EU-Japan Centre for Industrial Cooperation

日欧産業協力センター

The Space Sector

EU- Japan business and technological cooperation potential

Veronica La Regina
Minerva Fellow
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Abstract

This report aims to propose the best way of pursuing the EU-Japan industrial cooperation in the field of Space. Firstly, it reviews European and Japanese current cooperation in the field of Space. Secondly, it investigates the current level of trade between the two partners in order to understand the best way to generate further cooperation. Thirdly, the Report hopes to inform both sides about each region's current Space sector landscape from the political, policy and industrial point of views. Fourthly, it identifies areas of industrial cooperation for which local gaps in knowledge or experience could be filled by foreign expertise, for example the European technological gaps in the small-size satellite constellation could be filled by the Japanese expertise while the Japanese intention to become more commercially oriented could be supported by the more expansive European experience in this area. Finally, recommendations to the Japanese and European stakeholders are provided.

Acknowledgement

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Executive Summary

The European Union (EU) and Japan are both currently pursuing a host of similar challenges, including new governance structures with the recognition of new roles and functions, the launch of new technologies with higher commercial vocation, the enhancement of economic returns from Space investments and the increasingly emerging enabling value of space-based technologies for multi-purpose requirements in other fields, such as energy, transport, climate change, managing early warning systems in case of natural disasters, security and poverty alleviation.

The EU and Japan have recently initiated the EU-Japan Space Policy Dialogue. The two bodies met first in October 2014 to discuss their current programs and interests and are expected to meet again in Brussels by the end of 2015. Space has since been explicitly described as an element of cooperation by the joint statement released by the last EU – Japan Summit[1], held in Tokyo in May 2015.

Industrial cooperation is identified as the most promising tool for a successful EU-Japan collaboration. This report describes potential business opportunities within industrial cooperation between the EU and Japan in the field of Space. These opportunities have been evaluated through the different segments of the Space value chain from the front-runner R&D activities to launching technologies, manufacturing, components, downstream applications and spin-offs. They have also been evaluated based on potential future challenges.

A successful industrial cooperation strategy will require, at minimum, a common understanding of both the technological challenges but also the soft-skills required for intercultural interaction. In order to increase mutual trust in the Space business, it is crucial to have a clear understanding of each region's respective political framework, policy-setting and industrial dimension. To this end, this report serves primarily to inform the two partners about the each other's governance, policy measures and markets. It also presents local dynamics and the diplomatic contexts.

This report also identifies a number of potential business and technological opportunities in each segment of the Space value chain and identifies required action. Space business can also often include a governmental dimension, and thus required actions tend to involve other agencies such as the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA) in order to frame the guidelines for industrial player interactions. The report highlights three recommended goals for future EU-Japan industrial cooperation which are summarized in the table below.

Recommendations	Actions
1. Make EU-Japan Space industrial cooperation the best tool for growing existing and new space businesses that promote enterprise and investment	• Secure actionable measures to facilitate the exchange of expertise for downstream applications introducing unambiguous, flexible and achievable criteria for companies (mainly SMEs and start-ups) interested in entering the two areas • Harmonize the export control regimes between the two areas • Establish a Space session under the EU-Japan Business Round Table with the joint participation of the EU, supported by ESA, and the Japanese METI, supported by JAXA • Promote the trans-disciplinary dimension of Space under the scope of the EU-Japan Centre for Industrial Cooperation
2. Increase economic returns from space-related public expenditures by continuing to pursue new technological challenges and securing greater influence in the global market	• Facilitate Industry-to-Industry relations in the field of space launching systems, as a joint task of ESA and JAXA • Create an EU – Japan Engagement plan for the technological assets and facilities on board of the ISS for the fertilisation of spin-off opportunities • Develop a cost-effective space value chain by jointly funding innovative production procedures (e.g. a 3-D printer)
3. Stimulate a vibrant space sector by promoting internationally-oriented professional skills	• Propose the space sector to students, researchers and young professionals under the existing mobility programs (e. g. Vulcanus, Japan Society for the Promotion of Science, EURAXESS, etc.) • Motivate people to enhance the 3Is dimension of their professional profile with experiences at, for example, the ISU or the coming Okinawa School

Policy recommendations for pursuing EU – Japan industrial cooperation in space

[1] 23rd Japan-EU Summit, Tokyo, 29 May 2015 - Joint Press Statement – Last access in June 2015 at: http://www.consilium.europa.eu/en/meetings/international-summit/2015/05/Joint-Press-Statement-EU-Japan_pdf/

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List of Abbreviations

~	*circa*
3D	Three dimensional
A62	Ariane 6 with 2 boosters
A64	Ariane 6 with 4 boosters
AEB	Brazilian Space Agency
AECA	Arms Export Control Act
ALOS	Advanced Land Observing Satellite
ALOS-2	Advanced Land Observing Satellite-2
ANGKASA	Malaysian National Space Agency
AOCS	Attitude and Orbit Control System
APIC	Asia-Pacific International Space Year Conference
APRSAF	Asia Pacific Regional Space Agency Forum
ASC	Aeronautical Satellite Centre
ASEAN	Association of Southeast Asian Nations
ASNARO	Advanced Satellite with New system Architecture for Observation
AT	Austria
ATV	Attitude and Orbit Control System
B2B	Business to Business
B2C	Business to Consumer
BE	Belgium
BELSPO	Belgian Federal Science Policy Office
BG	Bulgaria
BIC	Business Incubation Centre
CAL	Calorimeter
CALET	Calorimetric Electron Telescope
CEOS	Committee on Earth Observation Satellites
CFSP	Common Foreign and Security Policy
CH	Switzerland (Confederation Helvetique)
CIRO	Cabinet Intelligence Research Office
CISTEC	Center for Information on Security Trade Control
CLS	Collect Localisation Satellites
CNES	Centre National d' Etudes Spatiales
CNR-IFAC	Consiglio Nazionale delle Ricerche - Istituto di fisica applicata "Nello Carrara"
COSMO-SkyMed	Constellation of small Satellites for Mediterranean basin Observation
CRISP	Singapore’s Centre for Remote Imaging, Sensing and Processing
CSDP	Common Security and Defence Policy
CSICE	Cabinet Satellite Intelligence Centre
CY	Cyprus
CZ	Czech Republic
DE	Germany
DG	Directorate General
DG ENTR	Directorate-General for Enterprise and Industry
DG MOVE	Directorate General for Transport
DK	Denmark
DLR	Deutsches Zentrum für Luft- und Raumfahrt
DOI	Australian Department of Industry
DOST	Philippine Department of Science and Technology
EAA	Export Administration Act
EACP	European Aerospace Cluster Partnership
EADS	European Aeronautic Defence and Space Company
EAR	Export Administration Regulations
EBIT	Earnings Before Interest and Tax
EC	European Commission
EE	Estonia

EEAS	European External Action Services
EEE	Electrical, Electronic, and Electromechanical
EGNOS	European Geostationary Navigation Overlay Service
EIAST	Emirates Institution for Advanced Science and Technology
EL	Greece
ELDO	European Launcher Development Organisation
ERSDAC	Earth Remote Sensing Data Analysis Centre
ES	Spain
ESA	European Space Agency
ESA IAP	European Space Agency Integrated Applications Promotion programme
ESDP	European Security and Defence Policy
ESRO	European Space Research Organisation
EU	European Union
EU JRC	European Joint Research Centre
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FI	Finland
FP7	7th Framework Programme
FP7	Seventh Framework Programme for Research and Technology Development
FR	France
FSJ	Freedom, Security and Justice
GCOM-W	Global Change Observation Mission - Water
GEOSS	Group on Earth Observations
GIS	Geographic Information System
GLONASS	GLObal NAvigation Satellite System (Russia)
GNSS	Global Navigation Satellite Systems
GOSAT	Greenhouse gases Observing SATellite
GPM/DPR	Global Precipitation Measurement/Dual-frequency Precipitation Radar
GPS	Global Positioning System
GSA	European GNSS Agency
GSI	Geospatial Information Authority of Japan
GSLV	GeoSynchronous Satellite Launch Vehicle
GTO	Geostationary Transfer Orbit
HR	High Representative of the Union for Foreign Affairs and Security Policy
HR	Croatia
HTS	High Throughput Satellites
HTV	H-II Transfer Vehicle
HU	Hungary
HVPS	High Voltage Power Supply
IA	IHI Aerospace
ICT	Information and Communication Technology
ICTPA	Mongolian Information Communications Technology and Post Authority
IE	Ireland
IGS	Information Gathering Satellites
ILS	International Launch Services
Industry-2-Industry	Industry to Industry
IPR	Intellectual Property Right
IRISS	Intelligent Railways via Integrated Satellite Services
IS	Iceland
ISRO	Indian Space Research Organization
ISS	International Space Station
IT	Italy
ITAR	International Traffic In Arms Regulations
JAROS	Japan Resources Observation System and Space Utilization Organization
JASPA	Japanese Aerospace Parts Organization
JAXA	Japan Aerospace Exploration Agency
JEM	Japanese Experiment Module
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
JP	Japan

JSF	Japan Space Forum
J-spacesystems	Japan Space Systems
JSPS	Japan Society for the Promotion of Science
JST	Japan Science and Technology Agency
JTF	Joint Task Force
KARI	Korea Aerospace Research Institute
KAZCOSMOS	Kazakhstan's Aerospace Committee
KUOA	KIBO Utilisation Office for Asia
LAPAN	National Institute of Aeronautics and Space Indonesia
LASER	Light Amplification by Stimulated Emission of Radiation
LEO	Low Earth Orbit
LI	Liechtenstein
LM	Lockheed Martin
LOX/LH2	Liquid Oxygen/ Liquid Hydrogen
LT	Lithuania
LV	Latvia
LX	Luxembourg
M	Million
MAFF	Ministry of Agriculture, Forestry and Fisheries
MASCOT	Mobile Asteroid Surface Scout
MCTI	Ministry of Science, Technology and Innovation
ME	Mid-life Evolution
MELCO	Mitsubishi Electric Corporation
METI	Ministry of Economy, Trade and Industry
MEXT	Ministry of Education, Culture, Sports, Science and Technology
MHI	Mitsubishi Heavy Industry
MIC	Ministry of Internal affairs and Communication
MilSatCom	Military Satellite Communication
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MOD	Ministry of Defense
MOE	Ministry of Environment
MOFA	Ministry of Foreign Affairs
MoU	Memorandum of Understanding
MPC	Mitsubishi Precision
MSC	Meteorological Satellite Centre
MT	Malta
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NEC	Nippon Electric Company
NEREUS	Network of European Regions Using Space Technologies
NG	Northrop Grumman
NICT	National Institute of Information and Communications Technology
NIES	National Institute of Environmental Studies
NL	The Netherlands
NO	Norway
NPO	National Police Office
NSC	Norwegian Space Centre
NSO	Netherlands Space Office
OECD	Organisation for Economic Co-operation and Development
P120	Propellant mass to 120 tons (P120)
PL	Poland
PT	Portugal
QZSS	Quasi-Zenith Satellite System
R&D	Research and Development
RESTEC	Remote Sensing Technology Centre of Japan
RO	Romania
SA	South Africa
SANSA	SA National Space Agency
SAR	Synthetic Aperture Radar

SatCom	Satellite Communication
SatNav	Satellite-based Navigation
SE	Sweden
SI	Slovenia
SIM	Satellite Image Marketing
SK	Slovakia
SME	Small and Medium Enterprise
SpA	Società per Azioni (Italian Public Company)
SPAC	Satellite Positioning Research and Application Centre
SPICA	Space Infrared Telescope for Cosmology and Astrophysics
SPOT	Satellite Pour l'Observation de la Terre
SRON	Netherlands Institute for Space Research
SSA	Space Situational Awareness
SSL	Space Systems Loral
SSO	Sun Synchronous Orbit
SST	Space Surveillance and Tracking
SUPARCO	Pakistani National Space Agency
SWAP	Size-Weight And Power
t.	Tons
TAS	Thales Alenia Space
TBD	To Be Defined
TEKES	Finnish Funding Agency for Technology and Innovation
TEU	Treaty on European Union
TFEU	Treaty on the Functioning of the European Union
TRMM	Tropical Rainfall Measuring Mission
TTN	Technology Transfer Network
TTP	Technology Transfer Program
TTPO	Technology Transfer Program Office
UK	United Kingdom
University-2-University	University to University
UNOOSA	United Nations Office for Outer Space Affairs
US/USA	United States / United States of America
USEF	Institute for Unmanned Space Experiment Free Flyer
USSR	Union of Soviet Socialist Republics
VAST	Vietnam Academy of Science and Technology
VEGA	Vettore Europeo di Generazione Avanzata
VP	Vice-President

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1 The Setting: Europe-Japan relations in the Space Sector

1.1 The EU – Japan Space Policy Dialogue

The EU is establishing its own international relations in the field of Space through Space Dialogues, which are *ad hoc* instruments of cooperation. At present, the EU has established seven Space Dialogues respectively with Africa, Brazil, China, Japan, Russia, South Africa and the USA.

The **EU-Japan Summit** started in 1991 and, since then, several sector-specific dialogues have taken place with Japan and the broader Asian Pacific region. Industrial cooperation was established even earlier in 1987 with the creation of a joint venture, named the EU-Japan Centre for Industrial Cooperation (hereinafter referred to as the "Centre"), between the European Commission and the Japanese Ministry of Trade and Economy (METI). The Centre has the mission of enhancing all forms of industrial, trade and investment cooperation between Japan and the EU, and strengthening the technological capabilities and the competitiveness of the European and Japanese industrial systems. Space was an element of the 2001 EU-Japan Forum in Research, Technology and Innovation Cooperation among Industry, Government and Academia[2]. Later, in the related EU-Japan Action Plan[3], Space is again an item of cooperation. In the first case, the new area of Space and satellite navigation was present in the agenda, presenting further evidence of the security dialogue expanding in the area of science and technology. The Action Plan saw Space exploration emerge as a new item on the EU-Japan security agenda. However, neither side has prioritized the Space domain, and it was only in its 2014 session that the EU-Japan Summit [4] established a specific dialogue on Space: the first space dialogue was held in Tokyo in October 2014, and future dialogues will be held on an annual basis. The areas for collaboration include launch systems, with a '*coopetition*' approach (a neologism mixing competition and cooperation) making compatible the two partners technologies, the field of earth observation, and the forthcoming R&D activities in the areas of robotics and electronic propulsion on board of satellites. Japan is willing to open a long-term collaboration with the EU, because the EU's industry-driven Space policy approach matches its own goals more closely than the policy approach of the USA. However, the two players do not have a longstanding relationship in joint Space endeavours. Therefore, R&D cooperation shall be the mechanism of choice for mutually beneficial development.

The two parties are currently preparing the second EU-Japan Space Dialogue. There is a desire to outline concrete actions in the second dialogue, as the first dialogue was for the most part a self-introduction by both parties. In particular, Japan has been very keen to open a debate towards a common vision on export control issues, while under the Lisbon Treaty the EU is still lacking the necessary competence to implement a solid policy in the area of defence. In order to predict a potential agenda of the forthcoming second dialogue it is important to consider what the current stakes are in the EU and in Japan. This overview takes into account the bilateral and multilateral relations of the EU and the ESA Member States [5].

Relations between the EU and Japan are primarily at a bilateral level (EU Members States-Japan) and take a variety of different shapes, from government-to-government, to inter-agency, inter-university, industry-to-industry and hybrid relations. The most privileged case is for a government-to-government agreement to act as a covering framework and have development activities following on from there. Among the EU

[2] Olena Mykal, *The EU-Japan Security Dialogue: Invisible But Comprehensive*, Amsterdam University Press, 2011, pp. 151

[3] 23rd EU – Japan Summit, shaping our common future – an Action Plan for EU – Japan cooperation, Brussels, 2001. Last access in June 2015 at: http://eeas.europa.eu/japan/docs/actionplan2001_en.pdf

[4] 22nd EU-Japan Summit, The EU and Japan Acting together for Global Peace and Prosperity – Joint Press Statement, Brussels 7 May 2014. Last access in June 2015 at: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/142462.pdf

[5] It considers the footprint of the participating nations of the European Space Council, as a concomitant meeting of the Council of Ministers of the European Union and the ESA Council at Ministerial Level for the coordination and facilitation of cooperative activities between the EU and ESA.

Member States this is the case only in the United Kingdom. Elsewhere, since 2012 the new space governance model in Japan, supplanting the Space Basic Law of 2008 and the related Space policy of 2009, has been unstable in its concept and role. With further layers added by a review in 2013 and a new plan in 2015, there are overlapping relations at different levels, and in particular, foreign stakeholders are misled as to which Japanese counterpart they should approach.

The following table -Table 1- lists the different relations at national level, and cases of multilateral agreements are also taken into account. Green rows show inter-agency relations, blue rows are business-to-business collaborations, clear pink is used for inter-university collaborations, violet rows are government-to-government relations and the white rows indicate hybrid cases, e.g. an agency collaborating with a business or similar.

Nation	European Party	Japanese Counterpart	Remarks	Estimated Value
---	ESA	JAXA	BepiColombo (ESA), Earth Care (ESA) Astro-H (JAXA)	1700 M Eur([6]) 590 M Eur ([7]) 300 M Eur ([8])
Austria	Industrial Companies	Industrial Companies	Component provision	0.8 M Eur
Belgium	BELSPO (Belgium)	JAXA	HINODE (JAXA) SPICA (JAXA)	1.9 M Eur([9])
Bulgaria	Bulgarian Universities	Japanese University	Astronomy	0.05 M Eur ([10])
Czech Republic	Czech Ministry of Transport	Cabinet Office for Space Policy	Memorandum of Understanding	*Pending status for bilateral signature*
Czech Republic	Czech Space Alliance	JASPA	Memorandum of Understanding	0.1 M Eur ([11])
Finland	Tampere University	Keio University, National Institute of Polar Research, Solar-Terrestrial Environment Laboratory of Nagoya University	Co-development of software for data storage of the Arctic Research projects	0.2 M Eur ([12]) 135 M Eur ([13])
France	CNES	JAXA	Memorandum of Understanding and Several Activities	100 M Eur ([14])

[6] Stephen Clark, ESA says BepiColombo will stay on budget despite delay, Spaceflight Now, 5 March 2012. Last access in June 2015 at: http://spaceflightnow.com/news/n1203/05bepicolombo/
[7] Estimation done by the author. Source: Jonathan Amos, Costly Euro space laser reviewed, BBC News, 24 January 2011. Last access in June 2015 at: http://www.bbc.com/news/science-environment-12263529
[8] Estimation done by the author. Source: Saku Tsuneta, Program and planning at JAXA-Space Science, March 2014. Last access in June 2015 at: http://sites.nationalacademies.org/cs/groups/ssbsite/documents/webpage/ssb_087080.pdf
[9] Estimation done by the author. Source: ESA, Extension of the Hinode Mission, 2012. Last access in June 2015 at: ftp://ftp.sciops.esa.int/pub/mkessler/Hinode.pdf
[10] Bulgaria Academy of Sciences – Space Research Institute, Self-evaluation report 2004 – 2008, Sofia 2009
[11] Anonymous referee
[12] Ubiquitous Cross-Cultural Multimedia Systems for Mobile Computing Societies – Last access in June 2015 at: http://www.mdbl.sfc.keio.ac.jp/JSPS_fin/index_en.html
[13] Purnendra Jain, Japan's Subnational Governments in International Affairs, Routledge, 13 mar 2006; http://www.diva-portal.org/smash/get/diva2:688731/FULLTEXT01.pdf
[14] CNES, Annual Reports 2009, 2010, 2011, 2012, 2013, 2014

France	Industrial companies (FR)	Industrial companies (JP)	Business partnerships for components and services supply	200 M Eur ([15])
Germany	DLR (DE)	JAXA	MoU for Space activities	200 M Eur ([16])
Germany	Universities	Universities	110 projects	800 M Eur ([17])
Greece	Industrial companies	Industrial companies	Co-development of components	0.5 M Eur ([18])
Hungary	Atomic Energy Research Institute	JAXA	R&D projects	0.02 M Eur ([19]
Ireland	Ministry for Research & Innovation	MEXT	MoU for Science & Technology	1.24 M Eur ([20])
Italy	Italian Space Agency	JAXA	MoU for cooperation in Space CALET ALOS vs. COSMO-SkyMed	0.3 M Eur ([21])
Italy	Industrial Companies	Industrial Companies	Industry-to-Industry cooperation including space	1 M Eur
Latvia	University of Latvia	JAXA	Stratospheric balloons Composite Materials	0.1 M Eur ([22])
Latvia	Industrial Companies	Industrial Companies	Vacuum shield thermal insulation of spacecraft and astronaut spacesuits	0.2 M Eur ([23])

[15] Corporate's Annual Reports, Press Releases, 2012 - 2014
[16] Estimation done by the author. Source: Commercial and US Government Launch Vehicles - Commercial Space Flight General. Last access in June 2015 at: http://forum.nasaspaceflight.com/index.php?topic=11507.15;wap2
[17] Anonymous referee
[18] Key company is Compucom for GNSS applications and GIS
[19] Anonymous referee
[20] Estimation done by the author. Source: Science Foundation Ireland, €1.24 Million in Research Funding Announced for Irish and Japanese Consortium, 2 December 2013. Last access in June 2015 at: http://www.sfi.ie/news-resources/press-releases/%E2%82%AC1.24-million-in-research-funding-announced-for-irish-and-japanese-consortium.html
[21] Italian Space Agency (ASI), 3-Year Plan of Activities, 2012-2015, *in Italian* Piano Triennale delle Attivita`2012-2015
[22] Latvian Research Plan-Space Technologies in Latvia, 2013
[23] Anonymous referee

Lithuania	Lithuanian Space Association	UNISEC Consortium	Small satellites	0.5 M Eur ([24])
Lithuania	Industrial Companies	Industrial Companies	Laser for Space applications	0.2 M Eur ([25])
Luxembourg	Industrial companies (LX)	Industrial Companies (JP)	SatCom payloads & services	1 M Eur ([26])
The Netherlands	Dutch NSO	JAXA	Mem. of Understanding (MoU)	60 M Eur ([27])
Romania	Institute of Space Science	JAXA	R&D activities on board of ISS (JEM – EUSO)	0.2 M Eur ([28])
Romania	INCAS	JAXA	Supersonic flights	0.1 M Eur ([29])
Slovakia	Institute of Experimental Physics, SAS, Košice	JAXA	R&D activities on board of ISS - JEM-EUSO	0.1 M Eur ([30])
Slovenia	Sašo Sedlaček [Space fan]	JAXA	Origami Space race	0,03 M Eur ([31])
Spain	CDTI	NICT	Optical and laser communication	0.08 M Eur
Sweden	Swedish National Space Board	JAXA	MoU for the development of Small satellites	0.5 M Eur ([32])
Sweden	Swedish Space Corporation	JAXA	Ground Segment Technologies	0.6 M Eur ([33])
United Kingdom	Government	Government	MoU for Space-related technologies & industry, 2012	---

[24] Linas Jegelevicius, Itsy-bitsy Lithuanian satellite on the way for a lengthy space journey, The Baltic Times, 2013. Last access in June 2015 at: http://baltictimes.delfi.lv/news/articles/32760/

[25] Lithuanian Laser Association, Laser Technologies in Lithuania, 2014. Last access in June 2015 at: http://www.ltoptics.org/uploads/documents/Laser%20technologies%20in%20Lithuania.%202014.PDF

[26] Corporate's Annual Reports, Press Releases, 2012 - 2014

[27] Netherlands Committee for Astronomy, Strategic Plan for Astronomy in the Netherlands - 2011-2020. Last access in June 2015 at: http://arxiv.org/ftp/arxiv/papers/1206/1206.5497.pdf

[28] Anonymous referee

[29] Anonymous referee

[30] Sašo Sedlaček, Origami Space Race. Last access in June 2015 at: http://sasosedlacek.com/origami-space-race/

[31] Nanoracks, FAQs, Last access in June 2015 at: http://nanoracks.com/resources/faq/

[32] A. Rosenqvist et al., An overview of the JERS-1 SAR Global Boreal Forest Mapping (GBFM) project. Last access in June 2015 at: http://www.eorc.jaxa.jp/ALOS/en/kyoto/ref/IGARSS04_GBFM-overview.pdf

[33] Swedish Space Corporation, Annual Reports 2012 – 2013 - 2014

United Kingdom	Industrial companies	Industrial companies	Small satellites, rocket components	1.2 M Eur ([34])
Switzerland	École Polytechnique Fédérale de Lausanne	JAXA	Space debris technologies	0.1 M Eur ([35])
Switzerland	Industrial Companies	Industrial Companies	GNSS' components	0.5 M Eur ([36])
Norway	Norwegian Space Centre	JAXA	Mem. of Understanding (MoU)	1.5 M Eur ([37])
Norway	Industrial companies (NO)	JAXA	Services based on downloading data from polar-orbiting satellites	1.1 M Eur ([38])
---	Supersonic Tunnel Association International	JAXA-Kawasaki-Mitsubishi	Sharing facilities & best practices	0.05 M Eur ([39])

Table 1: The relations between Europe and Japan at bilateral and multilateral level

[34] Corporate's Annual Reports, Press Releases, 2012 - 2014
[35] Anonymous referee
[36] Corporate's Annual Reports, Press Releases, 2012 - 2014
[37] Norwegian Space Centre, Long-Term Plan 2010 - 2014
[38] Corporate's Annual Reports, Press Releases, 2012 - 2014
[39] Anonymous referee

In conclusion, inter-agency relations feed almost 72% of the cooperation between Europe and Japan, 22% comes from inter-university activities, followed by 5.9% of industry-to-industry trade and the rest from hybrid relations. Government-to-government relations can be of different types; they can directly address business relations by planning a dedicated budget, e.g. the case of Ireland with Ministry of Education, Culture, Sports, Science and Technology (MEXT), or they can merely act as a framework for national stakeholders, e.g. agencies, universities or companies, to interact directly.

