space projects that are emblematic of the large-scale contributions space assets can offer their respective societies, as well as stimulate the growth of the space industries of both sides (e.g. small satellites or space-based solar power).

3.4 Space Security

Space Security (Security for Space)

Space security represents a key element of overall space policy and is a concern for all principal users of space (i.e. commercial, civilian and military). The Space Security Index uses the following definition of space security: "the secure and sustainable access to, and use of, space and freedom from space-based threats". Europe labelled this concept as "security for space" in its 7th Space Council Resolution of November 2010.[173] The resolution called for defining and introducing appropriate measures to monitor and protect space-based infrastructure, both through technology and diplomatic means. Japan has addressed the need for space security as one of the fundamental principles of the 2008 Basic Space Law that underlines "protection of outer space environment to achieve sustainable development and use of space". One of the measures designed to implement this principle is to "facilitate international cooperation to preserve the space environment".[174]

To achieve a predictable and stable space environment where all actors behave responsibly, there is a need to promote full adherence to the 1967 Outer Space Treaty (OST), as well as subsequent understandings. These include the development of Space Situational Awareness (SSA) and sharing the data; clarifying proper conduct for commercial, civil and military actors in space, including through the use of Transparency and Confidence-Building Measures (TCBMs) which will, among other benefits, facilitate international cooperation and interaction between the private and public sectors as well as address the degradation of the environment of Earth orbits due to the space debris (including through strengthening debris mitigation and enabling responsible debris removal).

Good space governance requires clear guidance, informed decision-making, comprehensive management, and consistent policies. Existing legal foundations, including Space Treaties and various bilateral and multilateral mechanisms and initiatives (such as the IADC and UN Space Debris Mitigation Guidelines and the international Code of Conduct for Outer Space Activities), represent a major head-start in addressing 21st century space-related challenges. In addition, space security governance can be encouraged by promoting self-restraint, self-control and self-discipline through demonstrating that sustainability of the space environment is squarely in the interests of all space-faring nations. This can be advanced by building a system of incentives and disincentives to all those that operate in space.

Space Situational Awareness (SSA) supports the safe and secure operation of space assets and related services, as well as risk management (on orbit and during re-entry) and liability assessment. Increasing numbers of space-faring nations and space aspirants, as well as new and emerging space technologies, complicate space surveillance and make comprehensive SSA of space objects a difficult task. There have been a number of efforts to advance space security through SSA, including a program of the U.S. to cooperate in preventing on-orbit collisions via the sharing of SSA-derived information with commercial operators and other governments. Thus the U.S. SSA Sharing Program offers services to users and partners. The U.S. Department of Defense has also signed bilateral SSA statements of principles with Canada, France, and Australia, and seeks to expand cooperation with other countries as well.[175] Another initiative is that of the Space Data Association (SDA) which seeks to exchange SSA information among satellite owners and operators. Indeed, broader discussions are already underway on the need to create a more com-

[173] Council Resolution: "Global challenges: taking full benefit of European spacesystems". Council of the European Union (26 November 2010): 9. <http://register.consilium.europa.eu/pdf/en/10/st16/st16864.en10.pdf>.

[174] Aoki, Setsuko. "Current Status and Recent Developments in Japan's National Space Law and its Relevance to Pacific Rim Space Law and activities". Journal of Space Law, Vol. 35 (2009): 386-389.

[175] Rose, Frank A. "U.S. Remarks on Space Security at UNIDIR Conference, April 2011" 4 Apr. 2011 Council on Foreign Relations. 2 Mai. 2011 <http://www.cfr.org/defensehomeland-security/us-remarks-space-security-unidir-conference-april-2011/p24615>.

prehensive SSA picture and share data and information internationally. These discussions are aimed at contributing to the improved security of space assets for responsible space-faring nations.

For its part, Europe recognizes that SSA is essential for the protection of critical European space infrastructure as well as for reliable and safe space-based operations and services. SSA capability is likewise viewed as an important element of Europe's extensive efforts to promote the peaceful uses of outer space. Europe possesses some radar and optical capabilities for space surveillance, often operated by different countries. Accordingly, Europe is seeking to construct a pan-European SSA system that would support the safe and secure operations of European space assets. Other counties, including Japan, are also seeking to improve their space surveillance capabilities.

The growing amount of orbital space debris remains one of the key challenges for a safe space environment. Space debris in the altitudes up to 200 km are burned in the atmosphere within days, those in altitudes up to 800 km can orbit the Earth for years, even decades, and those above 800 and in the geostationary orbit can remain there virtually forever. China's destruction of its aging weather satellite by an ASAT weapon in 2007, and the 2009 collision of Cosmos and Iridium satellites, moved space debris on to the radar screen of a global audience which, until that time, had not been especially sensitive to this issue. The U.S. Department of Defense (DOD) currently tracks approximately 22,000 man-made objects in orbit. About 1,100 of these are active satellites. The Joint Space Operations Center (JSpOC) of the US Air Force screens over 1,000 active payloads against the USG's space catalogue daily. Moreover, the US Space Surveillance Network (SSN) performs 1.4 million sensor taskings per week with an average of 190 conjunction warnings and assistance to an average of three satellite manoeuvres weekly.

Space for Security

Both Europe and Japan also place an emphasis on the utilisation of space systems for various security purposes on Earth. These include the use of communications, positioning and navigation, and Earth observation systems for tackling environmental issues (including climate change), disaster management, and national (in case of the EU labelled "external") security. The 7th Space Council resolution placed particular emphasis on establishing appropriate mechanisms to exploit effectively space systems to monitor, mitigate, and adjust to climate change, including through international partnerships. It also emphasized the role of space assets (and especially GMES) for security applications on Earth, including maritime surveillance, border control and support for the EU's external actions (including crisis management).

In Japan, the Basic Space Law identifies the use of space for security-related challenges on Earth in its provisions dealing with: "improvement of human security and creation of a safe and secure society"; "improvement of national security"; and "promotion of international cooperation". These are further translated into measures for "promoting space development and use to contribute to national and international security". The Basic Space Law also lifted the ban on the use of space technology for national security activities. Accordingly, Japan's Self Defence Force (JSDF) can develop, manufacture, and own and operate defence-related satellites to support its terrestrial operations, including ballistic missile defence within the scope of national self-defence.[176]

3.4.1 Europe's Objectives for Space Security

In Europe, space is now considered a strategic priority and increasingly an essential component of policy planning and decision-making. The topic of space security has gained momentum through such developments as the European Space Policy of May 2007 and the Lisbon Treaty of 2009, the latter of which gave the European Union (EU) an explicit mandate to be involved in space matters, as a competence to be exercised parallel to Member States. The main European-level institutions dealing with space-related issues are the European Space Agency (ESA) and the EU. ESA is increasingly involved in security matters. In June 2011, for example, ESA concluded an administrative arrangement with the European Defence Agency (EDA) that aims primarily at exploring the added value and contribution of space assets to the development of European capabilities in the area of crisis management and the Common Security and Defence Policy (CSDP).

The High Representative for Foreign Affairs and Security Policy, who is also a Vice-President of the European Commission and President of the Foreign Affairs Council, is supported by the European External Action Service (EEAS) and supervises two institu-

[176] Aoki, Setsuko. "Current Satus and Recent Developments in japan's National Space Law and its Relevance to Pacific Rim Space Law and activities". Journal of Space Law, Vol. 35 (2009): 386-388.

tions important for space security: the European Union Satellite Centre (EUSC) and the European Defence Agency (EDA). EUMETSAT, an independent intergovernmental organisation, is likewise important as it provides its members and cooperating states with weather-related Earth observation data and services, a major portion of which is destined for defence-related institutions.

The Resolution on European Space Policy (ESP) adopted in May 2007 clearly asserted the strategic importance of space for Europe and called for a „structured dialogue on space and security" involving the European Council (EC), the European Commission (EC), and the European Space Agency (ESA). The European Space Policy (ESP) promotes moving toward more interoperable, coordinated space capabilities among the relevant entities.

The Lisbon Treaty gave the European Union (EU) a stronger role in space as well as the mandate to strengthen its international engagement in security and defence matters. Accordingly, as it expands its international role, the EU is seeking to develop a comprehensive approach to space-related areas, including space security. The 7th Space Council Resolution of November 2010, as well as European Council Conclusions of May 2011, acknowledged the increasing dependency of the European economy and policies on space assets and recognized the need for an independent Space Situational Awareness (SSA) capability.

As the Common Security and Defence Policy remains an intergovernmental policy under the Lisbon Treaty, any meaningful space security cooperation needs to involve close coordination between individual European countries. Most of Europe's security-related space programmes have been conducted on a national level or through government-to-government collaboration. Accordingly, there is a high level of duplication and fragmentation if looked at from a pan-European perspective. European space technology priorities are also largely shaped by national preferences which can influence contract selection.

The European Commission has been the engine of civilian space security initiatives under EU leadership. The EC established a Space and Security Panel of Experts (SPASEC) that was convened in June 2004 and was followed by a SPASEC Report in March 2005.

The 2008 ESP Progress Report stated that European space capacities have become critical information tools in addressing a diversity of environmental, economic and security challenges on a global and regional scale. Autonomous access to information derived from space is thus a strategic EU asset. The EU will need to strengthen further its ability to respond to these challenges, including in the security and defence domains, both through improved coordination and the development of indigenous capacities.[177]

Although Europe has made great strides in developing European space systems, there is hesitancy on the part of individual MS to pool, or share, their individual military space capabilities under the EU umbrella as the limitations of doing so are perceived to exceed the benefits. That said, a number of bilateral and multilateral cooperative arrangements have been forged among European countries. The conflicts in Bosnia, Kosovo, Afghanistan and Iraq contributed to altering Europe's approach to military space and greater efforts emerged to coordinate European military space assets, particularly satellite communications and remote sensing.[178]

Five European countries constitute some 99% of military space expenditures. France is the most advanced in the development of military space systems. It operates communications, earth observation and surveillance, and electronic intelligence satellites and plans to launch a space-borne ballistic missile early warning system by 2020. Both Germany and Italy operate synthetic aperture radar (SAR) satellites and Germany also launched five medium-resolution, electro-optical satellites in 2008. France, the UK, Italy and Spain operate geosynchronous satellites for military communications. The Athena-Fidus and SICRAL-2 satellites are a result of cooperation between the French and Italian governments and are slated to be launched in 2013 or early 2014 (SICRAL-1 was launched in 2001).[179]

Concerning imaging capabilities, France took the lead in 2001, in cooperation with Germany, Italy, Spain, Belgium, and Greece, with a joint agreement on the Besoins Operationnels Communs (BOC, or common opera-

[177] Commission of the European Communities. Commission Working Document – European Space Policy Progress Report. COM(2008)561 final of 11 Sep. 2008. Brussels: European Union. 15 Dec. 2010. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0561:FIN:en:PDF>: 6.

[178] Robinson, Jana. "Europe's Key Foreign Policy Objectives Via Space". ESPI Report 30. Vienna: European Space Policy Institute (February 2011): 26-27. < http://www.espi.or.at/images/stories/dokumente/studies/ESPI_Report_30_FINAL.pdf>.

[179] Robinson, Jana. "Europe's Key Foreign Policy Objectives Via Space". ESPI Report 30. Vienna: European Space Policy Institute (February 2011): 26-27. < http://www.espi.or.at/images/stories/dokumente/studies/ESPI_Report_30_FINAL.pdf>.

tional requirements). The purpose of the BOC was to develop uniform requirements for a European global satellite observation system for security and defence purposes. The rationale was to expand already existing arrangements between France and Italy on the Orfeo system, consisting of the Pleiades optical system and Italian Cosmo-SkyMed radar component. In 2006, the six BOC signatory countries launched studies for a Multinational Space-Based Imaging System for Surveillance, Reconnaissance and Observation (MUSIS) with the goal of harmonising future optical and radar observation systems. It envisioned going beyond mere exchanges of military intelligence images and provide the users from the six countries with access to all space-based assets in a transparent and coherent manner. As EDA's Capability Development Plan includes space-based imaging capability for CSDP missions, the EU also became involved in March 2009. Thus EDA agreed to the MUSIS project, envisioned to be launched between 2015–2017. However, the future of the project has not been clear as the countries have struggled to agree on common requirements.[180]

Security for Space

Concerning the EU, the focus has been on efforts to enhance space security through the draft Code of Conduct for Outer Space activities, building European Space Situational Awareness (SSA) capabilities, and participating actively in multilateral venues, including the UN Committee on the Peaceful Uses of Outer Space (COPUOS).

The draft international Code of Conduct for Outer Space Activities introduced in 2008 by the European Union (EU), a revised version of which was put forth in September 2010, has been Europe's most significant space security-related initiative. The draft text of the Code of Conduct included transparency and confidence building measures and recognized that a comprehensive approach to safety and security in outer space should be guided by the following principles: freedom of access to space for all peaceful purposes; preservation of the security and integrity of space objects in orbit; and due consideration to the legitimate defence interests of states.[181]

With this non-binding, top-down, initiative, the EU sought to:

- "Strengthen existing UN Treaties, principles and other arrangements, through the subscribing parties pledging to comply with them";[182]
- "Complement UN Treaties, principles and other arrangements by codifying new best practices in space operations, including through notifications and consultations that strengthen the confidence and transparency among space actors and contribute to developing good faith solutions that would permit the performance of space activities and access to space for all."[183]

After reviewing the EU's proposal, the U.S. decided not to sign the draft of the Code of Conduct in its current form, but announced that it will "join with the European Union and other nations to develop an International Code of Conduct for Outer Space Activities".[184] The discussions will most likely benefit from inputs by space-faring nations reacting to the EU's draft Code. Perceived shortcomings of initiatives such as the Code of Conduct, or global-level governance generally, include that they lack definition in terms of an authority which can enforce the agreed rules and procedures.