1.2 Relations between ESA and JAXA

Relations between ESA and JAXA go back to 1975 with the European Launcher Development Organisation (ELDO) and the European Space Research Organisation (ESRO). There is no trace of a framework agreement but they have more recently signed a number of agreements for joint missions, such as BepiColombo, EarthCARE and ASTRO-H, and for Earth observation data sharing from the individual Space missions. Technical coordination agreements have been established between the two agencies for the purposes of the Columbus and KIBO share-utilisation and the related cargo mission ATV from JAXA and HTV from ESA, and the back-up agreement over the two launching vehicles, Ariane 5 and H2A. This last agreement is between Arianespace and MHI, as the corporate sector provides launch services and the technical feasibility of back-up between the two launchers implies coordination action for the delivery of a compatible technology between Europe and Japan.

1.3 Relations between Austria and Japan

Austria does not have any governmental or inter-agency agreement with any Japanese counterpart. There is some history of industry-to-industry collaboration, mainly in the aviation sectors, and some Austrian companies have a branch office in Japan. The Japanese Space program features some technological trends exploiting R&D activities from air Space to outer Space, *e.g.* re-entry vehicles, composite structures for hypersonic aircraft concepts, unmanned aerial vehicles and remote control & command systems.

1.4 Relations between Belgium and Japan

The Belgian Federal Science Policy Office (BELSPO) is the national public organization responsible for coordinating science policy in Belgium, including Space policy. BELSPO manages national space programs along with Belgian participation in ESA programs. In addition, it has legal status to conclude international agreements with relevant counterparts for bilateral and multilateral projects. In relation to Japan, BELSPO has two agreements with JAXA for Belgian contributions to the Space missions HINODE and SPI both of these agreements are led by Japan. Belgium's contribution, mainly for the ground segment, is independent from ESA's involvement. The value of this joint initiative is around €1.9m Eur.

1.5 Relations between Bulgaria and Japan

Bulgaria does not have a Space agency, despite a substantial heritage of Space technologies during the Soviet era. The leading organization of the Bulgarian Academy of Sciences, the Space Research Institute (SRI), is now the primary entity in charge of long-term planning and elaboration of Space research programs. This is done in close connection with national priorities, and a considerable part is performed within the framework of international Space research cooperation. So far, there has been only one joint project with JAXA in the field of Astronomy, specifically in accretion discs and X-ray.

1.6 Relations between the Czech Republic and Japan

The Ministry of Transport is the main coordinator of Space activities in the Czech Republic[40]. It issued the new National Space Plan 2014 – 2020 (NSP 2014)[41] in coordination with the Ministry of Education, Youth

[40] Czech Republic, Government Resolution No. 282 of 20 April 2011

and Sports, the Ministry of Industry and Trade and the Government Commissioner for the European GNSS Agency (GSA). The main objective of NSP 2014 is to *increase the international competitiveness and the technological and innovative level of the Czech Republic*. NSP 2014 represents the strategy of the Czech Republic to further develop the capabilities of its industry and academia while maximising the return on public investment in Space activities. There have been diverse government initiatives over the past 5 years to leverage national industry for these purposes. In this regard the Ministry of Transport is the only European government entity that has an *ad hoc* Memorandum of Understanding drafted with the Japanese Cabinet Office for Space Policy. The MoU was drafted in May 2013 and is likely to be signed by 2015.

Industry-to-industry collaboration seems promising because in May 2010 the Czech Space Association, having gathered the affiliation of the various Czech Space industries, signed an agreement of cooperation with the Japanese Aerospace Parts Organization (JASPA) for cooperation in technology development or joint participation in national and international R&D[42]. In addition, the Japanese multinational KYOCERA has an affiliate company in the Czech Republic called AVX, which is also active in the field of Space, providing components that are compliant with European and Japanese Space standards[43]. The company GINA Software SRO, developing mobile technologies for sharing of accurate real-time situation via interactive maps, had success during a search-and-rescue operation in Japan after the 2011 tsunami in Fukushima[44]. Recently, the company IGUASSU Software System SRO has also been exploring business partnerships in Japan for GNSS software solutions.

1.7 Relations between Finland and Japan

Finland does not have a Space Agency as such and its space affairs are managed by the Advisory Committee on Space-related Affairs, which operates in connection with the Ministry of Employment and the Economy as an advisory body that combines the views of the various administrative branches. The Advisory Committee has drawn up a national strategy containing the Finnish vision for Space-related activities, its objectives and a development strategy. TEKES, the Finnish Funding Agency for Technology and Innovation, coordinates the participation of Finns in the research and science programmes of the ESA. To date, the national Space plan does not include any activities with Japanese Space stakeholders. The only connections within this sector are between the University of Tampere and Japanese R&D institutions, such as Keio University, the National Institute of Polar Research, and the Solar-Terrestrial Environment Laboratory of Nagoya University, for the development of dedicated software system for the storage of data related to the Arctic.

1.8 Relations between France and Japan

There is a long tradition of Franco-Japanese collaboration in the Space field on several levels, from the governmental point of view, to inter-agency and business trade. At the governmental level there exists a bilateral agreement between the two ministries of education and research, under which Space is an element of cooperation. The long-term relationship is mainly between JAXA and CNES, the two national Space agencies, with the signing of a first agreement of cooperation achieved in 1996. Upon this foundation, 5 top-level working groups with joint participation have been established in the areas of Earth observation, Space transport, Space exploration, components and use of the International Space Station. The agreement was renewed in 2010 with confirmation of an annual bilateral meeting and the possibility to discuss specific items related to the transfer of technologies in terms of intellectual property rights, transfer of goods and technical data, and cross-waiving of liability. The main collaborations have been the cooperative observations of Space radiation using the Ocean Surface Topography Mission - Jason-2 led

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[41] Czech National Space Plan 2014 – 2020. Last access in June 2015 at: www.msmt.cz/file/11399/download/

[42] CzechInvest , Japan and the Czech republic to cooperate in aerospace, 26 May 2010. Last access in June 2015 at: http://www.czechinvest.org/en/japan-and-the-czech-republic-to-cooperate-in-aerospace

[43] Czech Space Portal, Catalogue 2014, pp. 8 – 9.

[44] Idem, p. 32

by France, the Greenhouse Gases Observing Satellite known as *Ibuki* and the interplanetary Space mission Hayabusa-2 led by Japan.

Collaboration for the Jason mission includes also a joint project working on Space radiation observation experiments according to an *ad hoc* agreement signed in 2006 in relation to data sharing.

Some additional minor projects have been in the field of composite materials, satellites technologies, rockets, the International Space Station and planetary exploration. Industry-to-industry relations are quite strong in different market segments. From the launch segment, Arianespace and MHI have a back-up agreement implying mutual exchange of availability to launch satellites in order to satisfy customer requirements for orbits at a particular time. This back-up agreement also implies technical compatibility, thus enhancing production business opportunities on both sides particularly when the launch pads can be crowded for governmental missions, e.g. Galileo and Copernicus satellites from the European side, and the almost 35 satellites involved in the new Japanese plan. Also in the field of rockets, the Safran group has been a contributor to Japanese technologies such as Epsilon. The benefit of having European technology integrated in Japanese technology is the disclosure of information: it is not a black-box technology transfer, unlike the trend of much US licensed technology where only the interfaces can be released. Apart from this agreement, Arianespace has often been selected as the launch provider of several Japanese satellites in the range of 29 commercial satellites and 2 antenna deployment experiments for JAXA. Additional business trades are coming from the partnership between Eutelsat and Panasonic for satellite telecommunication services for aviation in the shape of Very Small Aperture Terminals. The next cooperation between Panasonic and Eutelsat is for the provision of Ultra-HDTV by satellite over the Asia Pacific. EADS is very active in the field of remote sensing, holding a multi-year partnership with PASCO for data processing and value-added services for geospatial needs. PASCO initially held exclusive rights for the military market. In December 2014, PASCO acquired Tokyo Spot Image SA. The new company, Satellite Image Marketing (SIM), acts as a vehicle reseller in Japan for the high-resolution (50 cm) data from Pleiades 1A and 1B, medium resolution (from 2.5 m to 1.5 m) from Spot 1-5 and 6-7, FORMOSAT-2 and low resolution (22 m and swath of 600 km) from DEIMOS-2. Another successful case is the provision of monitoring services for the Japanese Coast Guard by a French company, CLS, specialised in downstream applications for the ocean environment.

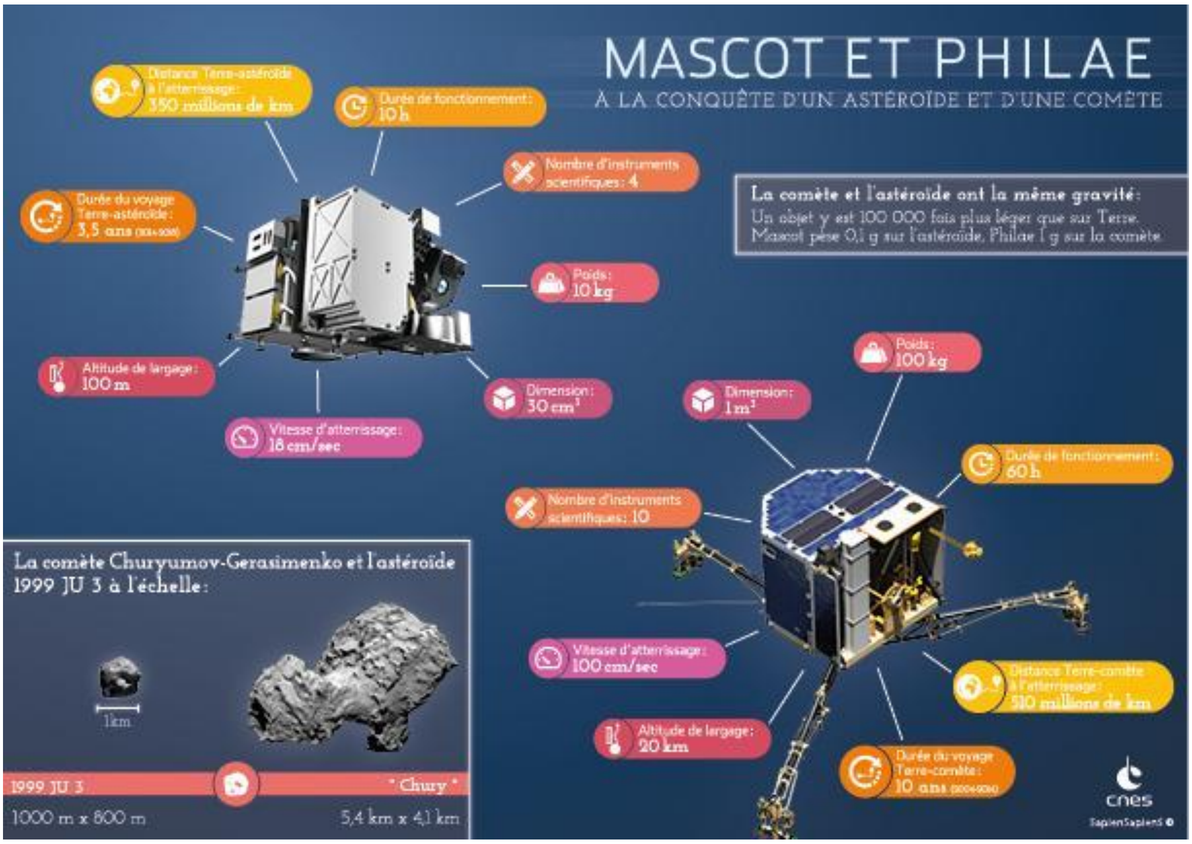

Figure 1: Comparison between ESA Rosetta-Philae Mission and the JAXA Hayabusa-2 Mission

1.9 Relations between Germany and Japan

Germany is another active European player in the field of Space in Japan. The German Space Agency, DLR, has a letter of intent with JAXA signed in 2009 for radar data sharing from ALOS, the Japanese Space mission, and TERRA-SAR and TANDEM-X from the German side. The agreement focuses on disaster management from R&D activities through to the development of commercial solutions for mutual purposes. In November 2012 DLR and JAXA signed an MoU for German contribution to the Japanese interplanetary mission, Hayabusa-2. Together with France, DLR provided the Mobile Asteroid Surface Scout (MASCOT). In addition to these major collaborative endeavours, DLR cooperates with Japanese universities in more than 110 R&D projects.

Business cooperation started recently, mainly for the co-development of component standards and innovative concepts for small spacecraft.

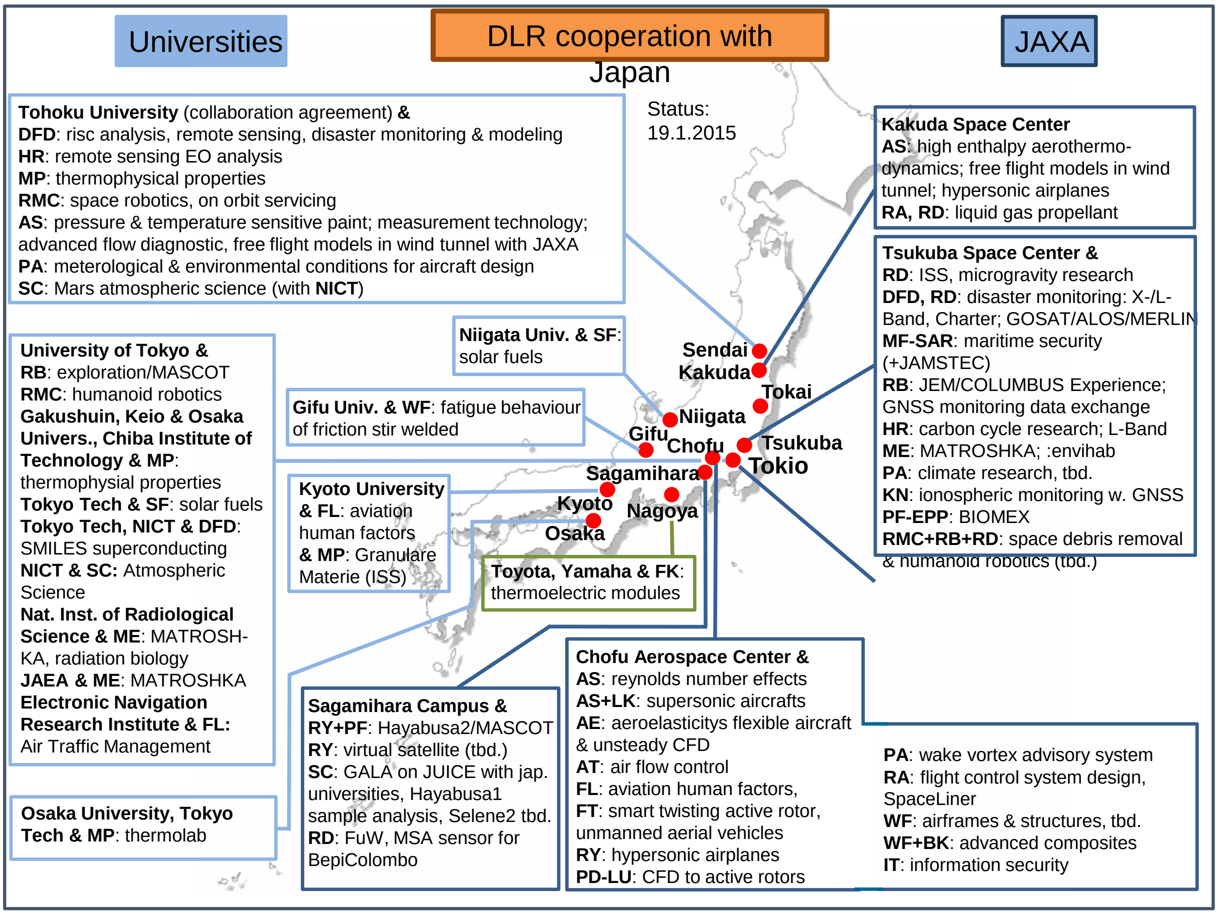

Figure 2: DLR cooperation with Universities and with the JAXA, 2015 [45]

1.10 Relations between Greece and Japan

There is a Greek business presence through Compucom developing GNSS applications and GIS platforms jointly with local partners. There is also business trade in component development, mainly of attitude control systems for in-orbit control of satellites. Recently, the economic crisis has made Greece attractive for its low cost of production in comparison to Japan.

1.11 Relations between Hungary and Japan

[45] *Source:* Courtesy of N. R. – DLR, Tokyo

InterComparison for Cosmic-ray with Heavy Ion Beams conducted by JAXA and the Hungarian Atomic Energy Research Institute, is the only research collaboration between Hungary and Japan. The outcomes of this project are promising for commercial exploitation in the field of pharmaceutical drugs.

1.12 Relations between Ireland and Japan

In October 2013 the Irish Ministry of Education and the Japanese MEXT signed an MoU for cooperation in science and technology, where Space is an item of the agreement. So far, the agreement has been exploited for research exchanges in the field of Space life sciences and for ICT activities, e.g. SatCom.

1.13 Relations between Italy and Japan

Italy and Japan have signed an MoU for bi-lateral cooperation in Science and Technology and for initial dialogues over defence technology provision in line with NATO commitments.

The Science and Technology agreement, renewed every four years, features Space as an item of cooperation for disaster monitoring, linked with volcanic dynamics and space technology transfer policy. JAXA and ASI have signed a number of agreements for Space collaboration. In 2004 there was the first inter-agency agreement to jointly promote Space sciences and their utilisation for peaceful purposes. In 2009 they signed an ad hoc agreement for disaster management through the co-sharing of data from the Italian COSMO-SKyMed and the Japanese ALOS: this agreement has been renewed with the upcoming ALOS-2 in September 2014. In addition, the framework agreement was renewed in 2010 including new items, such as re-entry vehicles and Space engines fuelled by Lox/Methane. In 2011, ASI and JAXA had another joint collaboration on board the ISS for the Calorimetric Electron Telescope (CALET). In this case, ASI was tasked to provide the High Voltage Power Supply (HVPS) Units for the CALET Gamma-ray Burst Model and Calorimeter (CAL) on board CALET along with scientific and technical support by Italian researchers belonging to Italian institutes led by National Centre of Researches – Institute for Applied Physics (CNR-IFAC) and the University of Siena.

From a commercial point of view, the Japan Space Imaging Co. became a reseller of COSMO-SkyMed data in Japan through a partnership with the Italian commercial company, e-GEOS SpA. Other flows of trade are the two-way exchange - according to demand - of satellite payloads, Li-Ion batteries and solar arrays between MELCO and NEC with Thales Alenia Space. Further developments in commercial trade are foreseeable in VSAT solutions for mobility, e.g. in the aviation market segment for antenna provision, electric propulsion and high throughput payloads for SatCom onboard spacecrafts, and ITAR- free components.

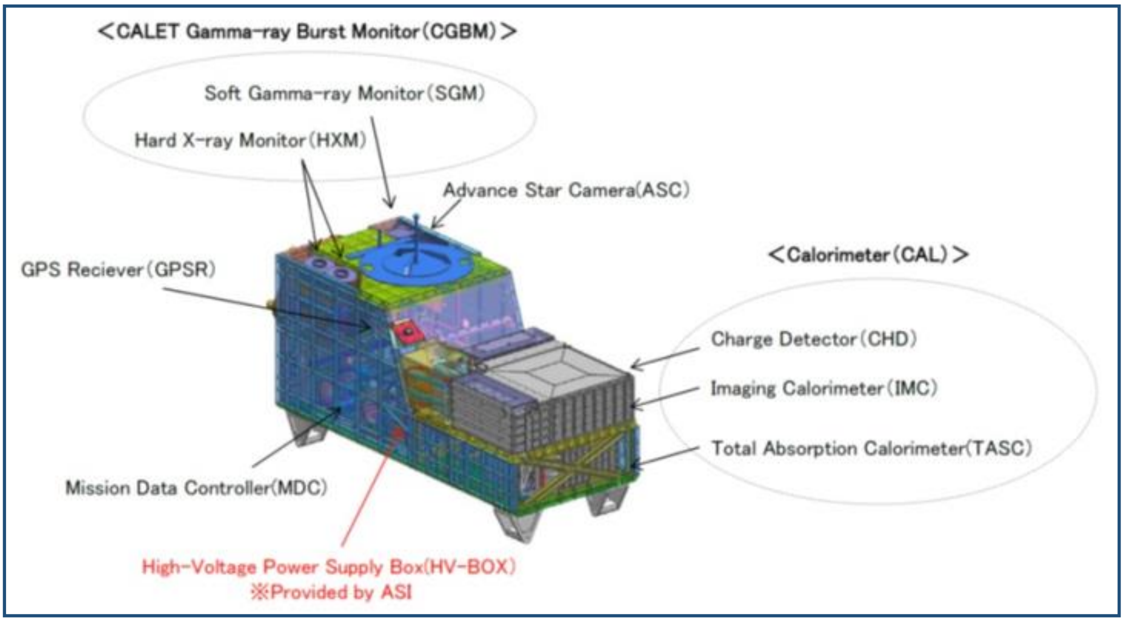

Figure 3: CALET Instrument[46]

1.14 Relations between Latvia and Japan

Latvia does not have any top-level agreement in place with Japanese stakeholders. Its contribution to JAXA comes through the University of Latvia for space science experiments with stratospheric balloons and composite materials. There is business-to-business collaboration with Sidrabe, Japan Space Co. (JSC) for the commercialisation of the vacuum shield thermal insulation of spacecraft and spacesuits.

1.15 The relations between Lithuania and Japan

The Lithuanian Space Association is collaborating wih the University Space Engineering Consortium (UNISEC) in Tokyo and Wakayama for small satellite projects. Cooperation in this field will address the design, launch and exploitation of small spacecraft (under 50kg). Two nano-satellites developed in Lithuania have been released into outer Space from the Japanese KIBO module of the ISS. New technologies, *e.g.* laser for space applications, mechatronics and optoelectronics, have been proposed as elements of the emerging Lithuanian Space collaboration with Japan.

1.16 Relations between The Netherlands and Japan

The Dutch National Space Office has in place a 2010 Memorandum of Understanding with JAXA as a framework for cooperation. The first concrete activity under this framework has been the contribution of the Dutch Space research institute SRON to the Japanese X-Ray space telescope ASTRO-H and its further exploitation in the Japanese SPICA telescope. The Dutch contribution amounts to a projected cost of €60m. Funding for SAFARI mostly comes from the SRON base budget (€36m), and €18m has been secured under the National Roadmap for Large Research Infrastructure 2012.

1.17 Relations between Romania and Japan

In Romania, space collaboration is pursued through the Institute of Space Sciences for R&D activities on board the ISS, utilizing the JEM-EUSO and the INCAS for Supersonic flights. In both cases, the Japanese counterpart is JAXA.

1.18 Relations between Slovakia and Japan

The Slovakian Institute of Experimental Physics, SAS, Košice and JAXA are jointly conducting Space R&D activities on board the ISS, utilising the JEM-EUSO.

1.19 Relations between Spain and Japan

The Spanish Centre for the Development of Industrial Technology (CDTI) is performing R&D activities alongside the Japanese NICT in the field of optical and laser communication.

1.20 Relations between Sweden and Japan

The Swedish National Space Board, the national Space agency of Sweden, signed a Memorandum of Understanding with JAXA in 2008 to consider potential future collaboration and to establish general procedures for conducting cooperation in areas of mutual interest in the field of Space for peaceful

[46] © JAXA – ASI

purposes. From a commercial point of view, the Swedish Space Corporation (SSC) supports JAXA in several satellite missions and SSC is also hosting two Japanese satellite antennae at the Esrange Space Center, the operational base of SSC in northern Sweden. A third antenna was under construction and ready for operations since the summer of 2009.

1.21 Relations between United Kingdom and Japan

Japan and the United Kingdom have a long tradition of international relations since the signature of the Treaty of Friendship and Trade in October 1854. Concerning Space affairs, the two Prime Ministers held their first summit in 2007, where they agreed to work towards achieving a set of objectives in the areas of international security, climate change, international development and science, technology and innovation. In 2012 an *ad hoc* MoU was drawn up between the Minister for Space Policy and the Minister of Foreign Affairs, on the Japanese side, and the British Minister for Universities and Science and the Secretary of State for Foreign Affairs, on the UK side. The MoU is signed in quadruple by the Cabinet office (formerly the Strategic Headquarters for Space Policy), the UK Space Agency and the two national Ministries of Foreign Affairs, who all agreed to mutually cooperate in the field of Space for the development of applications, technologies, industrial relations and the rule of law. The Joint Committee (*ex* art. 3 MoU 2012) gathers members from the two ministries of foreign affairs, the Cabinet and the UK Space Agency, to establish bilateral working groups on topics of cooperation and to identify points of contact. The Joint Committee will guide the Proof Of Concept and the working groups in the implementation of activities which are expected to comply with the current export control regimes and the regulation of intellectual property rights.. In January 2015, the two countries reconfirmed their alliance with a joint statement where they "decided to enhance cooperation in the area of disarmament, non-proliferation, and conventional arms control, as well as export control of arms and dual-use items and technologies". In addition, they "welcomed progress in cooperation on Outer Space Activities, including Space security initiatives such as the proposed Code of Conduct for Outer Space Activities". This legal framework allowed industries to cooperate in the field of aerospace and defence and for the development of dual-use technologies, resulting in annual trade volumes of around €8m. The Space technologies involved relate mainly to the launch and upstream segments of Space-based systems.

1.22 Relations between Switzerland and Japan

Switzerland is not a Member State of the European Union but is considered relevant to this report because it is a Member State of the ESA and a cooperative member of the two upcoming European Space Flagship Programmes. Its relation with Japan is particularly active in the provision of clock components for space purposes and GNSS receivers for smart devices. From a science and technology point of view, a joint project between the École Polytechnique Fédérale de Lausanne, leading the Swiss Space Centre, and JAXA has recently been established in the field of Space debris technologies.

1.23 Relations between Norway and Japan

Norway is not a Member State of the European Union but is considered relevant to this report because it is a Member State of the ESA and a cooperative member of the two upcoming European Space Flagship Programmes. The Norwegian Space Centre (NSC) and JAXA first in 2007 indicated their will to collaborate in the field of Space for research into sounding rockets. Later in 2010, they renewed and enlarged the footprint of activities for broader cooperation in Space-related research. In 2012, Space was included as an item of bilateral relations in the field of science and technology, in particular polar-related Space research activities involving the European Incoherent Scatter Scientific Association radar systems (EISCAT), and atmospheric studies using sounding rockets. In January 2015, a new MoU was agreed between JAXA and the NSC focusing on sounding rocket research. These framework agreements enhance also the industrial cooperation occurring mainly around the ground segment and data storage and based in the Norwegian polar region.

1.24 Multilateral relations between European and Japanese players

Apart from these bilateral relations, there are a number of initiatives involving different European and Japanese stakeholders; for instance, the Supersonic Tunnel Association International, gathering almost 13 European institutions in collaboration with the Japanese consortium of JAXA and industrial players such as Kawasaki and Mitsubishi. This partnership aims to share supersonic tunnel facilities and related best practices.

Aside from this, European R&D funds (formerly FP7 and currently Horizon 2020) have played a role in the relationship between Europe and Japan. In March 2011, the Agreement between the European Community and the Government of Japan on Cooperation in Science and Technology came into force. At the EU-Japan Summit in May 2014, leaders expressed their aim for a "new strategic partnership in research and innovation". The roadmap for cooperation between the EU and Japan provides an overview of what are considered the medium term priorities for future cooperation, reflecting the current state of agreement in the EU-Japan Policy Dialogue. The following areas are priority areas for future cooperation with Japan: critical raw materials and transport research including aviation and ICT. There is no clear statement about Space but at the same time, Space-based technologies are key enablers for these fields of research[47].

The following table reports the most recent Space-related R&D projects funded by the EU and involving Japanese entities. These projects present the contribution of Space technology and science as a core competence and/or as an element of the technological solutions. In this regard, Space played the role of a key enabler across different fields, such as ICT and telecommunications, urban planning, resilience measures, composite materials for aviation and Arctic studies. Regarding the participation of Japanese organizations, in general, legal entities established in any country may participate, as well as international organisations. However, organisations in Japan are not eligible for automatic funding. Only exceptional circumstances, such as the need for access to a specific research infrastructure that is vital for the success of the project, will the EC consider funding a Japanese organisation. For standard research projects, a consortium of at least three legal entities is required and each of these entities must be established in an EU Member State or an Associated Country[48]. Hence, at least three legal entities from three different countries are needed in the consortium ahead of a Japanese organisation. For smaller actions such as Coordination and Support Actions (CSA), only one legal entity in an EU Member State or an Associated Country is required. There are also specific coordinated actions between the EU and Japan, which are funded on a 50-50 basis and for which Japanese organisations are subject to specific Japanese rules. These calls are clearly indicated in the related work programme issued by the Commission. For this purpose, the green colour in background indicates that a Japanese entity obtained access to European funds, the blue colour indicates that the Japanese entity has been only a partner and a white background indicates missing joint-funding information.

[47] 22nd EU-Japan Summit, The EU and Japan Acting together for Global Peace and Prosperity – Joint Press Statement, Brussels 7 May 2014. Last access in June 2015 at: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/142462.pdf

[48] EC, Directorate-General for Research & Innovation, Associated Countries, 2015. Last access in June 2015: http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/3cpart/h2020-hi-list-ac_en.pdf

Project	Name	Relevance to the Space domain	Japanese participation	Value
ENV.2007.4.1.4.2. Grant No 212921 (CEOP-AEGIS)	Coordinated Asia-European long-term observing system of Qinghai – Tibet Plateau hydro-meteorological processes and the Asian monsoon system with ground satellite image	Earth observation	University of Tsukuba	- **Total cost: 4.4 [M Eur]** - **EU Contribution: 3.4 [M Eur]**
People- Marie Curie Action: IIF Grant No 221145 (OBSI-FSU)	Joining worlds apart: Observations and Simulations of the First Stars in the Universe	Space Sciences	Japanese Scientist to Keele University (UK)	- **Total cost: 135.289 [Eur]** - **EU Contribution: 135.289 [Eur]**
ICT - FP7-ICT-2007-2. Grant No 224263 (ONELAB2)	OneLab2 : An Open Federated Laboratory Supporting Network Research for the Future Internet	SatCom	National Institute of Information and Communication (NICT)	- **Total cost: 8.8 [M Eur]** - **EU Contribution: 6.2 [M Eur]**
People – ITN FP7-PEOPLE-ITN-2008. Grant No 235065 Marie Curie Action: "Networks for Initial Training" (ROBOT-DOC)	Robotics for Development of Cognition	Exploitation of Space Robotics know-how	Indirect participation of Tohoku University	- **Total cost: 3.4 [M Eur]** - **EU Contribution: 3.4 [M Eur]**
ICT FP7-ICT-2009-4. Grant No 248366 (ROBOSOM)	A Robotic Sense of Movement	Exploitation of Space Robotics know-how	Waseda University	- **Total cost: 2.1 [M Eur]** - **EU Contribution: 1.6 [M Eur]**
ICT FP7-ICT-2009-4. Grant No 248454 (QOSMOS)	Quality of Service and Mobility driven cognitive radio Systems	Exploitation of Space Robotics and GNSS know-how	NEC (JP branch is a partner)	- **Total cost: 15.5 [M Eur]** - **EU Contribution: 9.4 [M Eur]**
ICT FP7-ICT-2009.9.1. Grant No 248505 (EURSIAPAC)	European Asia-Pacific Cooperation on ICT Research	SatCom	Indirect participation of NICT	- **Total cost: 739 630v [Eur]** - **EU Contribution: 650.000 [Eur]**
Capacities Infrastructures FP7-Infrastructures Grant No 261747 (SIOS-PP)	Svalbard Integrated Arctic Earth Observing System - Preparatory Phase	Earth Observation	Inter-University Research Institute Corporation Research Organizations of Information and systems	- **Total cost: 6.6 [M Eur]** - **EU Contribution: 3.9 [M Eur]**
Capacities Infrastructures INFRA-2010-2.2.10. Grant No 262053 (CTA-PP)	The Preparatory Phase for the Cherenkov Telescope Array for Gamma-ray astronomy	Space Science	University of Tokyo	- **Total cost: 8 [M Eur]** - **EU Contribution: 5.2 [M Eur]**

Capacities Brazil, Canada, China, Japan, USA (INCO.2010-3.2) Grant No 266604 CONCERT-JAPAN	Connecting and Coordinating European Research and Technology Development with Japan	Space Science & Technology	MEXT JSPS JST	- **Total cost: 2.5 [M Eur]** - **EU Contribution: 2.0 [M Eur]**
Project	**Name**	**Relevance to the Space domain**	**Japanese participation**	**Value**
Capacities CONCERT_DIS-03 Grant No 266604 RAPIDMAP (CONCERT - JAPAN Pilot Joint Call on Research and Innovation)	Resilience against Disasters using Remote Sensing and Geo-information Technologies for Rapid Mapping and Information Dissemination	Earth Observation	Tokai University	- **JST Contribution: 10 [M \]**
Capacities CONCERT_DIS021 Grant No 266604 RAPSODI (CONCERT - JAPAN Pilot Joint Call on Research and Innovation)	Risk Assessment and design of Prevention Structures for enhanced tsunami disaster resilience	Earth Observation and SatCom	Port and Airport Research Institute	- **JST Contribution: 10 [M \]**
Capacities CONCERT_DIS013 Grant No 266604 ROADERS (CONCERT - JAPAN Pilot Joint Call on Research and Innovation)	Road Networks for Earthquake Resilient Societies	Earth Observation	Kyoto University	- **JST Contribution: 10 [M \]**
Capacities CONCERT_DIS033 Grant No 266604 URBIPROOF (CONCERT - JAPAN Pilot Joint Call on Research and Innovation)	Increasing resilience of urban planning	Earth Observation, GNSS and SatCom	Tohoku University	- **JST Contribution: 10 [M \]**
ENV.2011.1.1.3-1 Grant No 282700 (PAGE21)	Vulnerability of Arctic permafrost to climate change and implications for global GHG emissions and future climate	Earth Observation	Indirectly JAXA	- **Total cost: 9.3 [M Eur]** - **EU Contribution: 6.9 [M Eur]**
ENV Grant No 282862 (REAKT)	Towards real-time earthquake risk reduction	Downstream Applications	Ministry of Land, Infrastructure, Transport and Tourism	- **Total cost: 10.1 [M Eur]** - **EU Contribution: 6.9 [M Eur]**

ENV.2011.4.1.3-1 Grant No 282915 (GEOWOW)	Inter-operable integration of shared Earth Observations in the Global Context	Earth Observation	University of Tokyo	**- Total cost: 9.1 [M Eur] - EU Contribution: 6.3 [M Eur]**
ENV Grant No 283177 (CATALYST)	Capacity building in natural hazards risks reduction	Earth Observation	United Nations University	**- Total cost: 992 800 [Eur] - EU Contribution: 843 931 [Eur]**
Transport – Aeronautics AAT.2011.7-20. Grant No 284881 (SUNJET)	Sustainable Network for Japan-Europe aerospace research and Technology cooperation	Exploitation of Space technologies (composite structures)	Indirect participation of JAXA	**- Total cost: 333 347 [Eur] - EU Contribution: 308 494 [Eur]**
Project	**Name**	**Relevance to the Space domain**	**Japanese participation**	**Value**
Transport GALILEO.2011.4.3-1. Grant No 287244 International Activities (GNSS Asia)	GNSS in Asia - support on international activities	EGNSS Downstream applications	EU-Japan Centre for Industrial Cooperation	**- Total cost: 1.2 [M Eur] - EU Contribution: 1.2 [M Eur]**
People Grant No 295153 (ELiTES)	ET-LCGT Telescopes: Exchange of Scientists	Space Science	Exploitation of the large-scale Cryogenic Gravitational wave Telescope (KAGRA)	**- Total cost: 256 200 [Eur] - EU Contribution: 203 700 [Eur]**
Space FP7-SPACE-2012-1. Grant No 312807 (THOR)	Innovative thermal management concepts for thermal protection of future space vehicle	Space Technology	JAXA	**- Total cost: 2.7 [M Eur] - EU Contribution: 1.9 [M Eur]**
Space FP7-SPACE-2012-1. Grant No 313271 (PulChR)	Pulsed chemical rocket with green high performance propellant	Space Technology	JAXA	**- Total cost: 2.6 [M Eur] - EU Contribution: 1.8 [M Eur]**
Transport – Aeronautics FP7-AAT-2012-RTD-JAPAN. Grant No 313987 (HIKARI)	High speed Key technologies for future Air transport - Research & Innovation cooperation scheme	Space technology know-how	JAXA University of Tokyo	**- Total cost: 2.0 [M Eur] - EU Contribution: 1.4 [M Eur]**
TPT AAT.2012.4.1-6. Grant No 314307 (SHEFAE)	Surface Heat Exchangers for Aero-Engines	Space technology know-how	Sumitomo Seimitsu Kogyo KK University of Tokyo	**- Total cost: 2.0 [M Eur] - EU Contribution: 1.1 [M Eur]**
Transport – Aeronautics FP7-AAT-2012-RTD-JAPAN Grant No 314335 (JEDIACE)	Japanese-European De-Icing Aircraft Collaborative Exploration	Space technology know-how	JAXA Kanagawa Institute of Technology	**- Total cost: 1.8 [M Eur] - EU Contribution: 1.3 [M Eur]**
ENV KNOW-4-DRR Grant No 603807	Enabling knowledge for disaster risk reduction in integration to climate change adaptation	Earth Observation	Indirect participation of JAXA	**- Total cost: 1.1 [M Eur] - EU Contribution: 0.9 [M Eur]**
ENV.2013.6.4-3 Grant No 603839 (ASTARTE)	Assessment, Strategy And Risk Reduction for Tsunamis in Europe	Earth Observation	Port and Airport Research Institute	**- Total cost: 7.8 [M Eur] - EU Contribution: 5.9 [M Eur]**

Table 2: List of projects with Japanese partners under the European R&D Framework Programme Funds

The overall amount of money involved in these R&D projects under FP7 reaches a value of €100.93 million and the EC has funded approximately 70%. In particular, almost 48% of the funding has been invested for Earth observation projects, 40% for Space Science and Technology (mainly hardware elements for upstream of the value chain) and the rest for GNSS with a share of 5% and SatCom with 7%. In terms of European funds, there are some single-digit percentage difference such as 49% for Earth observation, 9.6% for SatCom, 2.4% for GNSS and 39% for Space Science & Technology. An exemplary case of co-funding between EU and Japan is the CONCERT-Japan initiative[49], funded by the EU as an international cooperation activity within the Capacities Programme of FP7. The project aims to further develop existing cooperation between European countries and Japan by promoting and enabling effective collaboration in science and technology research. The Japanese MEXT, the Japan Society for the Promotion of Science (JSPS) and the Japan Science and Technology Agency (JST) are the three partner institutions from Japan. Under this framework, the JST funded pilot projects in the areas of "Resilience against Disasters" and "Efficient Energy Storage and Distribution". Space has been a contributing element for the first of these, mainly through Earth observation services belonging to RAPIDMAP, RAPSODI, ROADERS and URBIPROOF. Each project received a contribution of 10M ¥ from JST over two years.

2 The EU and the Japanese Space Policy

Space continues to present significant technological and scientific challenges for the understanding of the planet and the universe. Space-based technologies, however, have a large set of applications related to several governmental activities and/or functions such as telecommunication, monitoring and data gathering of positioning, timing and navigation information. Space can thus be a trans-disciplinary technological and policy tool for R&D, transport, energy management, telecommunication, innovation and technological advancement, foreign and internal affairs.

2.1 The EU Space Policy

2.1.1 The EU role in the peaceful use of the Space Domain

Space activity has become a critical component of the EU's advancements on both the domestic front and in terms of international influence. Space programs can also be economic engines in that they tend to foster technological developments.

The Communication of the EC in 2010[50] has correspondingly identified Space as a driver for innovation and competitiveness at citizens' service in line with three imperatives:

i. *societal, because Space-based technologies and applications benefit citizens' lives,*
ii. *economic, for augmenting knowledge and driving innovation, and*
iii. *strategic, for furnishing Europe with assets and capabilities to Europe.*

Since the Lisbon Treaty (Treaty on the Functioning of the European Union, TFEU) in 2007, the EU has an explicit *sui generis* shared competence for Space, *ex* art. 4 comma 3 and art.189, which establishes a coordinated relationship between the EU and ESA. This relationship helps to ensure that European Space programs are delivered while respecting national Space programs of individual Member States. Thus, emerging European Space policies are a function of the interaction between at least three actors: the EU, ESA and the Member States. However, the complexity of this relationship is growing, and can hinder the EU's international relationships with extra - EU third

[49] JST, CONCERT – Japan. Last access in June 2015: http://www.jst.go.jp/inter/english/sicp/country/concert-japan.html

[50] EC, An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM (2010) 614, Brussels, 28 November 2010.

countries. These challenges were taken into account during the development of the two main Space flagship programs:

i. Galileo, the GNSS of the EU and
ii. Copernicus, the European Earth observation infrastructure.

The EU and ESA are primarily jointly leading these two flagship Space programs.

The EU is gradually becoming more involved in the Space domain, including Space situational awareness and Space exploration and has endorsed Europe's efforts to engage in Space exploration for the sake of knowledge, science and technological progress and to affirm its position as a world player. In 2013, the EC proposed a programme to support those EU Member States that own both radars and telescopes that are capable of monitoring satellites and Space debris, or relevant data centres. The proposed programme brings their capacities together to form the first European Space Surveillance and Tracking (SST) service. The diagram below illustrates the relationship between the European public entities with stakes in the Space affairs.

Figure 4: The European Governance model for Space programs

The European Council and the European Parliament manage the political oversight jointly. The Council defines the political agenda and all states or governments of the EU's member states, together with their respective Presidents and the EC's President sit in. The Council of the EU, in its configuration with member states' governments, in turn adopts laws and coordinates policies. Until 2011, there had been a specific Space Council in which EU Member states' governments and ESA Member States' governments jointly discussed the agenda items of the meeting. Today, however, the Council for Competitiveness coordinates Space with support from ESA. The EC is the public administrative body of the EU and executes the political will adopted by the Council and the Parliament. It manages the development of the programs based on political decisions and adopted policy transfer. The EC shares the programs among different Directorates. The current Directorate in charge of Space is DG Growth, Internal Market, Industry, Entrepreneurship and SMEs. The EC delegates the development of the upstream elements of the program to ESA. Meteorological activities related to the payload for meteorological applications of the Copernicus' Sentinels are partially delegated to the **EUMETSAT**[51]. With respect to the downstream deployment of the

[51] European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) is an intergovernmental organisation and was founded in 1986. Our purpose is to supply weather and climate-related satellite data, images and products – 24 hours a day, 365 days a year – to the National Meteorological Services of our Member and Cooperating States in Europe, and other users worldwide. Nowadays, current total of 30 European Member States, such as Austria, Belgium, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Iceland, Italy, Latvia, Lithuania, Luxembourg, the

two European flagship programs, the EC delegates and asks for support from its agencies. In particular, the **European GNSS Agency (GSA)** is an agency of the European Union, as stated by Regulation (EU) No. 512/2014 of 16 April 2014. GSA handles the deployment of innovative downstream applications related to the European GNSS systems EGNOS and Galileo in an industry-oriented approach. This approach is geared towards industrial players and responds to user-needs and new market demands. With respect to Copernicus, the other European entities involved play the same role as GSA. The following table summarizes each key entity and the related field of application with respect to Copernicus' downstream deployment.

Entity	Description	Role
European Environmental Agency (EEA)	An agency of the European Union whose task is to provide sound, independent information on the environment. Established in 1991 with Regulation (EC) No 401/2009 of the European Parliament and of the Council of 23 April 2009 on the European Environment Agency and the European Environment Information and Observation Network (Eionet).	EEA plays a key role in coordinating in-situ observations and contributing to the development of services, in particular, to the technical coordination of the Land Monitoring Service.
European Centre for Medium-Range Weather Forecasts (ECMWF)	An independent intergovernmental organization supported by 34 states, established in 1975.	Operates two services on behalf of the European Union: the Copernicus Atmosphere Monitoring Service and the Copernicus Climate Change Service.
European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union (FRONTEX)	Promotes, coordinates and develops European border management in line with the EU fundamental rights charter applying the concept of Integrated Border Management. Established by Council Regulation (EC) 2007/2004.	Handles downstream applications related with Security and boarder monitoring.
Joint Research Centre (JRC)	The European Commission's in-house science service, which employs scientists to carry out research in order to provide independent scientific advice and support to EU policy.	Its role within Copernicus is the development and management of Emergency downstream applications and the data hub of the system.
European Maritime Safety Agency (EMSA)	A decentralized agency of the EU that provides technical assistance and support to the European Commission and Member States in the development and implementation of EU legislation on maritime safety, pollution by ships and maritime security. Regulation (EC) No 1406/2002 established it.	Handles the maritime surveillance services under Copernicus.
European Union Satellite Centre (EUSC)	It was incorporated as an agency into the European Union on 1 January 2002. It shall, in coherence with the European Security Strategy, support the decision–making of the European Union in the field of the Common Foreign and Security Policy (CFSP), in particular of the Common Security and Defence Policy (CSDP), including European Union crisis management operations, by providing, as appropriate, products resulting from the analysis of satellite imagery and collateral data, including aerial imagery, and related services.	It deploys the downstream services compliant with the need of the External Action.