The Ministerial Council of the European Space Agency (ESA) authorized an optional SSA Preparatory Programme (SSA-PP) in 2008 with thirteen ESA Member States (MS) currently participating. The approval for further development of the SSA System is expected at the next ESA Ministerial Council in 2012. This three-year Programme, formally launched in January 2009, has sought to develop plans, architecture, and policies to provide space surveillance, space weather prediction and warning, and identification and tracking of Near-Earth Objects (see figure 31).[185]

The stated objective of this initiative has been to "support Europe's independent utilisation of, and access to, space through the provision of timely and accurate information, data and services regarding the space envi-

[180] deSelding, Peter B. „France Reluctant Yet Hopeful on Cooperative Military Space Programs". Space News (5 April 2011). <http://www.spacenews.com/military/110405-questions-euro-coop-milspace.html>

[181] "Council conclusions and draft Code of Conduct for outer space activities" 3 Dec. 2008. COUNCIL OF THE EUROPEAN UNION 11 Oct. 2011 <http://www.eu2008.fr/webdav/site/PFUE/shared/import/1209_CAGRE_resultats/Code%20of%20Conduct%20for%20outer%20space%20activities_EN.pdf>.

[182] Lála, Petr. EU Project for a Code of Conduct for Outer Space Activities. Information Note, June 2009. Online available <http://www.ifri.org/files/Espace/PresentLALA.pdf>

[183] Ibid.

[184] Selding, Peter. „U.S. Endorses Idea of Space Code of Conduct — with National Security Caveat" Space News (18 January 2012). <http://www.spacenews.com/policy/120118-us-endorses-space-code.html>.

[185] „What is SSA? About the programme." 18 May 2010. European Space Agency 3 Mar. 2011 <http://www.esa.int/esaMI/SSA/SEMYTICKP6G_0.html>.

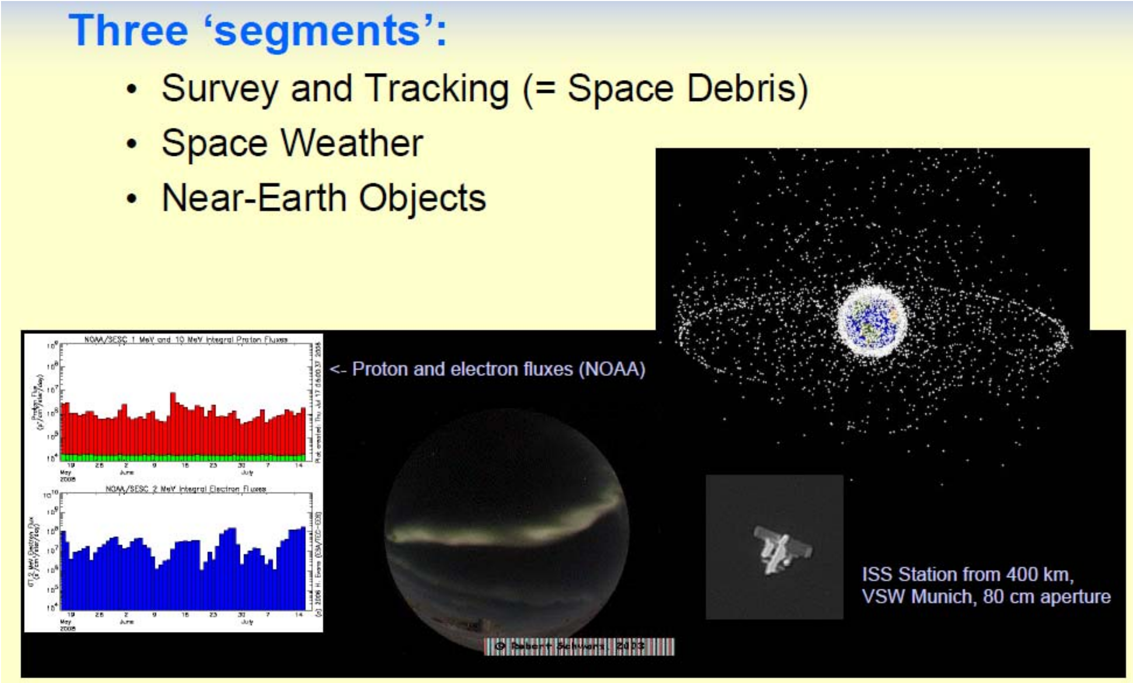


Figure 31: Three segments of European SSA Programme (Source: ESA)[186]

ronment, and particularly regarding hazards to infrastructure in orbit and on the ground". The "hazards" referenced include possible collisions, space weather, and potential threat of Near-Earth Objects (NEOs). The broader goal is to build an autonomous SSA capability to detect, predict, and assess threats to life and property in space, or stemming from the space environment and activities.[187] Concerning the SSA system's architecture, Europe envisions integrating existing as well as new assets, of private, national and intergovernmental entities. A network of ground- and space-based sensors would provide input data to a set of SSA Service Centres based on their main functions. The receiving of data from non-European sources would be based on mutually-agreed cooperation conditions. The full operational phase is to be achieved by 2019.

An initiative by the UNCOPUOS on "Long Term Sustainability of Outer Space Activities"[188] is focused on "ways and means of maintaining outer space for peaceful purposes". It was introduced by France in February 2010 in the Committee's Scientific and Technical Subcommittee (STSC). The Subcommittee set up a working group, the task of which is to identify areas of concern for the long-term sustainability of outer space activities and propose measures that could enhance space sustainability for the benefit of all countries. A report, currently scheduled for 2014, is to contain a comprehensive set of practices, operating procedures, technical standards and policies to advance the long-term sustainability of outer space activities.[189] During the STSC session of February 2011, the COPUOS adopted so-called "Terms of reference and methods of work of the Working Group (WG) on the Long-term sustainability of space activities", which specifies objectives, outputs, scope, method of work and a proposed multi-year work plan. Europe actively engages in this initiative through ESA and the member states.[190]

Space for Security

Europe has been increasingly emphasising the use of space systems to enhance security. Security in this context covers not only the military uses of space, but space-based systems for environmental, energy security, crisis management, early warning, peacekeeping, civil protection, and other areas.

Europe's priority programmes, Galileo and GMES, are designed to enhance the management of security-related challenges,

186 Koschny, Detlef. "Current Status of ESA's Space Situational Awareness Near-Earth Object Programme". European Space Agency, SSA-NEO-ESA-HO-028/1.0 (14 Feb 2010). < http://www.unoosa.org/pdf/pres/stsc2010/tech-36.pdf>
187 Ibid.
188 "Long-term sustainability of outer space activities" 8 Feb. 2010. Committee on the Peaceful Uses of Outer Space 10 Oct. 2011 <http://www.oosa.unvienna.org/pdf/limited/c1/AC105_C1_2010_CRP03E.pdf>.

189 For further information see: <http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_987E.pdf>
190 Ibid.

among other tasks. Once operational, Galileo is envisioned to provide the armed forces of the Member States, EU Battle groups and CSDP with navigation capabilities, although the system is considered to be civilian. Although an independent global navigation satellite system capability, Galileo will leverage the benefits of interoperability with the American Global Positioning System (GPS). The operational European Global Navigation Overlay System (EGNOSS), the wide-area augmentation system for Europe, is already deriving the advantages of cooperative arrangements.[191]

One of the functions of the Global Monitoring for Environment and Security (GMES) programme, which will integrate Earth observation (EO) satellites and ground-based sensors, is to support the CSDP. It will also be able to assist in the prevention of disasters such as flooding, forest fires and oil spills that require timely and precise information.