Table 3: European entities involved in the downstream deployment of Copernicus

The European Space Policy also includes the activities led directly by **ESA**, an intergovernmental organization which includes twenty-two European Member States plus an additional eight States under cooperating agreements.

Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom. These States fund the EUMETSAT programs and are the principal users of the systems. EUMETSAT also has 1 Cooperating State: Serbia.

Its legal status derives from 30th May 1975 ESA Convention that states at:

- **Art. 15.1** *The Agency shall have legal personality*;
- **Art. 2** *The purpose of the Agency shall be to provide for and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems*. The same article continues with:
  - ***Art. 2.a****: (…) elaborating and implementing a long*-*term European space policy*
  - ***Art.2.c:*** *(…) coordinating the European space programme and national programmes*
  - ***Art. 2.d:*** *(…) elaborating and implementing the industrial policy appropriate to its programme and by recommending a coherent industrial policy to the Member States*

ESA manages has both a decision-making and executive branch. The decision-making is the responsibility of the Council, which is composed of the representatives of the all Member-States. The ESA convention states at:

- **Art. 11.3.a:** *The Council shall elect a* Chairperson *and a vice*-chairperson
- **Art. 11.3.b**: *The Chairperson shall be assisted by a Bureau.*

The executive power is vested in the Director General, who is assisted by a structured staff of personnel. *The Council shall, by a two-thirds majority of all Member States, appoint a Director General ex* **Art. 12.1.a**. *The Director General shall be the chief executive officer of the Agency and its legal representative* ex **Art. 12.1. b**. ESA Council approves programs of activities. The programs shall be optional or mandatory. The mandatory programs in scientific activities represent the minimum commitment and involvement of Member-States **- Art. 5.1.a ESA Convention -**, and the optional programs includes building and launching of satellites **- Art. 5.1.b ESA Convention -**. Furthermore, ESA *can carry out any other activity requested by users and approved by the Council (…) The cost of such operational activities shall be borne by the users concerned*, ex **Art. 5. 2 ESA Convention**. ESA is an international player: ESA may establish informal relationships or formal agreements with other States or organizations. This legal provision allows ESA to be committed to develop additional activities by the EC, as a third party, to the development of further activities such as Galileo and Copernicus.

Furthermore, the overall European Space governance also counts on the activities of National Member States. Because the EU and ESA form a joint footprint with Member States from the EU and ESA. Nowadays, not all EU Members are Members of ESA while two Members of ESA, Norway and Switzerland, are not part of the EU.

The EU has signed agreements with ESA for the development of Galileo and Copernicus. *Ad hoc* acts are required on a case-by-case basis. National Member States contribute to ESA and they approve their own national Space programs. There are two recent trends: first of all, in the past, the ESA contribution and the share for national purposes were roughly equal: today, there is a tendency to contribute more to ESA programs. In addition, today's national programs tend to become augmented to ESA's main programs instead of running isolated Space missions[52].

2.1.2 The European Union's role for Security in the Space domain

Many space systems are ultimately dual-purposes in nature, i.e., for both civilian and military applications, but they are often initially developed for military purposes. Thus, they also serve the objectives of the EU's Common Foreign and Security Policy (CFSP) and the Common Security and Defence Policy (CSDP). For example, R&D projects, funded by the European FP7 programme, have provided innovative solutions which have been valuable for security purposes and have supported the European External Action Services (EEAS) in border monitoring and maritime awareness. Peaceful Space activities deployed by civil institutions incorporate the EU as a supranational body, ESA as an intergovernmental entity and Member States as sovereign nations.

[52] OECD, *Space Economy at Glance 2014*, Published on October 23, 2014. It provides evidences of these trends.

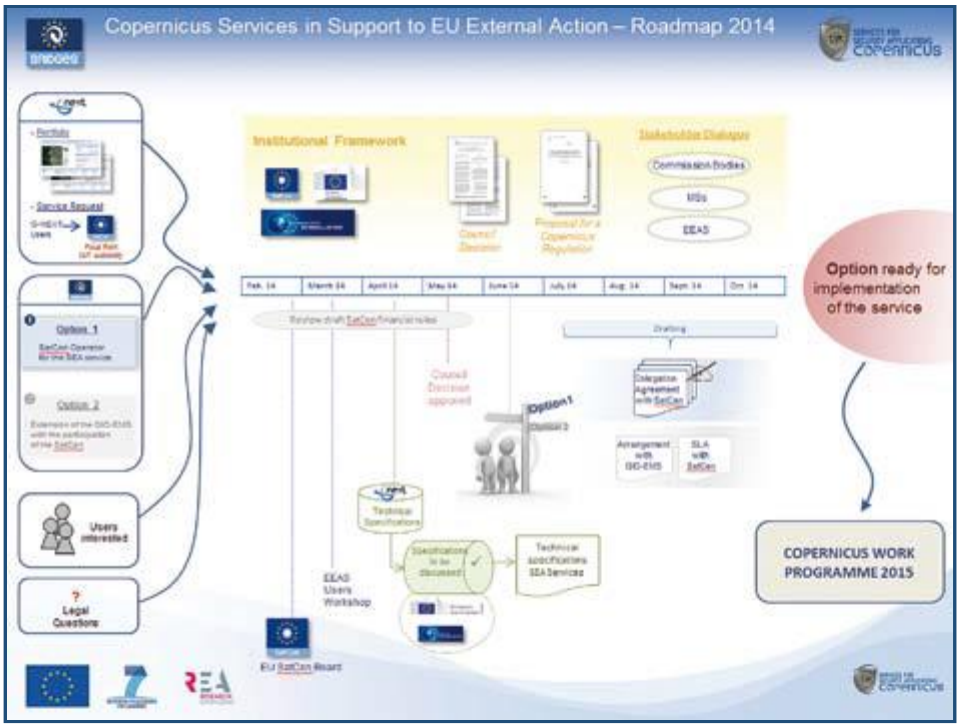

Figure 5: The use of Space for the EEAS' purposes

By synergizing various EU policies and instruments, and making the best of existing and diverse resources and capabilities (i.e. civil and military assets), the EU could become more engaged in the security field. This can be implied from the Lisbon Treaty under Title V of the Treaty on European Union (TEU) and Part V of the TFEU. The High Representative of the Union for Foreign Affairs and Security Policy (HR) (Art. 18 TEU) and of the European External Action Service (EEAS, Art. 27(3) TEU), while chairing the Foreign Affairs Council (Art. 18(3) and Art. 27(1) TEU), is also appointed as one of the EC Vice-Presidents (VP) (Art. 18(4) TEU). The EEAS is in charge of supporting the HR/VP through the relevant structures and services of both the Council and the EC that were therein absorbed, including those related to crisis management. As a result, even though The CFSP/CSDP continues to rely on an intergovernmental approach (Arts. 21-46, TEU), in particular, on the rule of unanimity and on the impossibility to adopt legislative acts (Art. 24(2) TEU), connections to, and synergies with the EU external action (Arts. 205-222, TFEU) as well as the area of freedom, security and justice (Title V, Arts. 67- 89, TFEU) can still be guaranteed. As far as security and defence are concerned, the CSDP is a EU defence policy and an integral part of the CFSP (Art. 42(1) TEU) as the Treaty specifies. A common Union defence policy might be an evolution from the CSDP[53] because the Treaty does not exclude this. Eventually, a common defence should be adopted by a decision on the European Council acting unanimously (Art. 42(2) TEU).

In addition, by Art. 36, of the TEU the HR/VP shall consult the European Parliament on the main aspects and choices of the CFSP/CSDP, while keeping it informed on the evolution of both policies. The HR/VP shall also guarantee that the EP's views are taken into account. For its part, the EP can address questions and recommendations to both the HR/VP and the Council and, twice a year, shall hold a debate on the progress of the CSFP/CSDP. The EP nevertheless adopted a resolution on the implementation of the CSDP in November 2012, and included a short paragraph on "A space policy to underpin the CSDP".[54]

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[53] Within such a policy, the definition and scope of CSDP missions have been widened (Art. 43(1) TEU) compared to the past, while envisaging the development of an operational capacity drawing on civilian and military assets and synergies (Art. 42(1) TEU). European Parliament, *Space, Sovereignty and European security*, 2014. Last access in June 2015 at: http://www.europarl.europa.eu/RegData/etudes/etudes/join/2014/433750/EXPO-SEDE_ET(2014)433750_EN.pdf

[54] European Parliament, Report on the on the implementation of the Common Security and Defence Policy - Based on the Annual Report from the Council to the European Parliament on the Common Foreign and Security Policy) (12562/2011 – 2012/2138(INI)) - Committee on Foreign Affairs -, A7-0357/2012, 31 October 2012.

Furthermore, security can be relevant to internal affairs. Compared to the latter, the Area of Freedom, Security and Justice (FSJ) – which was previously based on the intergovernmental approach - contributed towards *communitarization*. The Title V of the TFEU on FSJ states in the first Article (Art. 67(2) TFEU), that the Union shall frame a common policy on asylum, immigration and external border control. The Council is responsible for defining the strategic guidelines of legislative and operational planning within FSJ (Art. 68 TFEU), while Member States maintain their competence concerning law and order and the safeguarding of internal security (Art. 72 TFEU). Nevertheless, to assess the threats to internal security (i.e. terrorism, trafficking in human beings, illicit drug and arms trafficking, etc.) cooperation in police matters and external border management and surveillance is needed. As a result, the EP and the Council shall take measures in accordance with the ordinary legislative procedure, especially where deemed necessary for the gradual establishment of an integrated management system for external borders (Art. 77(2) (d))[55].

First of all, the broadening of the concept of security and the concurrent expansion of the European Space Policy to cover security are mutually reinforcing. Considering that the European Space Policy should promote the implementation of EU policies, the EU external action and the CFSP/CSDP as well as FSJ can be certainly included, based on appropriate rules.

Second of all, EU (civilian) assets with dual-use purposes like Galileo and Copernicus, can satisfy the CSDP's operational needs. For this purpose, Art. 42(4) of the TEU states that the HR may propose the use of both national resources and Union instruments to implement CSDP decisions, including missions. Nevertheless, the military use of such capabilities should be consistent with their civilian nature. In case of incompatibility, the decision should be taken in the framework of Title V of the TFEU. It is up to Member States in the Council to decide which measures should be approved, similarly to the statement of the Council Joint Action 2004/552/CFSP. In addition, those same assets can also support the surveillance of external sea and land borders and the safeguarding of lives in the wider framework of a common policy on asylum, immigration and external border control.

Third of all, the Treaty provides two frameworks of cooperation for both the CSDP and Space, namely, the permanent structured cooperation - Art. 42(6) of the TEU - and the enhanced cooperation (Art. 46(3) TEU). As a result, Space assets for military uses could be developed by Member States, which are more advanced in this field, such as France, Germany, Italy, Spain and the UK, with the support of other Member States which might have an interest in both Space policy and the CSDP. In general terms, cooperation on military capabilities would constitute an element of functional integration with a view to progressively framing a common defence.

Enhanced cooperation is also a subject of concern (Art. 20 TEU and Arts. 326-334 TFEU). It might include specific activities on *Space for security* with the purpose of furthering political integration in the field of CFSP/CSDP.

Fourth of all, Space capabilities are an element of the core work of the European Defence Agency (EDA) as established by Arts. 42(3) and 45(1) of the TEU. Based on these rules, military capacity could be improved or developed with the support of EDA. In particular, the Agency could, among other things, contribute to the definition of requirements and operational needs, propose multilateral projects to fulfil them, ensure coordination and/or management of cooperation programs, support defence technology research and launch joint research activities.

The field of security within the Space domain requires the involvement of several acting entities gathering different European sovereign nations. In this context, the interplay among EU, ESA, the European Defence Agency (EDA) and NATO shall be considered. The EU and ESA are well known in this context. EDA, however, is an intergovernmental Agency of the European Council which was founded in 2004 and became operational by mid-2005. From Art. 2 of the Joint Action 2004/551/CFSP on the establishment of EDA, 12 July 2004 its *mission is to support the Council and the Member States in their effort to improve the EU's defence capabilities in the field of crisis management and to sustain the European Security and Defence*

[55] For instance, the EUROSUR initiative was launched with the goal of improving management and enhancing informational exchange and cooperation among MS in the surveillance of external land and sea borders. Space assets, among other instruments, are to be exploited for the purposes of EUROSUR.

Policy (ESDP) as it stands now and develops in the future. The Agency's mission shall be without prejudice to the competences of Member States in defence matters.

EDA works at the top-level through the Steering Board, which sets EDA's priorities at the working level in expert teams. EDA derives its legal status from Joint Action 2004/551/CFSP ex. art. 6: *The Agency shall have the legal personality necessary to perform its functions and attain its objectives. Member States shall ensure that the Agency enjoys the most extensive legal capacity accorded to legal persons under their laws. The Agency may, in particular, acquire or dispose of movable and immovable property and be a party to legal proceedings. The Agency shall have the capacity to conclude contracts with private or public entities or organizations.* EDA falls under the authority of the Council of the EU, to which it reports and from which it receives guidelines. The EDA Steering Board meets at a ministerial level: Defence Ministers decide on the annual budget, the 3-year work program, the annual work plan and new initiatives. The *Head of Agency*, who is the High Representative of the Union for Foreign Affairs and Security Policy, is also Vice-President of the European Commission. The *Chief Executive* is appointed by decision of the Steering Board and assisted by staff. Art. 5 Joint Action 2004/551/CFSP: EDA is ascribed four functions, covering:

- Developing Defence capabilities;
- Promoting Defence Research and Technology (R&T);
- Promoting armaments co-operation;
- Creating a competitive European Defence Equipment Market and strengthening the European Defence, Technological and Industrial Base.

The EDA's programs shall mainly be clustered into:

- Pooling & Sharing
- Capability Development Plan
- Capabilities Programs: Air-to-Air Refuelling, Remotely Piloted Aircraft Systems, Governmental Satellite Communication and Cyber Defence.

Over the past three years, EDA's budget has been stable at around EUR 30 Million. The functioning element of the budget is used to cover the personnel and general running costs of the Agency. The Operational Budget is used for feasibility and other studies.

	2009	2010	2011	2012	2013	2014	2015
EXPENSES							
FUNCTIONING	21.561	22.131	22.031	22.531	23.088	24.131	24.400
OPERATIONAL	8.000	8.400	8.500	8.000	7.443	6.400	6.131
TOTAL EXPENSES	29.561	30.531	30.531	30.531	30.531	30.531	30.531
REVENUES							
DEDUCTIONS FROM STAFF REMUNERATION	1.255	1.268	1.347	1.395	1.423	1.330	1.320
FINANCIAL INCOME	620	550	150	50	51	50	50
MEMBER STATE CONTRIBUTIONS	27.686	28.713	29.034	29.086	29.057	29.151	29.161
TOTAL REVENUES	29.561	30.531	30.531	30.531	30.531	30.531	30.531

Table 4: EDA Financial statements from 2009 to 2014 and budget for 2015[56]

EDA has included several Space-related activities in its work programmS, with direct implications for cost-effective improvements in the defence community. In particular, five key areas have been highlighted, ranging from Space Situational Awareness (SSA); communications; observation; and command control of unmanned air systems; to critical space technologies for European technological non-dependence. The 7th Space Council in 2010 invited the EC, the EU Council assisted by EDA, together with Member States, and ESA to explore ways to support current and future crisis management needs through cost-effective access to robust, secure and reactive Space assets and services – integrating global satellite communications, Earth Observation, positioning and timing, and by taking full advantage of dual-use synergies as appropriate. In 2010, the EC-ESA-EDA Joint Task Force (JTF)[57] was established to address Critical Space Technologies for European Strategic Non-Dependence in order to assess the European technology capability to develop space-based items without barriers. In June 2011, EDA and ESA signed an agreement to cooperate by:

[56] Source: EDA, 2015

[57] ESA, Technology to-do list helping secure Europe's non-dependence, 2010. Last access in June 2015 at: http://www.esa.int/Our_Activities/Space_Engineering_Technology/Technology_to-do_list_helping_secure_Europe_s_non-dependence/(print)

- Identifying capability gaps and shortfalls that could be filled by space assets in support of EU policies
- Investigating whether identified capability requirements can be shared by both parties
- Coordinating research, technology and demonstration activities
- Investigating synergies in EDA and ESA programmes
- Coordinating activities in support of industrial competitiveness and European non-dependence issues

The joint project, led by ESA and EDA, labelled DeSIRE programme I - II (Demonstration of Satellites enabling the insertion of RPAS in Europe) is an example of a bilateral initiative in the field of Space. In addition, informal bilateral consultations are running between these two agencies. A dialogue exists between EDA and ESA in order to strengthen synergies in terms of:

- Non-dependence Space technology and
- European industrial leadership.

The institutional framework between ESA and the EU affects the relationship between EDA and ESA. The ad hoc policies addressing with data policy, SatCom pooling & sharing governance, and GNSS services shall address the operational relations between EDA and ESA. Space Policy and CSDP shall mutually benefit from stable and clear common work-plans.

When Space is consistent with security goals, it is relevant to consider the Member States participating the main related institutions, such as EU, ESA, EDA and NATO. The following diagram[58] shows the overlap of members in each of the abovementioned entity. The implication is that the military commitment of each country is potentially bounded by NATO alliances.

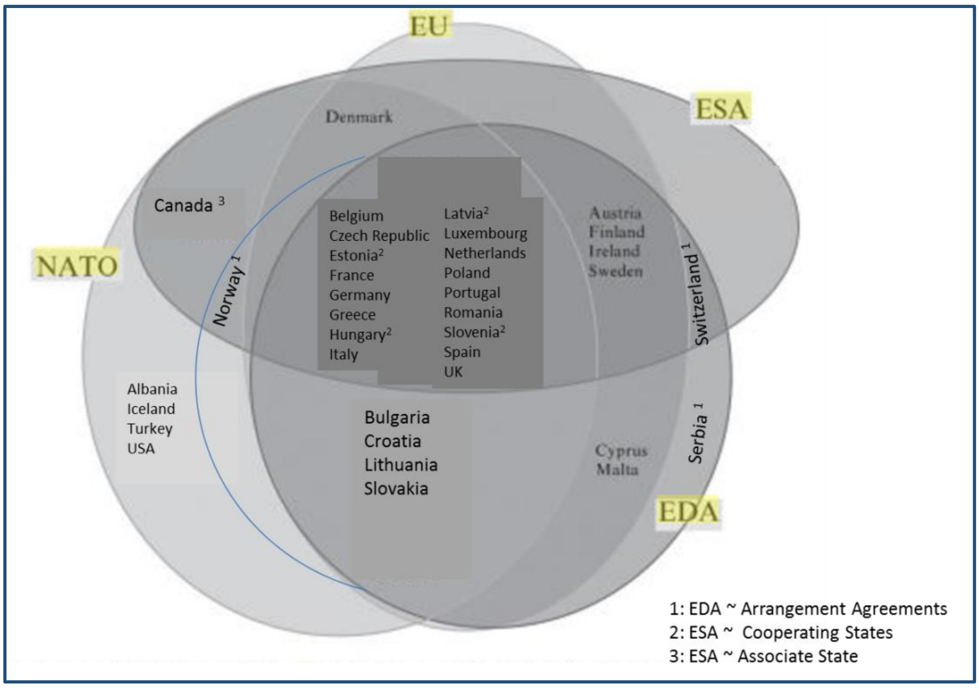

Figure 6: States' participation to EU, EDA, ESA and NATO[59]

Switzerland is peculiar because it is not a NATO member state. Other countries such as Cyprus and Malta are not members of ESA. These two countries recently started their potential involvement in ESA.

2.1.3 EU Space Policy: budget and programs

The budget for the European Space policy is implemented with the contributions of, at least, three main actors, *e.g.* EU, ESA and Member States. The military budget for the dual programs has historically been

[58] Derek L. Braddon, Keith Hartley, *Handbook on the Economics of Conflict*, Edward Elgar Publishing, 2011
59 Source: Handbook on the Economics of Conflict edited by Derek L. Braddon, Keith Hartley, 2011. Elaboration by the author.

managed at a single national level, until nowadays EDA is not managing any federative budget for a joint initiative. The following table reports the budget for 2015 from the three main three actors.

Source of budget	2015 [Million €]	Note
EU	1.030,5	73% transferred to ESA
ESA	3.241,1	Only ESA
EUMETSAT	343.9	23% transferred to ESA
EDA	30	
Member States	2.200 ~	Only National Programs
Total	**6.845,5**	

Table 5: Source of budget for Space Activities in Europe, 2015

Through the joint contribution of the EU and the Member States of ESA, Europe has accomplished a number of achievements in the field of Space. Europe has the capacity to handle Space programs from mission design to manufacturing and launch activities, to further operation management in orbits of Space objects and astronauts. The table below shows the main programmatic lines at the European level under the EU, the European cooperative level under ESA and the national level per field of applications, e. g. access to Space, SatCom, Earth observation, SatNav, Space debris' issues and early warming and electronic intelligence at present and at near future.

Level of deploying	Access to Space	SatCom	Earth Observation	SatNav	Space Situational Awareness	ELINT and Early Warming	Space Exploration (Human and no-)
National Programs (Member States)	National development of launching capabilities	Skyent 5 (UK) Satcom Bw (DE) Secomsat (ES) Syracuse 3 (FR) Sicral 1B (IT), Athena-Fidus (IT, FR)	SPOT, Helios 2, Pleiades (FR) COSMO-SkyMed (IT) TerraSAR-X, TanDEM-X, SAR Lupe (DE)	Support for downstream applications	National monitoring capabilities	National defence initiatives	Astronauts Scientific missions and ISS experiments
Cooperative Programs (ESA)	Ariane series VEGA	Alphabus/Alphasat SmallGEO NeoSat EDRS	ERS-Series, ENVISAT database SMOS CryoSat-2 Swarm ADM-Aeolus, MetOp-A and –B*	Technical development of the systems	Technical support to SST	Technology Development & Test-Demonstration	Astronauts Columbus
European Programs (EU)	Policy support	Solaris (S-Band) initiative	Copernicus (Sentinels)	Galileo EGNOS	SST		R&D funds (FPs, Horizon 2020)
*: Meteorological satellite are procured and managed by EUMETSAT through ESA							

Table 6: Overview of the current Space Programs in Europe of Member States, ESA and EU

2.2 The Japanese Space Policy

Since its inception in the 1950s, Japan's Space program has been R&D oriented. In 2008, Japanese Basic Space Law opened the doors to dual-use space technologies[60]. The related Space policy changes effected in 2009[61] and 2013[62] proposed a Space utilization-driven approach which sought to stimulate economic activity in Japan after several decades of stagnation. The Space sector was one of the key elements of

[60] Aoki, The National Space Law of Japan: Basic Space Law and the Space Activities Act in the Making: http://www.iislweb.org/docs/2011_galloway/Aoki.pdf

[61] Basic Plan for Space Policy, 2009: http://www.kantei.go.jp/jp/singi/utyuu/keikaku/pamph_en.pdf

[62] Basic Plan on Space Policy, 2013: http://www8.cao.go.jp/space/plan/plan-eng.pdf

Japan's developing *social infrastructures*[63] and, in particular, was meant to combat natural disasters and other emergencies to which Japan is prone. Developing services was one of the key elements of the Space strategy and encouraged the development of Japan's Space services sector. Japan's new Space Plan, issued in 2015, switches the focus of the Japanese Space policy potentially away from civilian market and towards the military[64].

2.2.1 Japanese Space Policy: peaceful and security purposes

The ***Basic Space Law***, issued in 2008, established a new policy approach that encompassed R&D-oriented Space activities and the Space utilization. Its main objectives were identified as:

- Improving daily lives of Japanese people
- Strengthening national security and ensuring international peace
- Encouraging Japan's Space industry and fostering socioeconomic development with the advancement of scientific research and technological capabilities
- Promoting international cooperation and Space diplomacy

The program's goals are societal, economical and international in nature, yet the seminal approach to the new program is the inking of national security with international peace. This has opened the doors to dual-use pace-based technologies and applications. However, their military potential renders their dissemination problematic. The domestic investments supporting this approach could dampen the multiplying economic dimension of exports when the military dimension is enhanced, as has sometimes been the case in the US.

In order to implement this, the new governmental stakeholders have been in charge of Space competence, and a new governance model was adopted in 2012[65]. In this new scheme, JAXA, the Japanese Aerospace Exploration Agency no longer works as a focal point of the Space affairs. It is now *The National Research and Development Agency*[66] as the core implementing agency under the MEXT and with board directors coming from MEXT, METI, Ministry of Internal Affairs and Communication (MIC) and the Minister for Space Policy from the Cabinet Office.

This has complicated the international partnership with Japan. Previously the partners only needed to approach JAXA for international cooperation in the Space domain. This new program also altered the role of the Minister for Space Policy. In this new structure, the Cabinet Office becomes the focal point in formulating the Japanese Space policy. The Cabinet is supported by a National Space Policy Commission, which gathers experts from different stakeholders, e.g. industries, academia, think tanks etc., as advisors. The following chart diagrams the interaction between governmental entities in different fields of applications and at different level for R&D, industrial and commercial policy.

[63] The 2013 Basic Plan on Space Policy established four social infrastructures for expanding the utilization of space and ensuring autonomy, e.g. space-based infrastructures for positioning, remote sensing, communication and broadcasting, and launching vehicle systems. Basic Plan on Space Policy, 2013: http://www8.cao.go.jp/space/plan/plan-eng.pdf

[64] Japan reorients space effort to bolster security, drive exports: http://www.reuters.com/article/2015/01/09/us-japan-space-idUSKBN0KI18F20150109

[65] The comprehensive overview of this epochal change in Japan is detailed in Keiichi Anan, Administrative reform of Japanese Space Policy Structures in 2012, Space Policy, Vol. 29, issue 3, (2013), pp. 210-218.

[66] In April 2015, JAXA became a national research and development agency as a performing agency to support the Government of Japan for Space development and utilization. Last access in June 2015 at: http://www.parabolicarc.com/2015/04/04/jaxa-national-agency/ JAXA Reorganization in April 2015, last access in June 2015: http://global.jaxa.jp/news/2015/files/org_change_e.pdf

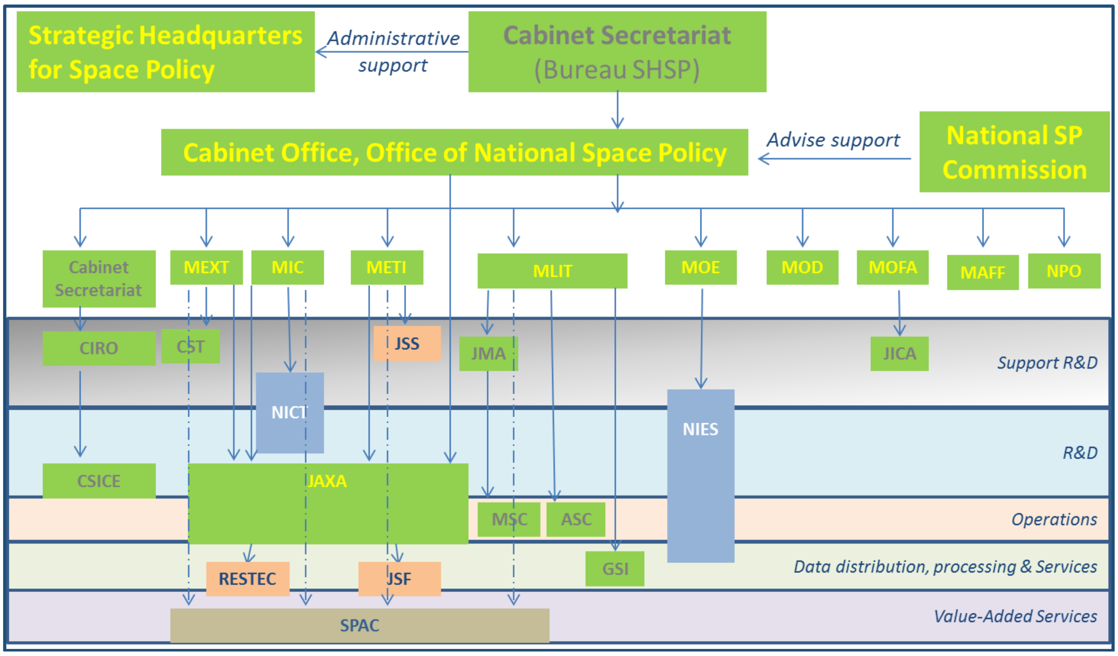

Figure 7: The Japanese Space governance

The **Strategic Headquarters for Space Policy** is chaired by the Prime Minister and is comprised of all of the Cabinet's ministers. It receives administrative support from the Cabinet secretariat acting as a bureau. Political decisions are passed to the **Office of National Space Policy** which plans, drafts, and coordinates affairs based on the fundamental policies for the comprehensive and systematic promotion of Space development and use. In particular, the Space Office drafts the Basic Space Plan and communicates budgetary prioritization to relevant ministries. The Space Office is also expected to negotiate with foreign Space agencies together with relevant ministries and JAXA, but the Cabinet Office and the Ministry of Foreign Affairs (MOFA) handle negotiations related to diplomacy. The Cabinet office and the related Space Office manage the relationships with several ministries when second-layer entities are also involved. The establishment of the Space Office allows every ministry to promote the development and utilization of Space in a strong national strategy but under a centralized leadership. The Cabinet Secretariat coordinates with the **Cabinet Intelligence Research Office (CIRO)** which acts as the central intelligence agency of the Cabinet Office[67], and the **Cabinet Satellite Intelligence Centre (CSICE)** which is mainly in charge of the management of the Earth Observation satellites, *e. g.* Information Gathering Satellites (IGS). **MEXT**, an administrative body responsible primarily for JAXA, provides the necessary budget for JAXA activities. In order to promote the use of Space in all ministries, a new mechanism enables JAXA to flexibly respond to all ministries' demands for Space technology. For this purpose, the Cabinet Office gained authority to participate in JAXA's jurisdiction with the Prime Minister becoming one of the competent ministers. Because the Prime Minister is the chief of the Cabinet Office, the Cabinet Office can oversee JAXA via the Prime Minister. Together with the ministers of the MEXT and MIC, the Prime Minister will direct the promotion of the use of Outer Space through JAXA. This means that the Prime Minister will work to gain consensus from users of Space and will determine development policies needed to achieve specifications and performance of satellites, rockets and rocket ranges, as well as the promotion of operational satellite use. In line with the national strategy, MEXT has promoted Space science, technology infrastructure, and human resource development in cooperation with other ministries. **MIC** is in charge of spectrum allocation in the operations of Space-based systems and the development of satellite communication. It also expresses its role on the R&D profiles both through its relationship with JAXA and also through its sole independent administrative institution, the **National Institute of Information and Communications Technology (NICT)**. **NICT** specializes in the field of information and communications technology and is charged with promoting R&D in the ICT sector, which in turn drives economic growth and creates an affluent, safe and secure society. To promote industrialization, the minister of **METI** was added to the list of ministers

[67] The CIRO was established in April 1952 with only 30 staffs and its model was US Central Intelligence Agency (CIA).

overseeing JAXA. Under METI, the Cabinet Office of Japan also approved Japan Space Systems (J-SpaceSystems) to become the general foundation from a non-profit organization on April 1, 2013, which resulted from the merger of three non-profit organizations under METI, such as the Institute for Unmanned Space Experiment Free Flyer (USEF), the Japan Resources Observation System and Space Utilization Organization (JAROS) and the Earth Remote Sensing Data Analysis Centre (ERSDAC). J-SpaceSystems conducts the following activities:

- Promotion of the researches, the developments, and the utilization of space systems,
- Promotion of commercialization, globalization and improvement of, global competitiveness regarding space systems,
- Promotion of international cooperation regarding space systems,
- Promotion of the popularization and education, and personnel training regarding space systems.

The **Ministry of Land, Infrastructure, Transport and Tourism (MLIT)** also oversees JAXA. MLIT had previously helped to sponsor the first QZSS satellite along with other ministries. Today, it is in charge of the Space utilization which is mainly downstream applications for land management, transport, asset management and disaster prevention. In addition, the **Japan Meteorological Agency (JMA)** and its auxiliary entity the **Meteorological Satellite Centre (MSC)**, along with the **Aeronautical Satellite Centre (ASC)** and the **Geospatial Information Authority of Japan (GSI)** are all under MLIT's jurisdiction. The JMA has operated geostationary meteorological satellites since 1978, producing data that helps to prevent and mitigate weather-related disasters based on the monitoring of typhoons and other weather conditions in the Asia-Oceania region. The MSC is in charge of operating the geostationary meteorological satellite (MTSAT) and manages the database fed by foreign satellite data. The ASC is in charge of serving aeronautical needs via satellite utilization. The GSI is a national organization that conducts basic survey and mapping, and instructs related organizations in the clarification of Japanese land. It also provides survey results in order to help improve this land. The **Ministry of Environment (MOE)** plays an important role for the support of Space assets for environmental issues, such as GOSAT which develops sensors (in collaboration with JAXA), validates processed data products, contributes to international efforts aimed at to reducing carbon emissions through scientific application of GOSAT observational data. Under its jurisdiction, the **National Institute of Environmental Studies (NIES)** develops and improves the methodologies to derive greenhouse gas concentrations from satellite and auxiliary data. It is also in charge of producing, validating, and distributing higher-level data products and estimating carbon fluxes using numerical models. It supports the R&D profiles as the undertakings of MOE and JAXA.

The new Space policy also emphasizes security as a catalyst for technological innovation and industrial challenges. From a governance point of view, the **Ministry of Defence (MOD)** is only one of the contributors as the user of Space-based systems and until now, it has not held a seat on any R&D entities. **MOFA** handles the foreign affairs Space issues, such as participation in International forums, the licensing of import-export control. MOFA supports capacity building measures with new emerging countries. The **Japan International Cooperation Agency (JICA)** is also under MOFA's jurisdiction, and its mandate is quite comprehensive because it implements two main aid schemes including Official Development Assistance (ODA) loans and grant aid in an integrated fashion. It plays a crucial role in Japanese international relations within the Asia Pacific. The **Ministry of Agriculture, Forestry and Fisheries (MAFF)** promotes Space utilization for its fields of competence, in particular, for a cost-effective food value chain, precision farming, and digitalization of forestry and monitoring of fisheries' activities. The **National Police Office (NPO)** is an agency administered by the National Public Safety Commission of the Cabinet Office in the cabinet of Japan, and is the central coordinating agency of the Japanese police system. It does not have any police officers of its own. Instead, its role is to determine general standards and policies although, in national emergencies or large-scale disasters, the agency is authorized to take command of prefectural police forces. Its role for Space affairs is the utilization of satellite images, positioning-navigation and timing services, and satellite communication with high requirements of fast and secure data transmission. In order to complete the overall governance model, there are also entities that leverage policy measures between users and governmental institutions for the development of the end-user and related economic issues. The **Remote Sensing Technology Centre of Japan (RESTEC)**, the **Japan Space Forum (JSF)** and the **Satellite Positioning Research and Application Centre (SPAC)** also help to achieve this object. RESTEC is commissioned by JAXA to conduct all operations at JAXA's Earth Observation Centre, located in Hatoyama Town, Saitama Prefecture, since 2007. RESTEC is responsible for the processing, analysis, and distribution of data obtained from Earth-observation satellites. From this data, it disseminates knowledge of remote-sensing technology and other utilization of Space technology in order to promote economic growth, social development, and the well-being of the nation. The JSF was established in order to coordinate an alliance of industry, government, and academia for the development of Japan's aerospace industry. It also provides for the exchange and development of human resources. Finally, SPAC contributes to the advancement of the Geospatial Information Society and the development of domestic industries around the exploitation of QZSS. Its mission is to promote research and application regarding the next generation satellite-based positioning, navigation and timing (PNT) in cooperation with related industries and organizations, wide dissemination of above obtained knowledge, activating and promoting the business activities in Geo-spatial Information utilizing PNT. The first two entities, RESTEC and JSF, are under the supervision of JAXA, while the third, SPAC, is founded by industrial players' pooling their resources in order to coordinate application development with the ministries in charge of the downstream applications. Thus, SPAC falls under supervision of METI, MIC, MLIT and MEXT.

This new governance structure initially managed the National Space Policy plan with a five-year roadmap, was issued in 2013. Its main policy target was to expand the utilization of Space by:

- Improving quality of life
- Ensuring national security
- Ensuring the capability of autonomous space activities by the
- Advancing technological capabilities for space activities
- Enhancing international competiveness of Japan's space industry

Here, the emphasis has been on the socio-economic dimension of Space utilization and industrial achievement. This plan also includes a reference to the role of diplomacy in Space activities. In the Basic Space Plan issued by the Strategic Headquarters for Space Policy in 2009, there was a subsection devoted to discussing the promotion of Space diplomacy, which includes both "Space for diplomacy" and "the diplomacy for Space". The promotion of "Space for diplomacy" is described as follows: "all prior experience [engagement in international cooperation] and the contribution of Japan to the international society, including in disaster monitoring and Space science are diplomatic assets which enhance Japan's international leverage and presence, as well as a source of its soft power". Promotion of "the Diplomacy for Space" aims to seek support from partners and create favourable conditions for the Space industry.

The new 2015 Japanese Space policy[68] revisits these goals and proposes more concrete actions over a 10 year time period in order to encourage the flourishing of industrial investment for enhancing its global market share in domestic and international levels. The new objectives address the environmental concerns surrounding the Space policy. The Cabinet, with the Government's approval, adopted a new policy responding to six needs:

- Change in the balance of power on Space policy: the shift from a bi-polar to a multi-polar world brings emerging states with a new Space capability[69];
- Growing importance of Space for national security purposes: the renewed alliance between the USA and Japan matches the needs of serving security through Space utilization;
- Growing risk against the stable use of outer Space: the Space debris issues is increasingly pressing in a Space of crowded orbit traffic and anthropogenic actions;
- Growing importance of the role of outer Space to solve global challenges: Space utilization

[68] Cabinet Office, The Japanese Space Policy 2015. Last Access in June 2015 at: http://www8.cao.go.jp/space/plan/plan2/plan2.pdf

[69] The draft of the Space policy plan has been open for public consultation since mid-October 2014 and has received almost 720 responses. Almost 12% of the comments expressed serious concerns about the militarization of Japan's space assets [Abe approves new space policy with profit, security in mind: http://www.japantimes.co.jp/news/2015/01/09/national/new-space-policy-focuses-security-science/#.VLcWSlL9n4g]. The main reasons behind the new space policy are the external threats from the North Korea and China in the Asia Pacific and the need to bolster Japan's space industry [Japan's space program ends peaceful policy with new military focus: http://eandt.theiet.org/news/2015/jan/japan-space.cfm].

can effectively handle many trans-disciplinary challenges from transport to energy, environment and disasters;

- Space industrial basis is at stake: the Japanese Space industry suffers from a stagnation, and has – in the past - lacked opportunities to invest in new business under the new trends[70];
- Absence of an organic cycle between science & technology, national security and industrial promotion: the Japanese industrial community has yet to seize the opportunity to respond to new and advanced requirements from military customers and benefit from the related spillover effect on commercial markets.

With these needs in mind, the new Japanese Space policy centres around three primary goals:

- Ensuring national security through, inter alia, Space utilization within a more sustainable outer Space environment and a stronger alliance with the USA;
- Promoting use of Space for civilian applications: civilian customers shall become more and more aware of the importance of Space utilization to address social challenges, thus improving Japan's national technological resilience and promoting comprehensive support from the contribution of geo-spatial information to society;
- Maintaining and strengthening the industrial, scientific and technological basis: the outcome of Space activities shall contribute to benefitting scientific and technological know-how of industrial players.

2.2.2 The Japanese Space Policy: budget and programs

Eleven governmental entities now contribute to this new plan's budget:

Source of Budget	Space Budget 2015 (B¥)	
Ministry of Education, Culture, Sports, Science & Technology	182.4 ⇩	56.1%
Ministry of Land, Infrastructure, Transportation and Tourism	9.6 ⇩	2.9%
Ministry of Economy, Trade and Industry	2.9	0.8%
Ministry of Environment	4.4	1.3%
Ministry of Defense	29.8	9.1%
Cabinet Secretariat	69.7	21.4%
Cabinet Office	22.3	6.8%
Ministry of Internal Affairs and Communication	2.4 ⇩	0.7%
Ministry of Foreign Affairs	0.2 ⇩	0.065%
National Police Agency	0.9	0.2%
Ministry of Agriculture, Forestry and Fishery	0.1 ⇩	0.035%
TOTAL	**324.7**	**100%**

Table 7: The Japanese Space budget 2015 per source of income[71]

The abovementioned three primary goals require two concrete approaches: the establishment of a policy framework and the development of concrete initiatives, as indicted in table 8 below. These programmatic lines and dual approach enhance the technological resilience of the Japanese Space system and is mainly applicable to remote sensing, public-private investment involvement and the deployment of a sound cycle among security requirements as well as industrial solutions in line with the challenge of new trends coming from the Science & Technology community. The enhancement of the industrial base not only requires a link between technology and security but is urgently needed in order to ensure better supply of components for Space-based systems. The coming Tokyo 2020 Olympics and Paralympics is a potential test-bed opportunity for the deployment of innovative downstream applications. The decision to pursue involvement in the ISS until 2050 is currently under deliberation. At this stage, involvement is only confirmed up until

[70] The largely military initiated and dominated Space programs are becoming important engines of economic growth and productivity improvements. In this regard, Japan's defense corporations have been interested in the changing structures and direction of Japan's Space program. Since post World War II, with the Japanese Diet in 1967 and the 1990 Super 301 trade Agreement on Satellite Procurement, Japanese corporations have been subject to regulatory constraints affecting their business expansion. These constraints have made the commercial Space industry unprofitable and pushed allies to encourage the government to develop military Space projects.

[71] The drop-down arrows indicate a decrease of budget from the previous year.

2020, where the Japanese contribution includes two HTV cargo missions and the life sciences' experiments on the domestic module KIBO. The Space-based solar power system[72] is also on the Japanese Space agenda for R&D.

Actions	Ensuring national security	Civilian Space utilization	Science & Technology and industry's basis	Remarks
Quasi Zenith Satellite System (QZSS)	X*	X§		*: Japan – US Cooperation §: Downstream applications
Space Situational Awareness	X			Japan – US Cooperation
Space Debris	X			Clean up technologies
X-band SatCom	X			
Information Gathering Satellite	X	X		
Small-sized Satellites - Operational Responsive System	X			Japan – US Cooperation in Maritime Domain Awareness
Advanced Optical and Radar Satellites	X	X		Big-data management
Data Relay Satellite	X	X		
New type of rocket			X	
Engineering Test Satellite			X	

Table 8: Space programs and Space policy objectives in Japan, 2015[73]

Space security is, however, complex and involves the security of Space objects in orbit, the security of access to Space, and the security of people on Earth from various types of satellites. The US-Japan relationship in Space addresses all of these issues. The alliance will implement a joint data sharing system for monitoring Space debris. The complementary function of the QZSS allows Japan to have sustainable domestic GPS-like services, which also serve as a back-up option to the US GPS system in the event of malfunction. The statements for the cooperation in the launch sector are not clearly defined but Japan and the US have signed a series of diplomatic notes[74] that enable US firms to license technologies and allow Japan to develop larger and more capable Space launch vehicles (e.g., the N series launch vehicle based on the US Delta one). The access to Space is a key programmatic line enhancing further development of the two launch systems, e.g. the H2-A, which serves geostationary large-scale satellites, and the Epsilon, which is intended to launch smaller satellites[75]. The development of the new type of rocket and the engineering test satellite are actions for the purpose of science & technology. The first one includes the demonstration experiments of a Liquid Natural Gas (LNG) propulsion system and a reusable transportation system. In order to raise the technical reliability of Epsilon, the rocket for smaller spacecraft, the program develops a new concept of small or mid-sized satellites. Smaller spacecrafts are generally more affordable operational responses in the event of attacks. Again, Japan's choice of Space activities is centered on national security objectives.

2.3 Comparison between the European and Japanese Space Policy

In conclusion, a comparison between Europe and Japan's Space policies would help illustrate the potential for cooperation. Firstly, cooperation for industrial purposes is more suitable for the EU, which has a limited security competence. In addition, in some fields, the current Japanese Space policy prefers the USA as the sole partner for GNSS, Maritime Awareness and Space Situational Awareness. From the comparison of policy objectives summarized below, the EU and Japan share common challenges, which could be addressed through collaboration.

[72] JAXA, Practical application of Space-based solar power generation, last access in June 2015 at: http://global.jaxa.jp/article/interview/vol53/index_e.html
Evan Ackerman, *Japan Demoes Wireless Power Transmission for Space-Based Solar Farms*, 16 Mar 2015. Last access in June 2015 at: http://spectrum.ieee.org/energywise/green-tech/solar/japan-demoes-wireless-power-transmission-for-spacebased-solar-farms
[73] The *X* indicates that the action contributes to the goal.
[74] Chronology of U.S.-Japan Relations, last access in June 2015 at: http://aboutusa.japan.usembassy.gov/e/jusa-usj-chronology.html
[75] Japan adopts new Space policy focusing on security, last access in June 2015 at: http://asia.nikkei.com/Politics-Economy/Policy-Politics/Japan-adopts-new-space-policy-focusing-on-security

Both countries are attempting to revitalize their industrial and technological base for promotion of better Space utilization through the creation of new industries from Japan's perspective and by facilitating the development of downstream applications from the EU's perspective. However, two areas are not as conducive to collaboration:

i. the exploitation of Space assets for national security purposes for Japan and
ii. the independent access to Space from the European side.