The International Charter, "Space and Major Disasters", initiated by ESA and the French Space Agency (CNES), represents a cooperative structure between space agencies and space system operators in the use of space capabilities to assist in managing crises caused by natural or technological disasters. The Charter can be activated by national authorized bodies from the member countries (e.g. civil protection, rescue, defence or security agencies). They are able to mobilize space and related ground-based resources (e.g. satellites RADARSAT, ERS, ENVISAT, SPOT, IRS, SAC-C, NOAA satellites, LANDSAT, ALOS, DMC satellites, etc.) to obtain critical information on the disaster.

There are four mechanisms to activate the Charter. They include:

- direct activation endorsed by bodies directly authorized to request the service for a disaster occurring in their country or on their territory (so-called Authorized Users);
- activation by an Authorized User on behalf of a user of a non-member country in case of a major emergency;
- activation by the UN for UN users based on an agreement among the Charter members and UN OOSA and UNITAR/UNOSAT to provide support to UN agencies;
- Activation by Sentinel Asia's partner, the Asian Disaster Reduction Center (ADRC) for users in the Asia-Pacific region based on a regional collaboration for EO-based emergency response in Asia-Pacific countries.[192]

October 2010 marked the tenth anniversary of the International Charter which provides satellite data required for managing natural disasters-related crises. As of 2011, eleven space agencies worldwide are members of this initiative.

3.4.2 Japan's Objectives for Space Security

Japan's foreign policy has largely been the one of multilateralism. The United Nations in particular provided the means for reintegration of Japan into the international community in the 1950s and 1960s, and an opportunity to exercise diplomatic independence from the U.S. At the same time, alliance politics often takes priority due to Japan's national security concerns. In early 1990s, with the passing of the peacekeeping bills, there was a change in Japan's outlook toward international peace and security. In 1990, the government introduced unsuccessfully a legal framework enabling Japan to participate in the international peacekeeping efforts, including as part of a multinational force deployed in the Gulf at that time. Although controversial domestically, the Diet eventually passed the "Law Concerning Cooperation for United Nations Peacekeeping Operations and Other Operations" (so-called the International Peace Operations Law) enacted in 1992 that enabled the logistic support of the Self-Defense Forces.[193]

The situation in the space arena has been influenced by the overall foreign and security policy of Japan. Since the beginning of its space activities, Japan has been reluctant to engage in security-related uses of space, largely due to its Constitution. In 1969, the Japanese Diet adopted a resolution called "Space Development for Exclusively Peaceful Purposes" which established a limit for the involvement of Japan's defence authorities in investment, ownership, or operation of space systems. Accordingly, the Japanese space program focused exclusively on civilian research and development.

[191] Robinson, Jana. "Europe's Key Foreign Policy Objectives Via Space". ESPI Report 30. Vienna: European Space Policy Institute (February 2011): 26-27. <http://www.espi.or.at/images/stories/dokumente/studies/ESPI_Report_30_FINAL.pdf>.

[192] International Charter on Space and Major Disasters activation mechanisms. <https://www.disastercharter.org/web/charter/activate>

[193] "Current Issues Surrounding UN Peace-keeping Operations and Japanese Perspective". Ministry of Foreign Affairs of Japan (January 1997). <http://www.mofa.go.jp/policy/un/pko/issues.html>.

The principle of "non-military" use of space is being transformed by Japan's Basic Law on Space of 2008. The law redefined the purposes and rationales for Japan to invest in space. For the first time, the terminology of "security" appears in an official document."[194] The law underscored the shift in priorities from mere scientific research and development to greater utilisation of space for industrialisation, diplomacy and security. With regard to security, it mandated the Japanese government to implement necessary measures that contribute to Japan's national security as well as the peace and security of the international community. Accordingly, the Basic Law allows Japan to use space for its defence in conformity with internationally-accepted norms.

The emphasis on the connectivity between security and diplomacy is significant as space is not perceived to be used only for purposes of defence, but is to position Japan as a strong regional leader to assure stability and security. Setsuko Aoki, Professor at the Keio University, believes that "the change of Japan's interpretation of the peaceful uses of outer space could be most useful in stabilizing Asian space security, and that it is not likely to become a destabilizing element for the region." She also suggests that a collective approach to space security that would begin with civilian cooperation on space applications and be accompanied by a space sustainability initiative developed under the framework of the United Nations could strengthen stability in Asia.[195]

Security for Space

The latter portion of the Basic Space Plan's third pillar calls for "diplomatic policy for space" (i.e. to engage in diplomatic efforts that help establish appropriate rules for space activities in accordance with space-related treaties). Japan has been one of the countries that supported the draft Code of Conduct for Outer Space Activities originally proposed by the EU in December 2008. Japan is also actively participating in the UNCOPUOS initiative on "Long-Term Sustainability of Outer Space Activities" described in detail in section 3.4.1.

Japan's Basic Plan on Space also states the importance of international cooperation on space security-related issues. In particular, Japan has begun to examine how it can advance its SSA capabilities and promote cooperation on sharing Space Situation Awareness (SSA) internationally. Japan has an existing infrastructure for engaging in SSA observations. A radar station for observation of space debris to support manned space missions is located in Okayama prefecture. The Kamisaibara Space Guard Center (in Okayama) can track one-meter objects (and up to 10 objects simultaneously) at a distance of 600 km.[196] There are two optical telescopes at the Bisei Astronomical Observatory for space debris surveillance in GEO.[197] Their work is supported by the National Aerospace Laboratory of Japan (NAL) that "operates ground-based optical telescopes for the detection and orbit determination of space debris".[198] Japan's involvement with the U.S. and Europe on enhancing space security, including via SSA, would be an important step in enhancing space security.

Space for Security

The Basic Plan for Space Policy released by the SHSP in June 2009, which constitutes Japan's overall space policy for the next five years, places national security at the forefront of space-related activities. The second pillar of Japan's Basic Space Plan calls for strengthening security through the utilization of space, while maintaining the country's exclusively defensive-oriented policy. It recommended that $26 billion (¥2.5 trillion) be dedicated to civil and military space development activities from 2010 to 2014. Programs authorized for funding in this five-year period include: two to six satellites for the Quazi Zenith Satellite System (QZSS), a GPS augmentation system; development of space-based sensor technology for detecting missile launches (specified further in the five-year FY2011-2015 Mid-Term Defense Plan); three small science satellites (beyond those funded under existing budgets) and several small satellite projects to be led by universities and small commercial companies. The Plan also recommended, but did not mandate, that Japan develop at least two follow-on missions to the Daichi mapping and disaster monitor-

194 Logsdon, John and James Clay Moltz, eds. "Collective Security in Space: Asian Perspectives". Washington DC: George Washington University's Space Policy Institute (January 2008). <http://www.gwu.edu/~spi/assets/docs/Collective%20Security%20in%20Space%20-%20Asian%20Perspectives%20-%20January%202008.pdf>.

195 Aoki, Setsuko "Japanese Perspective on Space Security." <http://www.gwu.edu/~spi/assets/docs/Collective%20Security%20in%20Space%20-%20Asian%20Perspectives%20-%20January%202008.pdf>. [11 November 2011]

196 "Space debris radar station operational" 9 Apr. 2004 Japan Times 30 Mar. 2011 <http://search.japantimes.co.jp/cgi-bin/nn20040409a9.html>.