The EU Space Policy from the EC COM (2013) 108 final[76]	The Japanese Space Policy issued on 9 January 2015
The objectives of EU Space industrial policy are: *1. Establishing a coherent and stable regulatory framework to Support space activities;* *2. Further developing a competitive, solid, efficient, and balanced industrial base in Europe and supporting the participation of small and medium-sized enterprises (SMEs) in the sector;* *3. Supporting the global competitiveness of the EU Space industry by encouraging the sector to become more cost efficient;* *4. Developing markets for Space applications and services;* *5. Ensuring technological non-dependence and Europe's independent access to Space.*	The Japanese policy objectives are: 1. *Ensuring national security* a. *Stable use of outer Space* b. *Security capabilities using Space* c. *Japan-US alliance* 2. *Promoting use of Space in civilian area* a. *Utilization of Space for global challenges* b. *Creation of new industries* 3. *Maintaining and stretching the industrial and Science & technological basis* a. *Maintaining and strengthening the Space industrial basis* b. *Maintaining and strengthening the scientific and technological basis for outcomes*

Table 9: Comparison of the policy objectives from the European and the Japanese Space Policies

There is a clear industrial-driven approach to the European Space policy, which aims to boost the economy and enhance European leadership and competitiveness. The EU's Space policy promotes the socio-economic dimension while security-related goals are left to the will and capacity of the Member States. Simultaneously, the European Commission's Communication in 2013 also states that Space-based *systems and services guarantee independence and security for the EU*[77]. In this regard, cooperation could potentially be established through NATO. This type of action requires high political commitment and could encounter obstacles should the USA utilize its veto.

A more promising reading of this objective on "independent and autonomous Space capacities" could be the independent ownership of technological know-how and related Intellectual Property Rights (IPRs). Then, the deployment would be ensured in a way in which neither foregoes leadership, For example, preserving IPR and industrial development could be co-shared in a cost effective way in order to ensure a large share of the global market for both parties. In addition, the Japanese Space policy also states the need to have a national Space application policy that contains a clear regulatory framework, which is also a critical pillar of the European industrial Space policy. Cooperation would be an opportunity to exchange best practices, particularly since Europe has greater experience in this area. Apart from top-level of policy objectives, an effective industrial cooperation could ensure the inter-play of the industrial actors under favourable policy conditions.

3.The Space Industry

For the purposes of this report, the Space industry is defined in accordance with the OECD definition[78] as "*all public and private actors involved in developing and providing Space-enabled products and services. It*

[76] EC, EU Space Industrial Policy - Releasing the potential for economic growth in the Space sector, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM (2013) 108 final, Brussels, 28 Feb. 2013.
[77] EC, idem supra
[78] Claire Jolly - Gohar Razi, OECD International Futures Programme, *Organisation for Economic Co-operation and Development*, 2007. The Space economy at a glance: 2007. OECD Publishing. p. 13. ISBN 978-92-64-03109-8.

comprises a long value-added chaining, starting with research and development actors and manufacturers of Space hardware and ending with the providers of Space-enabled products and services to final users". This definition includes the market segment of value-added services – with the contribution of SatCom, Earth observation and SatNav as stand-alone elements or as integrated solutions – and also sectors where Space is an enabling factor, such as Space tourism and other spin-offs. Spin-offs here refer to the transfer of inventive activities to secondary users and the adaptation of innovative technology for new purposes[79]; thus the Space industry is inclusive of activities that exploit technology initially developed for Space purposes for terrestrial uses. The Space value chain is broadly depicted as encompassing the steps from mission design to manufacture and launch, through to the operation of satellites in orbit for telecommunications, image and data, and PNT service provision. Above this, spin-offs and industrial services enabled by Space R&D are included for the purpose of this study.

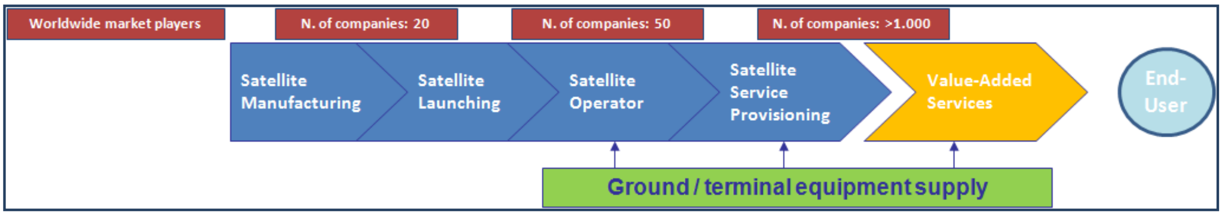

Figure 8: Space value chain and market density indicators

A value chain is the full range of activities that organizations engage in to bring a product to the market, from conception to final use. Such activities range from design, production, marketing, logistics and distribution through to customer support. At each step – design, production, marketing and distribution – value is added in some form or other. Driven by increased off-shoring and growing interconnectedness, these activities have become increasingly fragmented across the globe and between organisations. Many sectors now feature complex supply chains with a number of organizations involved across many different countries. In the case of the Space sector, there is limited global interconnection because many nations maintain a degree of control over sovereign interests and sub-sectors (e.g. defence-related Space programmes). Key drivers for increasing globalisation of the Space market will include sustained institutional support from new sources worldwide, new commercial opportunities opened by guaranteed double sourcing, and a wider global addressable market size for all actors. Globalisation can benefit a large number of countries in terms of economic development and innovation capabilities, but will also bring challenges for incumbents and newcomers alike. To better face these trends, there are two avenues for policy-makers to follow: first of all, improved tracking of who is doing what in the sector; and second of all, working to sustain value-creating industries. Therefore, EU-Japan industrial cooperation benefitting the overall value-chain has the potential to spread benefits globally. For instance, having a more cost-effective supply chain allows market players to deliver systems more quickly and at lower prices. This implies a more democratic access to Space for emerging Space-faring nations.

In order to assess the field of industrial cooperation between the EU and Japan it is necessary to understand their industrial capabilities and business performance.

3.1The European Space Industry

The European Space industry presents full capabilities and development across all segments of the value chain. The business performance is profitable overall, despite some market segments achieving a better economic outcome than others due to asymmetries in the public support for the development of institutional programs. The development of Copernicus and Galileo has recently opened greater opportunities in the areas of Earth Observation and GNSS. The SatCom sector, being the most self-sustainable, has not received large public support over the last ten years[80] and constitutes almost 50% of the market share of the European Space industry as a whole. The present shape of the European Space industry, in terms of its

[79] Van Gigch J. P., *Applied General Systems Theory*, New York, NY: Harper and Row, 1978.
[80] Eurospace, Space Telecommunications – Challenges of a key sector for Europe -, Position Paper 2015

major players and business performance is broadly measured by earnings before interest and tax margin (EBIT margin) as a percentage of revenues, as shown below.

Market Segment	Players (EU)	Typical EBIT margin	EU Market Share	Global Market
System Manufacturer	Airbus Thales Alenia Space OHB Surrey Satellite Technology Ltd (SSTL) INDRA	2 – 8 %	20%	15 B€
Launcher	Arianespace, Safran, Avio, Eurocomposite	minus - 6%	56%	5 B €
Satellite Operator	Eutelsat, SES, Avanti, Hispasat, Hellas-Sat, Inmarsat, Solaris, O3b, e-GEOS, Airbus, BlackBridge	40 – 70 % 5 – 15 %	48%	16.3 B€ (FSS) 2.6 B€ (MSS) 2.5 B€ (EO)
Terminal Equipment Manufacturer	Thrane & Thrane CMS Electronics Cobham	5 – 10%	15%	54 B€
Services Provider	Telespazio ND SatCom *Several SMEs*	minus - 15%	20%	97 B€

Table 10: The European Space Industry 2014

Among the Space manufacturers, Airbus, Thales Alenia Space and OHB have their own know-how accumulated in proprietary technologies for building spacecraft. Airbus handles its own spacecraft, such as Skynet-2 Bus[81], OTS Bus[82], ECS Bus[83], Eurostar-1000[84], Eurostar-2000[85], Eurostar-3000[86], Leostar[87], FlexBus[88], AstroBus[89], Myriade[90], SPOT Bus[91], and Polar Platform[92]. Alphabus[93] is a joint project funded

[81] Satellite Communication for Military purposes developed and launched in the 1970s for the British Ministry of Defence.

[82] The Orbital Test Satellites were experimental communication satellites inherited by ESA in 1975 from its predecessor, the European Space Research Organization (ESRO). These were the first GEO communications satellites to carry six Ku-band transponders (14/11 GHz) and were capable of handling 7,200 telephone circuits. With a mass of approximately 445 kg on station, the OTS bus was hexagonal with overall dimensions of 2.4 m by 2.1 m. Two solar panels with a span of 9.3 m provided 0.6 kW of electrical power. British Aerospace was the prime contractor from the European MESH consortium that developed the OTS vehicle.

[83] The European Telecommunications Satellite Organization (Eutelsat) has been servicing the European community since 1977, being formally established by a multi-lateral agreement in 1985. In 1979 ESA agreed to design, build, and launch five ECS (European Communication Satellite) spacecraft with responsibility to be assumed by Eutelsat after passing initial on-orbiting testing. At that time the name of each spacecraft was changed to Eutelsat1-F1, Eutelsat1-F2, etc. Of the five ECS spacecraft, four were successfully launched (1983, 1984, 1987, and 1988) and transferred to Eutelsat. ECS 3 was lost in an Ariane-3 launch accident in 1985. As noted previously, the ECS spacecraft was derived from the OTS vehicle but with an initial mass on station of approximately 700 kg. The payload included twelve (including two spares) 14/11 GHz transponders with 20 W output power for a capacity of 12,000 telephone circuits or 10 television channels. Two solar arrays with a span of 13.8 m provided 1kW of electrical power to the 2.2 m by 2.4 m spacecraft bus. With an anticipated working life of up to seven years, at the end of 1994 three ECS/Eutelsat 1 spacecraft were still operational at 21.5 degrees E, 25.5 degrees E, and 48 degrees E, although Eutelsat 1-F1 offered limited service due to its inclination of more than 4.5 degrees. Eutelsat 1F2 (ECS 2) was retired in December 1993.

[84] Satellite communication of Inmarsat for Mobile Satellite Services developed at the end of the 1980s and launched in the 1990s.

[85] Satellite communication for the main satellite operators (Eutelsat, SES, Arabsat, Nilesat, Hispasat, AalpAlfrisat and Hellasat). In the mid-1990s there was also an advancement of the platform, named Eurostar 2000+.

[86] This is the current satellite communication bus begun in 2000 with Eurostar-3000GM for Inmarsat. The family includes Eurostar-3000LX, Eurostar-3000S, Eurostar-3000 EOR and AstroBus-G for meteorological applications.

[87] The current satellite Earth observation bus.

[88] An innovative spacecraft for geo-scientific experiments.

[89] An innovative satellite platform for meteorological applications.

[90] Myriade is the name given to a micro-satellite product line being jointly developed by Astrium and the French

by the ESA and developed by Airbus together with Thales Alenia Space, Thales Alenia handles the development and deployment of the following proprietary spacecraft: ELiTeBus[94], Spacebus-300[95], Spacebus-1000[96], Spacebus-2000[97], Spacebus-3000 A-Class[98], Spacebus-3000/4000 B-Class[99], Spacebus-

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space agency CNES since 1998. The Myriade program is principally designed for scientific applications and technology missions, in response to increasing demand from the scientific community for quicker, cheaper access to space, with the accent on enhanced payload capacity in terms of mass, power, pointing accuracy, telemetry and processing and orbit control propulsion. The program also envisages institutional or export opportunities. The first mission flying this platform was the CNES scientific microsat DEMETER in 2004, followed by the French MoD system for electro-magnetic environment analysis, Essaim. Astrium is working in collaboration with the French space agency CNES to develop the Myriade micro-satellite product line. CNES missions are manufactured in-house by CNES, while Astrium produces commercial and other governmental missions. Astrium offers the Myriade bus commercially under the name AstroSat-100.

[91] SPOT has been the initial satellite bus for European Remote Sensing (ERS) series funded by ESA. It has three generations and the current one is adopted for SPOT and Helios Constellations. All these missions are Earth Observation related.

[92] The initial Envisat platform and has evolved for adoption in the METEOP series as Eutelsat's constellations for metrological purposes.

[93] Alphabus is a program initiated by ESA and CNES to jointly develop a product through a project industrial team made up of EADS Astrium and Thales Alenia Space. It is a new multi-purpose platform for the high-power payload communications satellite market. Alphasat will be the satellite using the Alphabus proto-flight platform, achieving in-orbit validation of the platform through a commercial operator. Implementation of a Geo-mobile application will use the Alphabus platform design in a configuration that requires a 90-degree change to the satellite flight orientation to improve accommodation of the feed/reflector configuration and allow the embarkation of a large deployable reflector. Both of these capabilities will be offered as options in the Alphabus portfolio. Inmarsat will manage Alphasat's craft for broadband commercial provision.

[94] ELiTeBus (Extended LifeTime Bus) is designed for LEO communications payloads. The platform is based on the Proteus bus. This spacecraft has been adopted for LEO and MEO multi-satellite constellations, such as Globalstar, Iridium and O3b.

[95] The initial broadcasting satellite developed in the 1980s.

[96] Arabsat's broadcasting platform used in the 1980s.

[97] The satellite communication space-based platform for commercial satellite operators, such as Eutelsat, Turksat and the Argentinian Nahuel. It was manly developed in the 1990s.

[98] The communication satellite platform developed for Arabic and Asian satellite operators, such as Arabsat, Thaicom and Chinese players, during the 1990s after the evolution of Spacebus 1000.

[99] The Spacebus 3000/-4000 B-Class family offers a full range of satellite solutions for fixed and mobile broadcasting services. It is offered with two kinds of avionic suites, which are called Spacebus 3000 or 4000, depending on whether it is fitted with avionics using a 50-volt or 100-volt power bus. Based on flight-proven design and technologies, the Spacebus 3000 platform product line has built a strong heritage and flight record, with sixteen Spacebus 3000 platforms now operating in orbit and more to be launched. Thanks to its modular concept, the Spacebus 3000 platform can be adapted to the most complex antenna and repeater configurations. Its key-features include:

- Three axis stabilized geosynchronous platform, compatible with all current launchers;
- On ground or in orbit delivery, with a 15-year operating lifetime;
- Accommodates payloads of up to 6.5 kW and 500 kg, for a satellite launch mass of up to 4100 kg;
- Fully regulated double power bus architecture;
- Reliable four wheels attitude control system, with advanced FDIR features;
- Four silicon panel solar array of up to 8.7 kW (15 years End-Of-Life Equinox); and
- Bipropellant propulsion system with flight proven ABM and 10N thrusters.

The Spacebus 4000 is a medium-class telecommunications satellite (launch mass from 3000 kg for the B3 version to 5900 kg for the C4 version) with a strong successful flight heritage and a realistic and safe proposed manufacturing schedule. It can easily accommodate a large range of payloads in every band (Ku, C, Ka, X, S, L) to satisfy customer needs. Its key-features include:

- Telecommunications satellite; launch mass from 3000 to 5900 kg; Solar Array power up to 15,8 kW;
- Payload power up to 11,6 kW, typically 80 to 100 active channels with medium RF power (105/110W in Ku band); standard equipment and system designs available in Ku/C and Ka frequency bands; other frequency bands (X, S, L) can be proposed;
- Realistic and safe manufacturing schedule (typically 27 à 33 months on ground delivery); attractive price;
- Accommodation antenna (from 2.4 m to 3.2 × 2.4 m); Flight proven units (payload and platform);
- Design, manufacture and test with experienced teams for system and equipment management;

3000/4000 C-Class[100] and Proteus[101]. In addition, Thales Alenia Space develops other platforms, such as GeoBus (Italsat-Bus)[102] and the innovative Prima[103]. Apart from these two big players, OHB is emerging with its own Luxor platforms[104]. Surrey Satellite Technology Inc. became part of the Airbus group in 2009 and owns a proprietary platform SSTL-X50. In Europe there are also emerging platforms for small satellites such as GOMSpace, and recently the US firm Spire opened a branch in the United Kingdom. These two players are targeting the nanosatellite market segment, within which D-Sat is an innovative platform; at the present time it is a test-bed for D-Orbit, an independent solid propulsion system embedded on satellites for end-of-life de-orbiting manoeuvres. Spacecraft developed by the German Technical

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- Launch capability demonstrated with all available launchers; and
- Avionics 4000: 100V bus.

[100] The Spacebus C-Class satellite busses are enlarged versions of the Spacebus-3000/4000 B-Class versions. The Spacebus 4000 is a medium-class telecommunications satellite (launch mass from 3000 kg for the B3 version to 5900 kg for the C4 version) with a strong successful flight heritage and a realistic and safe proposed manufacturing schedule. It can easily accommodate a large range of payloads in every band (Ku, C, Ka, X, S, L) to satisfy customer needs. The Spacebus 4000 expands the Thales Alenia Space portfolio of solutions to meet all the demands of its customers. Spacebus 4000 can support satellites weighing up to six metric tons and delivering 16 kW of power with 120 on-board transponders. At the same time, they need more flexible satellites able to fulfil a variety of missions. To guarantee compatibility with high-power performance, Thales Alenia Space has also developed the new generation Avionics 4000 based on a 100 Volt power bus. Flexible, modular and fully integrated with a central on-board computer, it is a world-first launch of an AOCS (Attitude and Orbit Control System) with a built-in star tracker for use in Geostationary Earth Orbit. The Spacebus 4000 is designed to accommodate communications services such as High Definition TV and broadband multimedia. Its key-features include:

- Telecommunications satellite; launch mass from 3000 to 5900 kg; Solar Array power up to 15,8 kW;
- Payload power up to 11,6 kW, typically 80 to 100 active channels with medium RF power (105/110W in Ku band); standard equipment and system designs available in Ku/C and Ka frequency bands; other frequency bands (X, S, L) can be proposed;
- Realistic and safe manufacturing schedule (typically 27 à 33 months on ground delivery); attractive price;
- Accommodation antenna (from 2.4 m to 3.2 × 2.4 m); Flight proven units (payload and platform);
- Design, manufacturer and test with an experienced teams for system and equipment management;
- Launch capability demonstrated with all available launchers; and
- Avionics 4000: 100V bus.

[101] Proteus (Plateforme Reconfigurable pour l'Observation, pour les Télécommunications et les Usages Scientifiques) is designed for LEO payloads in the 300 kg/300 W class. The platform also offers a 2-Gbyte mass memory and a 690-kbit/s S-band telemetry transmitter. Proteus is designed for use in sun synchronous, polar and near-equatorial orbits at altitudes from 500 to 1,500 km and for an orbital lifetime of 5 years. Proteus offers precision attitude control (to within 0.05°) with the main instrument package pointing in the Earth-centre (or anti-Earth-centre) direction for precision inertial stabilization and attitude control. Attitude can also be programmed to follow a customer-specified pattern. A Proteus control centre can be easily integrated with an existing facility using equipment that is both readily available and easy to maintain. The Proteus service module is compatible with all launch vehicles with a payload capacity between 500 and 1,000 kg. The only limits are those imposed by the customer's payload. The service module's precision AOCS (Attitude and Orbit Control System) features a fully redundant configuration of rate gyros, star trackers, GPS receivers, reaction wheels and magnetic torques.

[102] GeoBus is the Italian satellite bus from the ItalSat series for telecommunications. It has had diversified uses such as Artemis funded by ESA and is one of the first Eutelsat satellites.

[103] Prima is the current satellite bus for the Synthetic Aperture Radar payloads of COSMO-SkyMed and Copernicus' Sentinels.

[104] A small European geostationary platform (SGEO) for communications applications is being developed under OHB's management. Initiated by OHB, it has been established as a separate component of the long-term ESA schedule under the ARTES-11 program. The technical specifications for Luxor are based on a proposal submitted by OHB-System AG. What sets the SGEO platform apart is its modular structure. As a result, the satellite can be fitted individually in accordance with the customer's specific requirements without any major modifications to the satellite bus. The advantages are clear: short integration times make it possible to react swiftly to new market needs and reduce costs. The relatively low complexity of the system ensures high reliability in tandem with reduced program risk. SGEO has been developed as an optimum platform for communications payloads. With its modular design, however, SGEO also provides a cost-efficient basis for other applications such as Earth observation or meteorology. The first satellites utilising the SGEO platform were placed into orbit in 2012.

University of Berlin also complement the European spacecraft sector: Tubsat-C Bus and[105], its evolutionary successor Tubsat-N Bus and the Blackbird 350[106] developed by Kayser–Threde in the 1990s. These last two examples are of technologies belonging to European players that have not yet been commercially exploited. Thales Alenia Space has a strategy to develop a single platform for flexible applications and a variety of orbital positions. Airbus is more eager to meet customisation requirements and its portfolio is accordingly more diversified.

Airbus and Thales Alenia Space feature different corporate governance models but are both active along the entire Space value chain from manufacturing to launch, operational activities and services to end-users. Since its organisational review in 2013, Airbus is an industrial holding encompassing the former EADS manufacturer along with Astrium and Infoterra as satellite providers for telecommunication, navigation and remote sensing. Thales Alenia Space and Telespazio are corporate members of the Space Alliance between major partners Finmeccanica from Italy and Thales from France. Telespazio is a service provider for all Space-based applications, and does not yet possess full orbit capacity on its own. It manages COSMO-SkyMed data commercialisation through its subsidiary e-GEOS and MilSatCom commercialisation services under NATO's footprint via transponders on Sicral-1B and -2. Finmeccanica and Thales place their business within the broader market segment of Aerospace and Defence, which is also the commercial vocation of Airbus. Moreover, Airbus is handling more steps within the launch segment while Thales Alenia Space is more involved in human Space flight. For instance, Airbus has a dedicated department for Space transportation and Thales Alenia Space has advanced technological know-how for the International Space Station's habitat modules from European and NASA procurements.

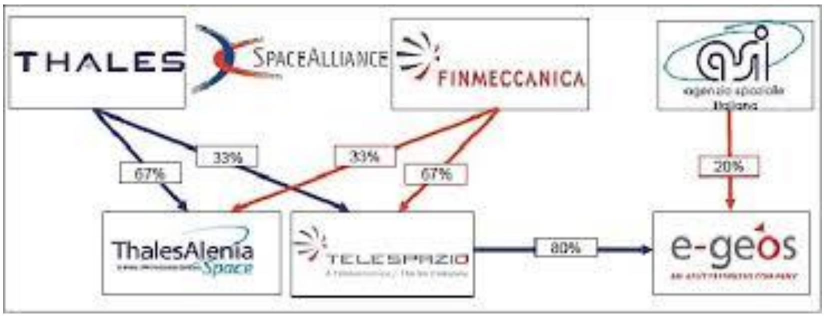

Figure 9: Space Alliance between Thales (FR) and Finmeccanica (IT)

Considering European industrial capacity in launching, Arianespace is the major commercial launch provider. Arianespace operates two main Space transportation vehicles, including Ariane 5 (currently under revision as Ariane 6) operating from the Kourou Space Center in the French Guyana (almost 4° from the Equator). This base also hosts the Russian Soyuz vehicle, and the new European rocket VEGA performs its launching services there. The commercial company behind VEGA is ELV, a joint venture between the Italian Space Agency (ASI) and Avio SpA.

Satellite operations include giant players such as Eutelsat, with a fleet of 34 GEO-satellites, and SES, with 54 orbiting GEO-satellites. These are global operators mainly catering for tele-broadcasting, although they are now moving towards broadband provision for end-users in remote and extreme locations, such as maritime, aviation and rural areas. The satellite operators for Earth Observation are mainly e-GEOS, Airbus (integrating the former SpotImage and Infoterra) and BlackBridge based in Germany which handles the RapidEye constellation.