197 Jaramillo, Cesar ed. Space Security 2010. Ontario: Pandora Press, 2010, 52.

198 "Space Debris Observation System by Optical Telescopes." Proceedings of the Space Sciences and Technology Conference 29 Mar.2011 <http://sciencelinks.jp/j-east/article/200207/000020020702A0147974.php>.

ing satellite and two to four satellites with a support role; replacement of the Kodama and Kizuna high-speed data transmission satellites; and the building of optical and radar satellites to support the existing Information Gathering Satellite constellation.[199]

Meanwhile, the Committee on Promotion of Space Development, established within the Ministry of Defense, formulated the "Basic Guidelines for Space Development and Use of Space" (so-called Basic Guidelines) in January 2009. The Guidelines made it clear that space capabilities are beneficial for defence purposes and will serve as effective means to strengthen SDF's command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) applications. It also listed the main issues associated with Japan's space capabilities in information-gathering, warning and surveillance; communication: positioning, navigation and timing (PNT); and meteorological observations.[200]

In December 2010, Japan released its National Defense Program Guidelines (NDPG), a ten-year defence strategy. The 2010 NDPG defines peace and stability as inseparable from that of the international community. It calls for the expanded role of Japan's Self Defense Force (JSDF) in peace cooperation activities, humanitarian assistance, as well as non-traditional security operations such as disaster relief, counter-piracy and counter-proliferation.[201] The new NDPG of December 2010 encouraged the development and the use of space to strengthen information-gathering, communications functions, etc. The Basic Guidelines of January 2009, the Basic Plan for Space Policy of June 2009, and the New Defense Policy Guideline (NDPG) of December 2010 serve as the instructive documents for Japan's Ministry of Defence in terms of development and use of space for national security.

The first part of the third pillar of the Basic Space Plan is "utilisation of space for diplomatic purposes". Japan is to use space for its diplomatic priorities and apply space technology to tackle the threat of natural disasters, climate change, and others. Japan also identified five systems and four programs that will receive high priority.

The five systems include: "Land and Ocean Observing Satellite System to contribute to Asia and other regions," including satellites such as ALOS and ASNARO; the "Global Environmental Change and Climate Observing Satellite System" that includes GOSAT, GCOM-W, GCOM-C and weather satellites; the "Advanced Telecommunication Satellite System"; the "Positioning Satellite System" (the QZSS); and the "Satellite System for National Security" (i.e. the Information Gathering Satellites - IGS).

The QZSS is a regional GPS augmentation PNT system with coverage of East Asia and Oceania. The first QZSS satellite, "Michibiki" was launched in September 2010. It is also interoperable with Europe's Galileo. In order to cover Japanese territory, the satellite is in a highly elliptical orbit and permanent coverage can only be achieved with three satellites.

With regard to the IGS, the North Korea's 1998 Taepodong missile launch in August 1998 ensured the Diet's support for the development of a domestic intelligence satellite system (as it only received the information about the launch from the U.S.). The proposed system was named the "multi-purpose information-gathering satellites" that could also monitor weather, natural disasters, and various illegal activities. This was to ensure that it does not violate the 1969 Diet resolution on space policy. Accordingly, it was possible to proceed with the program based on an authorization from the Ministry without the need to change the law. Japan approved the launch of four IGS (two optical and two radar) in 2002.[202] The first IGS was launched in 2003 and the latest IGS (radar) in December 2011. As several radar satellites have failed prematurely, the IGS fleet is left to three operational optical satellites. A fourth optical satellite, launched in September 2010, is not yet operational. Japan plans another radar satellite launch in the new fiscal year (FY2012).[203]

At a regional level, Japan has been actively engaged in the Sentinel Asia initiative, proposed in 2004. This Asia-Pacific Regional Space Agency Forum (APRSAF)-led activity focuses on the development of a disaster management support system in Asia. JAXA

[199] Kallendar-Umezu, Paul. "Missile Warning System at Forefront of Japan's New Space Policy". Space News (9 June 2009).

[200] "Basic Guidelines for Space Development and Use of Space." 15 Jan. 2009. Committee on Promotion of Space Development and Use Ministry of Defense of Japan 2 Feb. 2012 <http://www.mod.go.jp/e/d_act/d_policy/pdf/space_development.pdf>.

[201] Liff, Adam P. "Japan's 2010 National Defense Program Guidelines – Reading the Tea Leaves". Asia-Pacific Bulletin No. 89, East West Center (22 December 2010). < http://www.eastwestcenter.org/sites/default/files/private/apb089_1.pdf>.

[202] <http://www.fas.org/spp/guide/japan/military/imint/index.html>

[203] Kallender-Umezu, Paul. "Japan Launches IGS Radar Reconnaissance Satellite". Space News (11 December 2011). <http://www.spacenews.com/launch/121311-japan-launches-latest-radar-reconnaissance-satellite.html>.

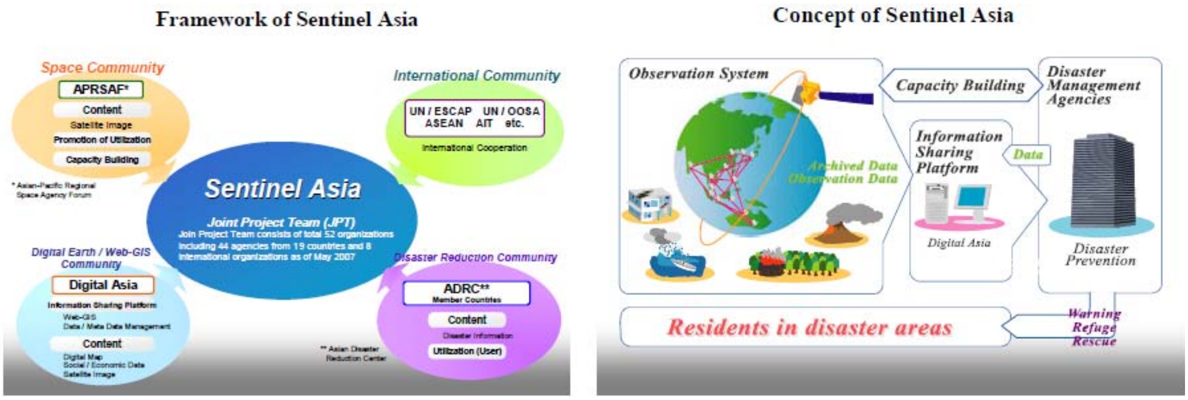


Figure 32: Framework and Concept of Sentinel Asia (Source: JAXA)[204]

has been at the inception of this rapid response system that uses satellite data and images. The main activities include: emergency EO in case of a major disaster; acceptance of observation requests; and wildlife, flood and glacier lake outburst monitoring. Cooperation is led by the APRSAF, ADRC, Digital Asia and international organisations. The Joint Project Team (JPT) includes 52 organisations (44 agencies from 19 countries and 8 international organisations). JAXA has two project offices, in Tokyo and Bangkok, to implement this initiative (see figure 32).

3.4.3 Europe-Japan Space Security Cooperation

Democracy, the rule of law, respect for human rights and free market economics are shared values of Europe and Japan. With regard to security, the EU emphasizes counterterrorism, combating piracy, and international peace cooperation activities, all areas of increased interest to Japan. Accordingly, Japan's cooperation with European countries and the EU strengthens Japan's role in dealing with global challenges. This is in accordance with the strategy of Ministry of Defense to increase Japan's security through "multilayered security cooperation in the international community" stated in Japan's 2011 Defense White Paper.[205]

Both Europe and Japan share a number of similar views on space as well as comparable goals. They both view space as an important strategic asset and seek maximum autonomy in a number of space activities. With regard to space security, they actively participate in diplomatic exchanges on the future governance of space, including via the UNCOPUOS and initiatives such as the international Code of Conduct for Outer Space Activities. Space Situational Awareness (SSA) and the space debris issue area are also high on the agenda. Overall, both Europe and Japan are in the process of establishing a clear vision for a comprehensive space security policy.

With regard to using space for security-related activities on Earth, Europe seeks to utilise space for its Common Security and Defence Policy (CSDP), including crisis management and peacekeeping missions, as well as for disaster management, and maritime and border surveillance (belonging to Europe's so-called "internal action"). Japan views space as a diplomatic tool to enhance its national (and international) security, including through providing their assets for multilateral initiatives (e.g. Sentinel Asia). Disaster management and maritime surveillance are both viewed as essential aspects of national security space activities. Moreover, both Europe and Japan place considerable emphasis on using space assets for tackling environmental issues, especially climate change-related effects as an effort to contribute to international security.

Different efforts to address space security and bolster security on Earth will likely continue. The direction in which these efforts will go depends on future leadership. This will also involve educating the public about the issues connected with safe and secure operations in space. Europe and Japan will have to strike a balance between multiplying the benefits of enhanced cooperation and the level of independence/autonomy they can achieve.

Relevant recommendations appear below:

- *Add agenda item on space security into the broader foreign and security policy agendas of the EU and Japan:* Europe and Japan share a number of views on space policy as well as associated goals. They both view space as an important

[204] Nakamura, Takayuki. "Sentinel Asia Project: Abstract". Tsukuba: International Workshop on Information Platforms for Disaster Reduction (3-4 October 2007): 2. <http://www.jst.go.jp/asts/asts_tsukuba/files/session2/part1/JAXA_Abstract.pdf>.
[205] "Japan's 2011 Defense White Paper". Japan's Ministry of Defense (December 2011): 326.

strategic asset and seek maximum autonomy in a number of space activities. With regard to space security, they actively participate in diplomatic exchanges on the future governance of space via various bilateral and multilateral mechanisms and initiatives (e.g. the UNCOPUOS, the International Code of Conduct for Outer Space Activities etc.). Space Situational Awareness (SSA) and the orbital debris issue area are also high on the space agenda. Indeed, both Europe and Japan are in the process of establishing more comprehensive space security policies. Good space governance requires clear guidance, informed decision-making, comprehensive management, and consistent policies. To achieve a predictable and stable space environment where all actors behave responsibly, there is a need to facilitate international cooperation, closer interaction between the private and public sectors, and the political will to address the degradation of the environment of Earth orbits due to space debris. Accordingly, adding the most pressing space security challenges to the broader bilateral foreign and security policy agenda would demonstrate heightened awareness and priority accorded this rapidly growing issue portfolio.

- *Pursue cooperative strategies for improved space debris mitigation and removal supported by upgraded Space Situational Awareness (SSA) and transparency and confidence-building measures (TCBMs):* The alarming increase of space debris in Earth's orbits has been recognized as one of the most challenging threats to secure space operations. With the adoption of the IADC Space Debris Mitigation Guidelines at the UN in 2008, there is a continuing need for political endorsement of, and support for, these guidelines. Both Europe and Japan should strengthen further their existing engagement in various efforts to preserve space sustainability, including through space debris remediation efforts, SSA and transparency and confidence-building measures (TCBMs).
- *Increase cooperative opportunities for the EU and Japan in the area of crisis management:* Both sides are involved in various humanitarian and rescue undertakings, peacekeeping operations and crisis management. Enhanced cooperation can help fill existing gaps in crisis management operations, including through the establishment of more responsive multinational forces. Space assets are indispensable to the effective operations of such forces. Joint participation of Europe and Japan in crisis management exercises, actual missions and the sharing of space-based information, can improve prospects for mission success and more effective exploitation of the benefits of available space systems.

4. Conclusion

Japan and Europe seek to exercise political leadership on issues of strategic importance and have acknowledged the need for enhanced security and defence-related capabilities (e.g. independent access to space, Europe's Galileo and Japan's QZSS, etc.). The prosperity and economic competitiveness of the domestic space industry are also a prime concern. The EU seeks a solid technological base to have an independent, competitive space industry with global horizons. Strong industry is also seen as a way to strengthen Europe's standing at multilateral venues. Innovation is the key to such competitiveness, achieved not only through funding science, technology, engineering and math, but also by seeking to undertake ambitious objectives in space exploration and security. Japan is basically on the same page concerning support for space commercialisation and economic advancements via space. Employing international space cooperation as an instrument and force-multiplier for foreign policy is also identified as a strategic priority by both Europe and Japan.

Reviewing space cooperation in four select areas of space activities revealed a compelling rational for closer space ties between Europe and Japan. Space exploration projects expand mankind's reach and technological prowess. Space-based systems can provide long-term monitoring of the Earth's environment and climate change, contribute to disaster management operations and numerous other important undertakings. Industry-to-industry collaboration helps drive innovation and generates spin-off technologies that benefit the broader economy. Space security seeks to protect space systems as well as utilise them for various security-related purposes on Earth. Overall, the four areas are loaded with scientific dimensions, often involving creation of new technologies that fuel industry. Space security-related projects can often create new commercial spin-offs, and vice versa.

Given this confluence of similar objectives for space, it is only natural for these partners to intensify space-related cooperation in various forms. In an era marked by considerable international uncertainty, global economic/financial tensions and conflicting political agendas, enhanced cooperation in the space field can shift the focus to promising contributions and benefits to Europe, Japan and the broader international community. Indeed, the modalities through which Europe and Japan interact in space are likely to be one of the more important arenas for potential cooperation in the future.

List of Acronyms

Acronym	Explanation
A	
ADEN	ALOS European Data Node
ADEOS	Advanced Earth Monitoring satellite
ADRC	Asian Disaster Reduction Center
ALFLEX	Automatic Landing Flight Experiment
APRSAF	Asia-Pacific Regional Space Agency Forum
ARV	ATV Return Vehicle
ATV	Automated Transfer Vehicle
AVNIR-2	Advanced Visible and Near Infrared Radiometer Type-2
B	
BOC	Besoins Operationnels Communs
BRT	Business Roundtable
C	
CCI	Climate Change Initiative
CEOS	Committee on Earth Observation Satellites
CIS	Commonwealth of Independent States
CNES	Centre National d'Études Spatiales
COPUOS	Committee on the Peaceful Uses of Outer Space
CSDP	Common Security and Defence Policy
CSTP	Council for Science and Technology Policy
D	
DBS	Direct Broadcasting Services
DMSS	Disaster Management Support System
DOD	Department of Defense
E	
EAP	Environmental Action Programmes
EGNOS	European Geostationary Navigation Overlay Service
EGNOSS	European Global Navigation Overlay System
ELDO	European Launcher Development organization
ELINT	Electronic Intelligence
Elips	European Programme for Life and Physical Sciences
ELV	European Launch Vehicle
EO	Earth Observation
EPA	Economic Partnership Agreement
ESRO	European Space Research Organisation