The ground segment, including end-user equipment and ground infrastructure for handling constellations, is generally shared between manufacturers, operators and providers. Europe does not presently have a leadership vocation in this area, which is not highly profitable. Nonetheless, as the market becomes

[105] This platform has been used for university purposes.
[106] The satellite type Blackbird 350 had already been introduced in 1993 by Kayser-Threde onto the then developing market. The first application of this satellite bus was Temisat (size: 35x35x35 cm; mass: 42 kg). Kayser-Threde succeeded in developing, building, testing and launching this micro-communications satellite within a record-breaking period of less than 12 months. The satellite was launched piggybacked with a Tsiklon carrier from the Russian spaceport Plesetsk. The commercial launch of a Western satellite on a Russian carrier was itself unprecedented.

increasingly customer-oriented the ground segment gains in strategic importance because it helps to develop and maintain a close relationship with end-users. At this point, a close analysis of how to close this potential gap would be beneficial. The above Table 10 (page 48) shows two critical points in terms of business performance measured by EBIT margin as percentage of revenues: launchers and value-added service providers. A negative profit margin is to be expected in the launch sector because not all launchers can provide for every satellite platform, thus the market cannot feature free and open competition. In addition, the launching segment still produces a number of non-recurrent and non-reusable components, and is an extremely resource-heavy activity.

3.2. The Japanese Space Industry

Giant corporations for whom Space is not the sole market segment mainly dominate the Japanese Space Industry. This situation arose from a prolonged lack of a national industrial Space policy, regrettably bounded by security compromises with the United States of America and vetoes over exports. These regulations have negatively affected Japanese entrepreneurship and Space has become a commercially non-profitable industry In Japan.

Spacecraft manufactured in Japan belong to the Mitsubishi group and NEC. Mitsubishi Electric Corporation (MELCO) has commercialised the DS 2000[107] platform since 2000. The other Japanese company with proprietary manufacturing capability is NEC, which develops the NEXTAR platform series with the -300L as a small bus, the -1500L as a medium satellite bus, and the -G for GEO SatCom. There is a strong legacy in the segment of small satellites, mainly related to Japanese universities and, during recent years, spin-offs such as AXEL and SED have emerged as commercial platforms. The AXEL platform is a bus for up to 50kg and up to 100kg micro-satellite missions[108]. Even in Japan, there are emerging players interested in having their own proprietary spacecraft and related payloads, such as Canon Electronic for Earth observation, and different Japanese trade companies are also looking for small satellite providers.

Market Segment	Players (JP)	Typical EBIT Margin	JP Market Share	Global Market
System Manufacturer	MELCO, NEC, Fujitsu, Mitsubishi Precision, Tamagawa S., Meisei	5%	7%	15 B€
Launcher	MHI, IHI & IHI, Aerospace, KHI, FHI, NOF	3.4%	1.5%	5 B €
Satellite Operator	SKY-Perfect JSAT, BSAT Pasco	20 – 30% (3 - 7%)	15%	16.3 B€ (FSS) 2.5 B€ (EO)
Terminal Equipment Manufacturer	Hitachi, MELCO, Fujitsu Siemens, Panasonic, etc.	7-12 %	35%	54 B€
Services Provider	KK, Asia Air Survey, Aeroasahi, RESTEC, NTT, etc.	5%	15%	97 B€

Table 11: The Japanese Space Industry, 2014

[107] The DS2000 platform was developed based on a design originally created for the DRTS and ETS 8 platforms by JAXA. After winning an international bid competition for the MTSAT-2, a Japanese commercial satellite launched in 2006, the company incorporated evolutionary changes to match the requirements for standard commercial communications satellites and thereby introduced the DS2000. An original program management system, developed by drawing on Mitsubishi Electric's years of experience in the communications satellite business, allows customers to access design data and processes and request changes during development, production and testing. This high level of visibility ensures that each platform is tailored to exact requirements and is completed in time to meet the delivery schedule, thus allowing the DS2000 to meet the needs of communications satellite operators around the world. The distinctive features are:

- Highly reliable design and production based upon rich experience derived from participation in more than 280 satellite projects worldwide;
- Capable of providing an output of up to 15 kW, satisfying the power requirements for powerful and multiple communications transponders; and
- Flexible design matches various applications including hybrid communications payloads.

[108] AXEL is a low cost solution ($3-5M) and promises quick delivery within 1-2 years to launch. Its power generation performs at a 50W average and more power is achievable with paddles. It includes a 3-axis attitude control system with a pointing accuracy of 0.08 deg. and related stability of a lower 0.1 deg. The X-band downlink performs at speeds up to 100Mbps. The bus hosts a H2-O2 propulsion system.

Apart the two main Space manufacturers, NEC and MELCO, other Japanese market players provide relevant components and Space-based technologies. Among others, Mitsubishi Precision (MPC)'s main products are actuators and sensors for precise control of satellite attitude, and other electronic components. IHI Aerospace (IA) has delivered around 800 monopropellant thrusters for rockets and satellites since beginning development in 1964. Over 100 bipropellant thrusters have also been flown and successfully operated. IA has developed a wide range of propellant and pressuring tanks and over 200 propellant tanks have been flown and successfully operated. Mitsubishi Heavy Industry (MHI) supplies propulsion systems mainly for science missions (e.g. HAYABUSA) and has been involved in more than 70 projects to date. Based on the technology acquired through these projects, MHI orients itself towards developing advanced thruster technology. Meisei Electric has provided scientific instruments and bus equipment to satellites, rockets and the ISS for JAXA, ESA, NASA and other missions. In total, more than 2700 pieces of equipment have been launched into Space for these missions. Meisei is an especially notable manufacturer for nano- and micro-satellite systems and equipment. In addition, ancillary technology know-how is held by the companies listed in Table 12.

Company name	Main products
FUIJITSU LIMITED	Orbit calculation software, mission analysis software software
Ube Industries, Ltd.	Thermal materials (MLI etc.)
Tamagawa seiki Co,.Ltd.	Motor, Resolver, etc.
High-Reliability Engineering & Components Corporation (HIREC)	MPU, Memory, FPGA, etc
Advanced Engineering Services Co.,Ltd (AES)	Small satellite system, Onboard equipment for small satellite
NIPPI Corporation	Solar array paddles, Separation mechanisms, Antenna expansion systems, etc
SPACE ENGINEERING DEVELOPMENT Co., Ltd. (SED)	Satellite Operation and Service
Orbital Engineering Inc	Thermal materials (Heater etc.)
Addnics corp.	COTS-based RF equipment for micro satellite
Micro Lab Co., Ltd.	COTS-based RF equipment for micro satellite
Spacelink Corp.	COTS-based GPS Receive for micro satellite

Table 12: Japanese companies and space-based technologies (e.g. components, software, etc.) [109]

Within the launching segment are two main capacities, the H2-A and H2-B (under revision as H2-X) for large payloads and Epsilon for smaller ones. The H2- series is commercialised by Mitsubishi Heavy Industry and operates from the Tanegashima Space Center at almost 30° from the Equator. The Epsilon vehicle lifts off from Uchinoura Space Center, nearby the launch pad of the H2- series. The commercial arm of Epsilon is IHI Aerospace Co.

Two regional satellite operators, Sky Perfect J-SAT (with 16 GEO-satellites in orbit) and BSAT (with 5 GEO-satellites in orbit) mainly serve the Japanese SatCom market. The area of Earth observation has only recently been entered by a commercial satellite operator, Pasco, which manages the Japanese ASNARO satellite, launched in November 2014 with a high-resolution optical payload on board.

In terms of overall business profitability, the Japanese Space industry does not appear to perform better than the European Space industry when looking at EBIT margin, with the exception of negative values for launchers and value-added service providers. The Japanese Space industry reaches a constant single-digit average EBIT Margin as a percentage of revenues, aside from telecommunication satellite operators, which, in any case, achieve a lower EBIT than European equivalents.

[109] Source: J-Spacesystems, 2015

In conclusion, a comparison between the European and Japanese Space industries shows that the later has a quite flat business performance and is symptomatic for missed export opportunities. All market segments are quite self-sustainable and satisfy domestic needs but there are few opportunities to exploit economies of scale by providing the same technologies to several customers, domestic and foreign, without increasing costs. The European Space industry has a strong legacy of deriving sustainable profits from exports, mainly from launcher services and SatCom services.

4. Industry-to-Industry Collaboration Potential

This section presents technological fields where the EU – Japan industrial cooperation ought to take place. These proposals come not only from the author's assessment: they have been discussed during dedicated sessions[110] and seminars and even a B2B event in Tokyo, where relevant stakeholders from the European and Japanese Space communities have been involved and encouraged to communicate their thoughts.

4.1.R&D Activities

Business related to Space-based technology has a direct and strong relationship with t R&D activities, with more R&D activities financed. Space-based technology is a challenging field of knowledge and application. The remote and extreme conditions of Outer Space, including microgravity, means that many variables must be kept under control and therefore the systems are quite complex and enormous funds are required. Thus, it is common for two or more partner countries to jointly fund the mission for cost sharing and/or geopolitical reasons. Joint R&D activities are often conducted under a common understanding and related binding agreements between two or more national Space agencies or similar governmental entities in charge of Space. It is less common for two corporations to voluntarily conduct joint R&D projects, because both feel threatened by the potentially unfair behaviour of the other in individually exploiting the commercial profiles. An inter-agency framework is therefore beneficial in keeping industrial players collaborative. Space-based technologies encompass a broad range of fields, e.g. manufacturing, launching, operations and services for several applications. The following table shows the identified areas of R&D activity, the related stakeholders and the framework for cooperation.

Field	Items	Stakeholders	Remarks
R&D Activities	- Exploitation of ISS Modules	JAXA & ESA University-2-University	Supporting the UNOOSA initiative in favour of emerging Space-faring nations
	- Space Science Missions	JAXA & ESA	Coordination of bilateral relations

Table 13: The identified R&D activities pursuing the EU – Japan Industrial Cooperation

For a strategic relation to develop between Europe and Japan, joint R&D activities should be defined for the International Space Station and for Space science missions. The EU defines its field of activity to include the ISS, of which ESA owns Columbus (the experimental habitat module). Japan also has an ISS module, owning KIBO. Although both parties are partners in ISS, neither of them plays a leading role because they do not autonomously handle the Space transportation segment to reach ISS, nor do they control the fundamental elements making the ISS inhabitable and operational. Thus, both follow the will of

110 The author, during her stay as a Minerva Fellow at the EU–Japan Centre for industrial cooperation, ran two dedicated *Cosmo Cafés* – following the World Café method – where the participants in the first session were European industrial players (Tokyo, 16 December 2014), and participants in the second session were Japanese industrial players (Tokyo, 18 December 2014). This approach allowed participants to be free of concerns about hierarchal status and able to report relatively freely about the main issues such as well as constraints and barriers standing in the way of cooperation between the two parties. The author was also invited to present her analysis at local workshops with Space on the agenda, such as during visits to Japan by European national delegations. The author also delivered a presentation at the 21st annual meeting of the Asia Pacific Regional Space Agency Forum (APRSAF) in Tokyo, and she was keynote speaker at the Satellite Positioning Research and Application Centre (SPAC) event in March 2015. In addition, she visited numerous companies, meeting with managers in charge of international business development and strategy. She also offered a significant contribution to the preparation and organization of the first EU-Japan Partnering Support Mission in the Space Sector, held in Tokyo from 9 to 11 March 2015, and played a bridging role between the two sides. All of these opportunities have been utilized to discuss and share the fields of cooperation between EU and Japan in the Space sector.

Russia and the USA. To adopt a leadership role, they could capitalize on the availability of the two modules by offering them to the United Nations Office for Outer Space Affairs (UNOOSA), which supports capacity building among developing countries towards the ISS through scientific experiments in micro-gravity conditions, small satellites released into Outer Space from the ISS, and education initiatives. In this way, they will also increase the fill rate of their modules, at a time when low module usage rates is calling into question the financial sustainability of the ISS for players such as Europe and Japan.

In the field of Space science missions, the Europeans and the Japanese regularly manage quite similar activities directed at understanding analogue phenomena and testing exchangeable technologies. The cases of European Rosetta and Japanese HAYABUSYA clearly show more individual approaches being taken where mutual sharing opportunities exists, and more could have been achieved if the required resources were jointly provided. In order to prevent further antagonistic behaviour, the two parties ought to identify opportunities for combination and cooperation. For instance, both parties often give thought to a lunar mission. This can be a testbed not only for technological development but also for a joint political understanding in which each party selects the other as partners in a new and innovative venture to the Moon. Working jointly can enhance technology advancement and shorten delivery time. Earlier technological achievements potentially boost industrial advantages for further exploitation, which can eventually be commercialised. In order to achieve this, the two space agencies, ESA and JAXA, should leverage regular contacts to identify fields of action and related effort and resources, and to develop a successful roadmap of joint activities and projects.

4.2.Launching systems

Access to Space is a key segment in ensuring independence and technological resilience within the overall Space sector. It is obvious that in order to reach Outer Space, the launching technologies, launch pad and related Space transportation vehicles need to be handled in an autonomous manner. The autonomy of launching capacity also makes access to Space more cost effective because costs can be controlled internally rather than dependent on external settings.

The current market landscape features two threats to European and Japanese launching service providers, these being the low prices of both the US Space-X and the Chinese players. Space-X can have a greater effect on the market because it is free from ITAR-constraints. The Chinese launching service has a low price but can raise geopolitical issues due to the export control measures put in place by certain countries. This prevents it from achieving as wide a market share as the US launching service provider. Launching is necessary and highly demanding in resources, and many of the procedures are non-recurrent, which makes this step extremely costly.

Launch costs have remained pretty much the same since the earliest days of Space exploration, mostly due to the unchanging underlying technology of chemical rockets. The costs for launching a chemical rocket have been reduced somewhat through iterative innovations[111] as well as equatorial launch services[112]. Launching a rocket from the equator can minimize the necessary fuel by taking advantage of the Earth's rotation, thereby lowering the launch costs by a significant margin. Launch costs can be reduced somewhat by using reusable launch vehicles, but the poor cost performance of the reusable Space Shuttle has led many to question this idea. There is a consensus that a real breakthrough in decreasing launch costs will require the development of new methods[113] to get into Space. In both the EU and Japan, reusable launching

[111] New initiatives in private spaceflight are taking place.
[112] For instance, the case of such as Sea Launch.
[113] Since space travel began with the launch of Sputnik in 1957, scientists have been looking at ways to exploit some method other than chemical rocketry to reach Space. It has been determined that a sufficiently long cannon could be used to launch acceleration-resistant payloads into Space, but no country has yet tried to build one, though a few companies are trying. A similar concept, a launch loop, would accelerate a payload using powerful magnets to escape velocity, and then launch it upwards. Such an approach would also require acceleration-resistant payloads, as the accelerations on the payload would be in the range of thousands of gravities. Another proposed method of reducing launch costs is the construction of a Space elevator; a concept, which can received some funding and attention in the United States and Japan. A Space elevator would consist of an extremely long carbon nanotube cable, with a counterweight in geosynchronous orbit. Though reaching orbit would still require expending the same amount of energy, it could be expended gradually rather than over the course of a few

vehicles are being planned for future space technology. In particular, Japanese R&D activities in this regard are focusing on the reusable technologies directly involved in the launching segment, whereas the Europeans are considering a broader concept, with re-entry vehicles to be eventually exploited also for launching services. The challenge in both cases is economic sustainability. Various re-entry and reusable technologies already exist, with the crucial point being the adoption of a cost-effective solution that can be easily replicated to benefit from economies of scale. To achieve this target, the joint working group should include not only the industrial players, licensing and commercialization of launching services, but also the related Space agencies, JAXA and ESA, binding their roles in order to frame their R&D activities towards a single common objective. When two commercial players co-fund R&D activities there is always the threat that at the end one shall play the lion preying on the market. To prevent this, co-ownership of the intellectual property rights should be established as a rule among partners.

The following Table 14 displays additional potential activities, such as synergies towards new launching rocket designs and new launching sites. Following the ESA ministerial meeting at the end of 2014, most of the launching technologies are licensed to industrial players, thus the European launching services provider's mission is for profit sustainability. One step in this regard is the move to develop the new Ariane 6 instead of modernising the existing Ariane 5. The new Ariane 6 initiative comprises a range of features in order to make a competitive vehicle at a competitive market price; these features include a modular three-stage launcher with a solid–cryogenic–cryogenic configuration, and two configurations – the A64 with four boosters and the A62 with two[114].

Field	Items	Stakeholders	Remarks
Launching system	-Reusable launching vehicle	Industry-2-Industry with support of JAXA and ESA	Co-ownership of IPR
	- Synergies for new conceptual technology	Industry-2-Industry	WG under joint coordination of ESA & JAXA
	- New Launch sites	Support of Governments	Trade-off between manned and unmanned launching capacity

Table 14: The identified actions for the Space launching field

The upgrading of H2-A into the coming H3-X is driven by efficient manufacturing and operation by common core stages. This process would ensure synergies in the development of Epsilon, the smaller launcher, and the H3-X.

Ariane 6 is based on a main stage with liquid oxygen and hydrogen (based on the Vulcain engine of Ariane 5 ECA and ME), two or four P120 solid rocket boosters (in common with Vega-C, the new evolution of the current Vega launcher), a cryogenic upper stage (LOX/LH2) propelled by a Vinci engine (based on the A5ME upper stage, with limited adaptations). Ariane 6 will have re-ignition capability and will be capable of performing a direct deorbiting and controlled re-entry of the upper stage. Flexibility is a design characteristic for both the A64 and A62. In essence it is the same launcher, responding to different market needs by varying the number of boosters in the configuration. The A62, with two P120 solid boosters, will be used mainly in single-launch configurations, while the A64 – with four P120 solids – will enable double launch of medium-class satellites up to 4.5–5 t, mainly for commercial market needs. In addition, the initiative also involves corporate actions to streamline the industrial organization, reduce the number of interfaces and thus reduce the costs and risks to be borne by Member States in the development and exploitation. Airbus Space & Defence and Safran, the two largest European industrial actors in launchers, intend to create a joint venture to lead the development and production of the future European launching system.

This type of corporate operation is already familiar to the Japanese Space community, where the launcher

minutes, greatly expanding the number of options that could be used to get a payload into orbit. US Air Force, *Streamlining Space Launch Range Safety*, National Academies Press, 2000.

[114] Ariane 6 in its A62 or A64 configuration is deemed the best possible long-term solution for Europe to maintain competencies and deliver launch services at competitive costs.

H2- series are licensed to MHI from JAXA, taking care only of launch safety management[115], and to IHI Aerospace for the Epsilon launcher. In this regard, Japan is a potential source of best practice to facilitate this process. In addition, the Japanese case provides insights into the capacity of artificial intelligence in the cost-effective guidance and control of launching manoeuvres. This has the potential to meet European needs of keeping development costs down and consequently achieving a lower market price to compete effectively with US and Chinese launching service providers. In addition, EU and Japan do not yet have a cost-effective human Space transportation system. This option is strongly driven to the orbital location of the Space station, thus at current time the only option shall be an Equatorial launch pad. A potential new operational launch-pad shall be the Italian “Luigi Broglio” Space Launch Centre[116] in Malindi, Kenya.

From Table 15 it can be seen that the technologies from both sides are rather sophisticated and the reliability assessment is very promising in almost every cases, exceptionally for Epsilon with a single launching performance. In fact, to have the capacity to serve market needs from different space-based manufacturers with assorted types of spacecraft, it is worth assessing the reliability associated with the technical compatibility of different rockets with the spacecraft and their launchers. The following two tables show the relationships between the rockets and spacecraft available on the market. Compatibility in some cases has already been achieved and in others, it is under development. This implies that different launchers vary in their competitiveness for different types of spacecraft.

The main commercial launchers are capable of transporting space vehicles into GEO-orbit (at around 36,000 km from the Earth) and into LEO-orbit (at around 700 km). The tables below report on rockets and spacecraft.

[115] Launch safety management includes ground safety confirmation, flight safety assurance, and overall countdown control and supervision.
[116] AU Space Primer, Chapter 20 –Rest of World (RoW) Space Launch, last access in June 2015 at: http://space.au.af.mil/primer/rest_of_world_launch.pdf

Space Transportation Vehicle	Manufacturer	Launch Services Provider	Remarks
Japanese Launching Families			
Epsilon	IHI Aerospace	IHI Aerospace	-3 stages with solid-fuel -Payload capacity to low Earth orbit of up to 500 kilograms, with the operational version expected to be able to place 1,200 kilograms (2,600 lb) into a 250 by 500 kilometres (160 by 310 mi) orbit, or 700 kilograms (1,500 lb) to a circular orbit at 500 kilometres (310 mi) with the aid of an hydrazine fuelled stage -Launching-pad from Uchinoura Space Centre (31.25°N- 131.08° E) -Shorter launch preparation time -Mobile launch control and the rocket needs only eight people at the launch site
H2-A	MHI (Licensing component from ATK-US)	MHI	-2 stages with LOX/LH fuel -Payload to LEO in the range of 10,000 - 15,000 kg (22,046 - 33,069 lb) -Payload to GTO in the range of 4,100 - 6,000 kg (9,038 - 13,227 lb) -Launching-pad from Tanegashima Space Centre (30.40° N 130.97° E) -Extremely high orbit injection accuracy and the versatility to launch satellites into various types of orbit -Shorter performance of flight
H2-B	MHI	MHI	-2 stages with LOX/LH fuel and 4 strap-on solid rocket boosters -Launching the H-II Transfer Vehicle (HTV) as a vehicle for transportation to the International Space Station (ISS) and contributing to the future satellite market by providing a variety of launch capabilities with the H-IIA -Launching-pad from Tanegashima Space Centre (30.40° N 130.97° E) -Enhanced rocket engine propulsion power and larger satellite fairing
H3-X	MHI	MHI	-New Evolution of H2-A -Payload to GTO in the range of 2,000 - 6,500 kg -Payload to SSO at 800km up to 3 t.
European Launching Families			
Ariane 6	Airbus Safran	Arianespace	-Modular 3-stage launcher (solid–cryogenic–cryogenic) in 2 configurations with 4 boosters (A64) or 2 boosters (A62) -Payloads to GTO with A62 up to 5,000 kilograms (11,000 lb) and with A64 up to 11,000 kilograms (24,000 lb) or up to 10,000 kilograms (22,000 lb) with dual payload -Launch-pad from the French Guiana Space Centre (5.23° N 52.76° W) -Flexibility is a design characteristic responding to different market needs by varying the number of boosters in the configuration. It will have re-ignition capability and will be capable of performing a direct deorbiting and controlled re-entry of the upper stage
VEGA	ELV	Arianespace	-A single-body launcher (no strap-on boosters) with three solid rocket stages and a upper liquid rocket module -Payload to Polar orbit at 700km with an inclination 90° up to 1,430 kg (3,150 lb) -Payload to Elliptic orbit at 1500x200km with an inclination 5.4° up to 1,963 kg (4,328 lb) -Payload to SSO at 400km up to 1,450 kg (3,200 lb) -Launch-pad from the French Guiana Space Centre (5.23° N 52.76° W) -The rocket's flexibility allows it to serve a wide range of missions and payload configurations related with market opportunities. It offers configurations able to handle payloads ranging from a single satellite up to one main satellite plus 6 microsatellites.

Table 15: European and Japanese Launching capabilities

	TAS	Airbus	Orbital	LM	Boeing	SSL	OHB	NG	MELCO	NEC
Ariane										
Atlas										
Delta										
Falcon										
GSLV										
H2A										
CZ Long March										
Proton										
Soyuz										
Zenit										
Angara										
Key-reading	**Under Development**					**Developed and Performed**				

Table 16: technical compatibility between rockets and space-buses related to GEO-orbit

Ariane refers to Ariane 5; Atlas to Atlas V from US companies Convair, General Dynamics Lockheed Martin and United Launch Alliance; Delta to the homonymous family from Delta II to Delta IV from US United Launch Alliance; Falcon is from US Space-X; Geo-Synchronous Satellite Launch Vehicle (GSLV) is from Indian Space Research Organization and commercialized through Antrix Company; H2A is from the Japanese MHI; Changzheng rocket – Long March is the Chinese space vehicle; Proton is the Russian vehicle; Soyuz is the Russian vehicle compatible with Ariane 5; Zenit is a Ukrainian launching capacity; the upcoming Angara belongs to the Russian Khrunichev.