Acronym	Explanation
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
F	
FLPP	Future Launchers Preparatory Programme
FSS	Fixed satellite Services
FTA	Free Trade Agreement
G	
G8	Group of Eight
GCMs	General Circulation Models
GCOM	Global Change Observation Mission
GEO	Group on Earth Observation
GEOSS	Global Earth Observation System of Systems
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GLI	Global Imager
GMES	Global Monitoring for Environment and Security
GNI	Gross National Income
GNSS	Global Navigation Satellite System
GOCE	Gravity field and steady-state Ocean Circulation Explorer
GTO	Geostationary Transfer Orbit
H	
HSPG	High-level Space Policy Group
HTV	H-2 Transfer Vehicle
HYFLEX	Hypersonic Flight Experiment
I	
IAWG	International Architecture Working Group
ICT	Information and Communication Technologies
IFRI	Institut Français des Relations Internationales
ILS	International Launch Services
IRS	Indian Remote Sensing
ISAS	Institute of Space and Astronautical Science
ISECG	International Space Exploration Coordination Group
ISS	International Space Station
ISWG	International Standards Working Group
J	
JAMSS	Japan's Manned Space Systems Corporation
JEM	Japanese Experiment Module
JRC	Joint Research Centre
JSDF	Japan's Self Defence Force
JSF	Japan Space Forum
JSpOC	Joint Space Operations Center

L	
LEO	Low-Earth orbit
LPT	Light Particle Telescope
M	
ME	Midlife Evolution
MELCO	Mitsubishi Electric Corporation
MEO	Medium-Earth orbit
METI	Ministry of Economy, Trade and Industry
MEXT	Japanese Ministry of Education, Culture, Sports, Science and Technology
MFF	Multiannual Financial Framework
MHI	Mitsubishi Heavy Industries
MIC	Ministry of Internal Affairs and Communications
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MMO	Mercury Magnetospheric Orbiter
MOFA	Ministry of Foreign Affairs
MPO	Mercury Planetary Orbiter
MR	Medium Resolution
MS	Member State
MUSIS	Multinational Space-Based Imaging System for Surveillance, Reconnaissance and Observation
N	
NAL	National Aerospace Laboratory
NASDA	National Space Development Agency of Japan
NDPG	National Defense Program Guidelines
NEDO	New Energy and Industrial Technology Development Organisation
NEOs	Near-Earth Objects
NGL	Next-Generation Launcher
O	
OOSA	United Nations' Office for Outer Space Affairs
OST	Outer Space Treaty
P	
PALSAR	Phased Array type L-band Synthetic Aperture Radar
PCRF	Protein Crystallization Research Facility
PNT	Position, Navigation and Timing
PRISM	Panchromatic Remote-sensing Instrument of Stereo Mapping
R	
R&D	Research and Development
RESTEC	Remote Sensing Technology Center
RFSA	Russian Federal Space Agency
RLV	Reusable Launch Vehicle
RRD	Regulatory Reform Dialogue
RVS	Rendezvous- and Docking Sensor

S	
SAC	Space Activities Commission
SAR	Synthetic Aperture Radar
SATCOM	Satellite Communications
SCC	Space Communications Corporation
SDA	Space Data Association
SFOC	Space Flight Operations Contract
SJAC	Space Activities Commission
SMEs	Small and Medium-Sized Enterprises
SMOS	Soil Moisture and Ocean Salinity
SPASEC	Space and Security Panel of Experts
SPI	Space Policy Institute
SPICA	A joint ESA-JAXA mission
SSA	Space Situational Awareness
SSA-PP	SSA Preparatory Programme
SSN	Space Surveillance Network
STSC	Scientific and Technical Subcommittee
SWG	Science Working Group
T	
TCBMs	Transparency and Confidence-Building Measures
TEU	Treaty on European Union
TsSKB Progress	The Progress State Research and Production Space Centre
U	
ULA	United Launch Alliance
UNEP	UN Environment Programme
UNFCCC	UN Framework Convention on Climate Change
UPLC	Unpressurized Logistic Carrier
USA	United Space Alliance
USEF	Unmanned Space Experiment Free Flyer
USOCs	User Support & Operation Centers
USSTRATCOM	U.S. Strategic Command
V	
VHR	Very High Resolution
W	
WP	Working Parties
WTO	World Trade Organization

Annex

A.1 Project Methodology

To address the topic of Europe–Japan cooperation in space, information and research materials were collected through a number of means, including in-house, open source research and expert interviews via telephone and in-person. The research involved a review of the current status of Japan's cooperation with Europe in space, including with the EU, Member States (through national space programmes) and participation in ESA programmes.

Experts in the areas of space policy, civilian space activities and space security, from ESA, JAXA, the national space agencies of Europe, the EU, relevant Ministries in Japan, commercial entities, academia and non-governmental organizations were contacted to provide their expert views to augment and reinforce the study. Particular attention was paid to those experts familiar with past cooperative efforts in various fields to gain insights concerning the technical and practical issues that accompany such cooperative efforts.

A number of interviews with high-level officials took place during a fact-finding visit to Japan that occurred in March 2011. Preliminary discussions were also conducted at that time concerning a gathering entitled "Europe–Japan Space Cooperation" that was held on 17 January 2012. Former ESPI Director, Kai-Uwe Schrogl, and ESPI Resident Fellow, Jana Robinson, met with government officials from various Ministries, including the Deputy Secretary-General of the Cabinet Secretariat's Strategic Headquarters for Space Policy, the Chairman of the Space Activities Commission (SJAC), the Deputy Director-General of the Ministry of Education (MEXT), and the Director of International Science Cooperation Division of the Ministry of Foreign Affairs (MOFA). A scheduled meeting with the Director of the Space Industry Office at the Ministry of Economy, Trade and Industry (METI) had to be cancelled due to the devastating earthquake/tsunami that struck Japan on Friday, 11 March 2011. With regard to Japanese industry, meetings were held with the President of Japan's Manned Space Systems Corporation (JAMSS) and the President of the Japan Space Forum (JSF).

On 14 March, a special meeting was arranged for ESPI representatives and the Director of the George Washington University's Space Policy Institute (SPI), Dr. Scott Pace, with JAXA President, Keiji Tachikawa, and JAXA Executive Vice President, Kiyoshi Higuchi. In JAXA's offices, ESPI gave a presentation on the European perspective concerning future space transportation programmes and international cooperation.

At JAXA with President Keiji Tachikawa and Executive Vice President Kiyoshi Higuchi (third and fourth from left standing)

On 17 January 2012, ESPI organised, on its premises in Vienna, a workshop entitled "Europe–Japan Space Cooperation". Jana Robinson, the report's author, was responsible for of the workshop's organisation. Four panels discussed the four dimensions of Europe–Japan cooperation addressed in this report. The workshop participants included Jiří Buriánek, Director of the EU Council's Directorate for Competitiveness, Lisbon Strategy, Industry, Research, Information Society and Electronic Communications; Tetsuhiko Ikegami, Chairman of the Space Activities Commission at Japan's Ministry of Education, Culture, Sports, Science & Technology (MEXT); Hirotoshi Kunitomo, Counsellor at the Secretariat of the Strategic Headquarters for Space Policy at Japan's Cabinet Office; Andreas Lindenthal, Senior Vice President, Business Division Products, Astrium; Kaoru Mamiya, President of the Japan Space Forum (JSF); Naoto Matsuura, Secretary General of the Remote Sensing Technology Center of Japan (RESTEC); Giuseppe Morsillo, Director of ESA Policies, Planning and Control; Jana Robinson, ESPI Resident Fellow; Kazuto Suzuki, Professor of International Political Economy at the Public Policy School of Hokkaido University; Gerhard Thiele, ESPI Resident Fellow and former astronaut; Christophe Venet, Research Associate at the Space Policy Program, Institut Français des Relations Internationales (IFRI); and Hirotaka Watanabe, Special Researcher at the Graduate School of Law and Politics, Osaka University. The workshop proceedings were integrated into the Final Report.

Conference speakers:
From top left: Gerhard Thiele (ESPI), Christophe Venet (IFRI), Andreas Lindenthal (Astrium), Kazuto Suzuki (Hokkaido University), Peter Hulstroj (ESPI Director), Hirotaka Watanabe (Osaka University).
From bottom left: Jana Robinson (ESPI), Naoto Matsuura (RESTEC), Hirotoshi Kunitomo (Japan's Strategic Headquarters for Space Policy), Giuseppe Morsillo (ESA), Tetsuhiko Ikegami (MEXT), Jiří Buriánek (EU Council), Kaoru Mamiya (JSF)

A.2 Agenda of the Europe-Japan Space Workshop Organised by ESPI

ESPI
European Space Policy Institute

FINAL AGENDA

Europe – Japan Space Workshop
17 January 2012, ESPI, Vienna, Austria

8:30 – 9:00	**Registration and Coffee**
9:00 – 9:45	***Opening Session***
Welcome Remarks:	**Peter Hulsroj**, Director, European Space Policy Institute (ESPI)
Opening Remarks:	**Giuseppe Morsillo,** Director for ESA Policies, Planning and Control, European Space Agency (ESA) **Hirotoshi Kunitomo**, Counsellor, Secretariat of Strategic Headquarters for Space Policy, Japan's Cabinet Secretariat
9:45 – 11:15	***Panel 1: Exploration and Access to Space***
Moderator:	**Hirotaka Watanabe**, Researcher, Graduate School of Law and Politics, Osaka University
Speakers:	**Tetsuhiko Ikegami**, Chairman, Space Activities Commission, Ministry of Education, Culture, Sports, Science & Technology (MEXT), Japan **Gerhard Thiele**, Resident Fellow, ESPI, and former astronaut
11:15 – 11:30	**Coffee Break**
11:30 – 13:00	***Panel 2: Earth Observation and Related Applications***
Moderator:	**Christophe Venet,** Research Associate at the Space Policy Program, Institut Français des Relations Internationales (IFRI)
Speakers:	**Jiří Buriánek**, Director, Directorate for Competitiveness, Lisbon Strategy, Industry, Research, Information Society and Electronic Communications **Naoto Matsuura**, Secretary General, Remote Sensing Technology Center of Japan (RESTEC)
13:00 – 14:00	**Buffet Luncheon**
14:00 – 15:30	***Panel 3: Industry-to-Industry Cooperation***
Moderator:	**Kazuto Suzuki,** Professor of International Political Economy, Public Policy School of Hokkaido University, Japan
Speakers:	**Kaoru Mamiya**, President, Japan Space Forum (JSF) **Andreas Lindenthal**, Senior Vice President, Business Division Products, Astrium GmbH
15:30 – 17:00	***Panel 4: Space Security***
Moderator:	**Jana Robinson**, Resident Fellow, ESPI
Speakers:	**Hirotoshi Kunitomo**, Counsellor, Secretariat of Strategic Headquarters for Space Policy, Japan's Cabinet Secretariat **Christophe Morand,** Crisis Management and Planning Directorate (CMPD), European External Action Service (EEAS)
17:00 – 17:15	***Concluding Remarks*** **Peter Hulsroj**, Director, European Space Policy Institute (ESPI)
17:15 – 18:00	**Closing Reception (Drinks and Canapés)**

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The author would first like to express special thanks to Kai-Uwe Schrogl, Head of ESA Policies Department and former Director of the European Space Policy Institute who initiated this project. It is likewise important to recognise the high-level officials, industry representatives and space experts that took time to meet with us during a visit in Tokyo in March 2011. They include Hirofumi Katase, the Deputy Secretary-General of the Cabinet Secretariat's Strategic Headquarters for Space Policy, Tetsuo Ikegami, Chairman of the Space Activities Commission (SJAC), Jun Yanagi, the Director of International Science Cooperation Division of the Ministry of Foreign Affairs (MOFA), Kazuhide Todome, President of Japan's Manned Space Systems Corporation (JAMSS), Kaoru Mamiya, the President of the Japan Space Forum (JSF). Sincere appreciation is extended to the JAXA representatives who facilitated the ESPI visit, especially Motoko Uchitomi and Mami Sasamura, as well as a memorable meeting with JAXA President, Keiji Tachikawa, and JAXA Executive Vice President, Kiyoshi Higuchi.

The author is also grateful to the participants of the "Europe-Japan Space Workshop" organised by ESPI on 17 January 2012 from which valuable insights were gained, including Giuseppe Morsillo, Director of ESA Policies, Planning and Control; Hirotoshi Kunitomo, Counsellor at the Secretariat of the Strategic Headquarters for Space Policy at Japan's Cabinet Office; Jiří Buriánek, Director of the EU Council's Directorate for Competitiveness, Lisbon Strategy, Industry, Research, Information Society and Electronic Communications; Tetsuhiko Ikegami, Chairman of the Space Activities Commission at Japan's Ministry of Education, Culture, Sports, Science & Technology (MEXT); Andreas Lindenthal, Senior Vice President, Business Division Products, Astrium; Kaoru Mamiya, President of the Japan Space Forum (JSF); Naoto Matsuura, Secretary General of the Remote Sensing Technology Center of Japan (RESTEC); Kazuto Suzuki, Professor of International Political Economy at the Public Policy School of Hokkaido University; Gerhard Thiele, ESPI Resident Fellow and former astronaut; Christophe Venet, Research Associate at the Space Policy Program, Institut Français des Relations Internationales (IFRI); Hirotaka Watanabe, Special Researcher at the Graduate School of Law and Politics, Osaka University and Peter Hulsroj, ESPI Director.

About the Author

Jana Robinson has been Resident Fellow at the European Space Policy Institute (ESPI) since December 2009. She has published a number of articles on space security and sustainability in various journals. Prior to joining ESPI, she served as Development Director for the Prague Security Studies Institute (PSSI) from 2005–2009, a leading, Prague-based, non-profit public policy organisation focused on security policy and studies. She was likewise responsible for the corporate establishment of PSSI Washington, a non-profit organisation in Washington D.C., closely affiliated with PSSI Prague. She holds an MA in Asian Studies from George Washington University's Elliott School of International Affairs, in Washington DC specialising in Asia-Pacific security issues and space policy, and an MA in Asian Studies from Palacky University, Olomouc, Czech Republic. She received scholarships to attend the International Space University (ISU) 2009 Space Studies Program (SSP09), 2008 Summer Mandarin Training Course at the Mandarin Training Center of the National Taiwan Normal University in Taipei, and Shanghai University in 1999-2000.

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