TAS stands for Thales Alenia Space; Airbus for itself; Orbital is a US company operating the GEOStar-series; LM is for Lockheed Martin mainly controlling Space bus A2100; Boeing provides the 702 spacecraft family; SSL stands for Space Systems Loral with its 1300 Series Satellite Platform; OHB is the German manufacturer; NG is the US Northrop Grumman with its T100-330 platform; MELCO is Mitsubishi Electric from Japan and NEC is the Japanese Nihon Electric Corporation.

	TAS	Airbus	Orbital	LM	OHB	NG	Ball	MELCO	NEC
Antares									
Ariane									
Athena									
Atlas									
Delta									
DNEPR									
Epsilon									
Falcon									
KOSMOS									
Minotaur									
Pegasus									
PSLV									
Rokot									
Soyuz									
Titan									
VEGA									
Zenit									
Key-reading	**Under Development**					**Developed and Performed**			

Table 17: technical compatibility between rockets and space-buses related to LEO-orbit

Antares comes from the US Orbital ATK and the Ukrainian Yuzhnoye; Ariane refers to Ariane 5; Athena is developed by the US Lockheed Martin; Atlas refers to Atlas V from US companies as Convair, General Dynamics Lockheed Martin and United Launch Alliance; Delta refers to the homonymous family from Delta II to Delta IV from US United Launch Alliance; DNEPR is the Russian-Ukrainian vehicle; Epsilon is the Japanese small rocket; Falcon is from the US Space-X; KOSMOS is another Russian rocket potentially still available; Minotaur and its predecessor Taurus are US ballistic launchers with intercontinental capacity; Pegasus is an air-launched rocket developed by the US Orbital; Polar Satellite Launch Vehicle (PSLV) is developed by the Indian Space Research Organisation and commercialized by Antrix Company; Rokot is a Russian technology; Soyuz is the Russian vehicle compatible with Ariane 5; Titan is a US vehicle; Zenit is a Ukrainian launching capacity; VEGA is the European small rocket.

TAS stands for Thales Alenia Space; Airbus for itself; Orbital is a US company operating the GEOStar-series; LM is for Lockheed Martin mainly controlling the Space bus A2100; Boeing provides 702 spacecraft family; SSL stands for Space Systems Loral with its 1300 Series Satellite Platform; OHB is the German manufacturer; NG is the US Northrop Grumman with its T100-330 platform; Ball stands for the US Ball Aerospace & Technology Corp. with its BCP series 300/100 – 2000 and -5000; MELCO is Mitsubishi Electric from Japan and NEC is the Japanese Nihon Electric Corporation.

a. Space-based systems and components

This section reports the identified fields for industrial collaboration with a business-oriented approach. Thus, the fields are selected based on satisfying current customer needs for a lighter satellite driven by efficiency gains, a more promising data rate due to increasing data unit in transmission, secure and dedicated data communication for military purposes, and sustainable and fair behaviour for debris mitigation in Space.

The current SWAP (Size-Weight And Power) trend impacts also the Space sector in various ways, such as the miniaturization of components leading to a reduction in the size and weight of satellites and a consequent reduction in launching rocket dimensions. Light and smart materials can also contribute to efficiency gains, and innovative sub-systems as an alternative to classical ones can improve the power consumption of the orbiting satellite. Proven know-how in handling this challenge is a key to matching customer expectations and taking advantage of the substantial willingness amongst customers to pay for a better system. After the case of US Boeing[117] providing the full-electric propulsion satellite to the French satellite operator Eutelsat, electric propulsion on board satellites is becoming an increasingly common customer requirement because it makes for a lighter satellite and consequently saves weight, fuel and extends orbiting life.

In the meantime, competitors in Europe are now selling larger and much more powerful all-electric platforms using Hall-effect propulsion systems that require less time to finalize their orbit when compared to the 702SP developed by Boeing. The French government is now financing the development of a European electric-propulsion thruster being designed by Safran's Snecma motors division. Snecma has been producing electric thrusters for years for in-orbit station keeping, under license to EDB Fakel of Russia. The new development is for an all-European thruster that will fly on spacecraft platforms built by Airbus Defence and Space and Thales Alenia Space of France and Italy. Airbus Defence and Space, which is offering an electric-propulsion variant of its Eurostar E3000 equipped with the new Snecma propulsion system, says that of the four commercial telecom satellites it sold last year, two were all-electric, including the 3,500-kg Eutelsat 172B, which is the first European communications satellite equipped with electric plasma thrusters designed to raise, manoeuvre and position itself in geosynchronous orbit. Customers are using the mass savings in different ways. For instance, one can decide to keep the mission, with the satellite weighing roughly 3,500 kg, which will allow it to fit in the lower-cost position on the launch. If the satellite had been built to use traditional chemical propulsion for orbit raising, it would weigh more than 6,000 kg. Other customers can choose to do the opposite, for instance using the saved mass to increase the payload and the mission. The European industry is also supported by ELECTRA[118], the innovative ESA program to develop a fully European electric propelled satellite through an innovative financial policy, such as an industry-generated public–private partnership. In this case the partnership is between ESA and SES, the Luxembourg satellite operator. The project is led by the German manufacturer OHB, hosting the electric propulsion on board of the small-GEO[119]; the core payload is provided by a consortium of other European companies, such as RUAG Space, Thales Alenia Space and Airbus, among others.

Another important current challenge is the capability to transmit at a high data rate, thus high throughput performance is required. One option is to embark a dedicated sub-system to ensure a high throughput transmission mainly working at high frequencies. Another option is to guarantee the high data rate to end-users from the overall Space-based system. In this case, small satellite constellations can also be

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[117] Stephen Clark, Boeing's first two all-electric satellites ready for launch, 1 March 2015. Last access in June 2015 at: http://spaceflightnow.com/2015/03/01/boeings-first-two-all-electric-satellites-ready-for-launch/

[118] The initiator program for electric propulsion is related to ARTEMIS, the ESA satellite launched in 2001. ESA's Artemis telecom satellite was Europe's first experimental use of electric thrusters to raise a satellite to its target orbit. Artemis proved that electric thrusters are capable of performing the same task as conventional chemical propulsion but with up to 90% savings in fuel consumption

[119] SmallGEO is a general-purpose small geostationary satellite platform that is giving European industry the opportunity to play a significant role in the commercial telecom market. The platform is developed through a public-private partnership. ESA is focusing its support on research and development activities through ARTES 11 while industrial partners finance a substantial part of the development costs. SmallGEO is being developed by an industrial team managed by OHB System AG. The consortium includes OHB subsidiaries LuxSpace and OHB Sweden (formerly Swedish Space Corporation), along with RUAG Space Switzerland. This core team will also commercialize the platform.

considered.

High Throughput Satellites (HTS) is a classification for communications satellites that provide at least twice, though usually by a factor of 20 or more, the total throughput of a classic satellite providing Fixed Satellite Services for the same amount of allocated orbital spectrum, thus significantly reducing cost-per-bit. Most current High Throughput Satellites operate in the Ka band, however this is not a defining criterion, and there are Ku band HTS projects in development. Nowadays, the definition is very sensitive to the change in speed and volume of data transmission. Obsolescence is very rapid because terrestrial technology can easily modify its performance to meet user needs. The current HTS in orbit are reported in the following Table, including their manufacturer and details of coverage and frequency band usage.

Satellite	Launched	Launcher	Manufacturer	Operator	Frequency	Footprint
Anik F2	July 17, 2004	Arianespace	Boeing 702	Telesat	C-,Ku-band	North America
Thaicom 4	August 11, 2005	Arianespace	SSL – LS-1300	Thaicom Public Company Limited	Ku-band	South East Asia
Spaceway-3	August 14, 2007	Arianespace	Boeing 702	Hughes Network Systems	Ka-Band	North America
WINDS[120]	15 February 2008	MHI	MELCO	JAXA/NICT	Ka-Band	Asia
Ka-Sat	26 December 2010	ILS (Proton)	Airbus	Eutelsat	Ka-Band	Europe & North Africa
Yahsat Y1A	April 2011	Arianespace	Airbus & TAS	Yahsat	C-, Ku-, Ka-Band	Middle-East
ViaSat-1	19 October 2011	ILS (Proton)	SSL – LS-1300	ViaSat – Isle of Man	Ka-Band	North America & Hawaii
Yahsat Y1B	23 April 2012	ILS (Proton)	Airbus & TAS	Yahsat	Ka-Band	Middle-East
EchoStar XVII	5 July 2012	Arianespace	SSL – LS-1300	Hughes Network Systems	Ka-Band	North America
HYLAS 2	August 2, 2012	Arianespace	Orbital	Avanti	Ka-Band	Southern Africa, Eastern Europe and the Middle East
Astra 2E	29 September 2013	ILS (Proton)	Airbus	SES	Ku- and Ka-Band	Europe and the Middle East
O3b Satellite Constellation	2013 – 16	Arianespace	TAS	O3b (SES)	Ka- Band	Equator
Inmarsat Global Express	December 2013	ILS (Proton)	Boeing 702	Inmarsat	Ka-Band	Europe, the Middle East, Africa and Asia
Intelsat Epic Constellation	2016 -	*TBD*	Boeing	Intelsat	C-, Ku-, Ka-Band	Global

Table 18: High Throughput Satellites from 2004 to present

HTS know-how is spread across US, European and Japanese manufacturers. The Europeans are also taking HTS into consideration within the Neosat program under ESA jointly with the French CNES. A crucial objective for Neosat is to reduce the cost of a satellite in orbit by 30% compared with today's designs by the end of the decade. Existing and new technologies will be used in innovative ways and to achieve economies of scale by creating a common supply chain for both satellite prime contractors. Neosat will be optimized for electric propulsion – both for raising the satellite into its final orbit after separation from its launcher, and for maintaining its operating position. Electric thrusters use significantly less propellant than

[120] Wideband InterNetworking engineering test and Demonstration Satellite, also known as Kizuna.

traditional thrusters to reach the same destination. The Neosat product lines will offer the option of all-electric, hybrid electric/chemical and all-chemical propulsion versions. In the hybrid and all-chemical versions, the telecommunications operator will have the flexibility to speed-up orbit raising using chemical propellants – a manoeuvre that could take a few months by electric propulsion alone.

Small satellites are also an element of the SWAP trend. The European industrial heritage is mainly devoted to traditional large satellites of over 300kg, whereas the Japanese are more knowledgeable in small satellites of below 300kg, including the 1-50kg classes. The critical differentiating factor has been launching opportunities, even though the partnership between the US Nanorack and JAXA for launching the Japanese module of the ISS is playing a fruitful role. Small satellites are often piggybacked on to traditional launches, when there are opportunities to do so because of excess space on the rocket. The tables included below as Tab. 17 report on the reliability rates for the different launching vehicles in the two classes of 1-10kg and 11-50kg. As launch does not seem to be an issue, the Europeans should enhance collaboration with Japanese partners, especially in light of the opportunities emerging from the current Japanese Space Plan, under which small satellites are a key technology for targeting new investment for the development of new military and dual space-based systems. The advantage of small satellites are related to the requirements of the Operational Responsive System, which is a typical military approach demanding rapid replacement in cases of attack and/or malfunction. Small satellites are intuitively more easily replaceable than large ones. As the new Japanese Space Plan searches for synergies between security and Space purposes, small satellites are selected as items in new programs for earth observation and telecommunications. Nevertheless, Japanese industries launching from a pad relatively far away from the Equator in order to keep costs low are faced with the necessity to build smaller satellites and consequently spacecraft from MELCO and NEC are of smaller size than European satellites. This has now turned into an advantage because the market trend for small satellites is promising[121] due to new categories of customer with limited budgets, e.g. developing countries, private operators and Space enthusiasts. For these customers large satellites are not affordable, and also their purposes are not always so complex and sophisticated as to require an advanced Space-based system.

Launch Vehicles: 2000-2013 for 1-10 kg Satellite Class

Launch Vehicle	No. of Satellites	No. of Launches	Percentage of Satellites Launched
Kosmos-3M	50	6	20%
Dnepr-1	34	4	14%
Minotaur I	34	4	14%
PSLV	21	6	9%
H-2	18	5	7%
Space Shuttle	12	6	5%
Falcon 9	11	2	4%
Soyuz	9		4%
Delta II	8	3	3%
Long March	7	4	3%
Minotaur IV	8	1	3%
Vega	8	2	3%
Other	8	5	3%
Antares	4	1	2%
Atlas V	5	2	2%
Rokot-KM	6	1	2%
Falcon 1	2	1	1%
M-5 (2)	2	2	1%

Launch Vehicles: 2000-2013 for 11-50 kg Satellite Class

Launch Vehicle	No. of Satellites	No. of Launches	Percentage of Satellites Launched
Kosmos-3M	25	9	24%
Dnepr-1	9	2	9%
H-2	9	6	9%
Minotaur I	9	2	9%
PSLV	8	6	8%
Minotaur IV	7	5	7%
Safir	6	6	6%
Soyuz	6	6	6%
Long March	5	5	5%
Other	5	5	4%
Pegasus-XL	3	1	3%
Space Shuttle	3	2	3%
Delta IV Heavy	2	1	2%
KT-1	2	2	2%
Rokot-KM	2	2	2%
Atlas V	1	1	1%
Delta II	1	1	1%
Falcon 1	1	1	1%
Falcon 9	1	1	1%

Source: SpaceWorks Enterprises, Inc. (SEI), 2014

Table 19: Launch vehicles for 1-10 and 11-50 kg Satellite classes

The issue of the Space debris also arises in the broad debate over small satellites. JAXA, together with military institutions, is looking into several innovative methods and solutions of Space clean-up technologies. Some examples are: a Space net that will theoretically be able to capture a portion of the

[121] For a comprehensive overview, see SpaceWorks Enterprises, Inc. (SEI), Nano / Microsatellite Market Assessment, 2014, last access in June 2015 at: http://www.sei.aero/eng/papers/uploads/archive/SpaceWorks_Nano_Microsatellite_Market_Assessment_January_2014.pdf

estimated 100 million pieces of man-made trash orbiting our planet; an electrodynamic tether that would slow down debris enough to make it re-enter the atmosphere; a satellite with ion engines that could use its thruster to knock objects into a lower orbit, and, even more far-fetched, a giant “Styrofoam ball, kilometres in diameter” that debris would stick to.

The European Space community also leads in this field, in both policy and technology. From a policy point of view, the EU is playing a substantial leadership role in proposing and supporting the negotiation of the International Code of Conduct for Outer Space Activities. From a technological point of view, ESA manages programs such as the CleanSpace, with a satellite grabbing Space debris, and there is a new proposal for an autonomous solid-fuelled rocket, developed by the Italian-Portuguese start-up D-Orbit, as an embarkable satellite sub-system. In order to establish fruitful industrial collaboration in this field, two levels of interaction are required, both aiming to reach a safer and more sustainable Space environment.

In the political domain, the Japanese Ministry of Foreign Affairs and the EU, through the European External Action Service, should handle coordinated measures; meanwhile ESA and JAXA should frame the technical profiles supporting bilateral industrial activities.

Field	Items	Stakeholders	Remarks
Space-based system	-Electrical propulsion	Industry-2-Industry under coordination of ERC, ESA and JSS/JAXA	Market-oriented approach
	-High Throughput Satellite	Industry-2-Industry supported by EU (Digital Agenda) and Japan	High Throughput is the data-rate for end-use
	-International Code of Conduct	Industry-2-Industry under coordination of EU supported by ESA and MOFA supported by JAXA	Space clean up technologies
	-MilSatCom	NATO and GoJ	GoJ is Major Non-NATO Ally and Individual Partnership and Cooperation Programme

Table 20: The identified actions for the development of space-based systems

The new role played by Japan in the global military scenario is one of an actor with its own military assets and no longer that of a passive subject receiving defence and support from the USA. The new concept of collaborative self-defence allows Japan to initiate its own military facilities projects and technological assets, including Space-based systems[122]. The current Space Plan includes the development of military satellite communication systems. In this regard, the EU and Japan have a common arena of action – NATO – where members provide technologies compliant with NATO standards in terms of safety, security, reliability and resilience. The following chart displays the Japan-NATO closer cooperation.

[122] The Congressional Research Service reports on the Japan-U.S. Relations: Issues for Congress: *Japan’s own defence policy has continued to evolve, and its major strategic documents reflect a new attention to operational readiness and flexibility. The original, asymmetric arrangement of the alliance has moved toward a more balanced security partnership in the 21st Century, and Japan’s decision to engage in collective self-defence may accelerate that trend. Unlike 25 years ago, the Japan Self-Defence Forces (SDF) are now active in overseas missions, including efforts in the 2000s to support U.S.-led coalition operations in Afghanistan and the reconstruction of Iraq. Japanese military contributions to global operations like counter-piracy patrols relieve some of the burden on the U.S. military to manage security challenges. Due to the co-location of U.S. and Japanese command, facilities in recent years, coordination and communication have become more integrated. The joint response to a 2011 tsunami and earthquake in Japan demonstrated the interoperability of the two militaries. The United States and Japan have been steadily enhancing bilateral cooperation in many other aspects of the alliance, such as ballistic missile defence, cybersecurity, and military use of space*. Last access in June 2015 at: https://www.fas.org/sgp/crs/row/RL33436.pdf

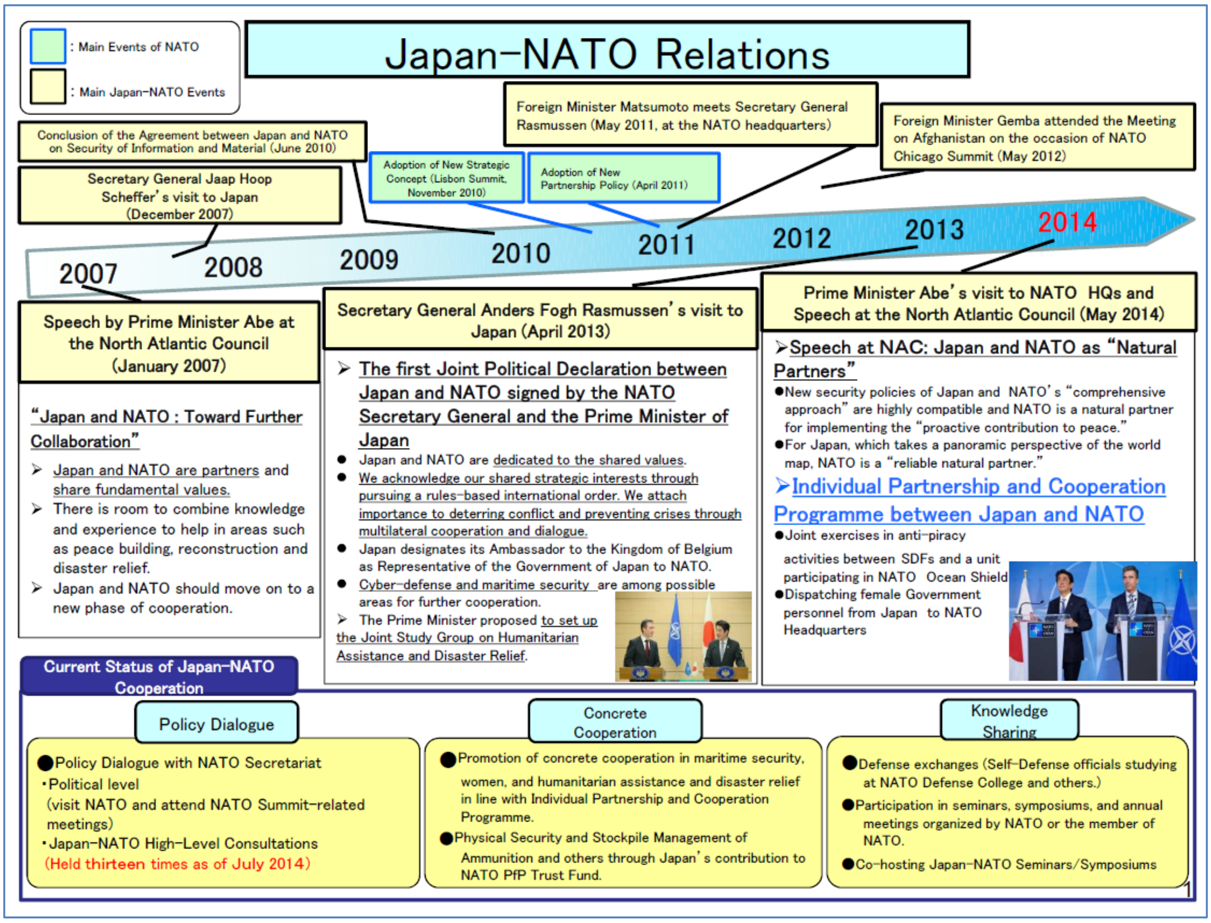

Table 21: Japan towards NATO from 2007 to the present[123]

Most of EU Member States are NATO Members, and the provision of SatCom services in favour of NATO allies is already in place. Each European State has its own telecommunication systems for military purposes, even if SatCom is being increasingly adopted for dual-use and/or civilian applications. SatCom is clearly relevant in this area but Europe does not have a coordinated approach that would surely result in cost-savings. It should be noted that currently the sales of the European industry could also be split into civilian and military systems. Interestingly, the total value of military systems sold exceeds the value of sales to military entities. This is because military systems are procured by some civilian customers, as is the case of the private operator Paradigm procuring the military Skynet-5 systems, and also of some civilian agencies, such as CNES, DLR and ASI, that procure military systems for defence authorities. The European Union's ESDP includes the gradual framing of a common defence policy. The ESDP aims to allow the Union to develop its civilian and military capacities for crisis management and conflict prevention at an international level, thus helping to maintain peace and international security in accordance with the United Nations Charter. The ESDP, which does not involve the creation of a European army, is developing in a manner that is compatible and coordinated with NATO. Space capabilities that could be made available to NATO forces run the entire gamut of Space products and services available. NATO has already made great strides in the areas of SatCom and missile warning systems, and also has notable achievements in geographic imagery exploitation. SatCom is an area where NATO has long been successful in providing NATO commanders and forces with a vital military Space capability. Since the launch of the first NATO communications system via satellite in 1970, NATO has united in providing common funding according to agreed cost-sharing formulas. Although that arrangement provided a vital capability in an area where resources were very scarce, the communications requirements in the information age have outstripped the capacity of the dedicated NATO satellites. In response, NATO changed the scheme in 2005 to an arrangement with the United Kingdom, Italy, and France to provide military communications to NATO from within their nationally owned systems[124]. This provides NATO with more communications capacity and an increased

[123] Source: MOFA, 2015

[124] SATCOM Post-2000 - Improved satellite communications for NATO, December 2011 Last access in June

robustness by virtue of the inherent diversity of the satellite design and command and control architecture. Designed to published NATO standards and guidance, the Space-based systems and the ground-based equipment used within the NATO force structure and by NATO member nations are compatible. Under these assumptions, NATO has a continuous need of for X-band Satellite Communication[125], in which the Japanese Ministry of Defense will procure a 3-satellite constellation with a Public-Private-Partnership involving a consortium led by Sky Perfect J-Sat with NEC and NTT Communication. For instance, the current NATO footprint is partially lacking in Asia Pacific coverage, as shown in the following diagram.

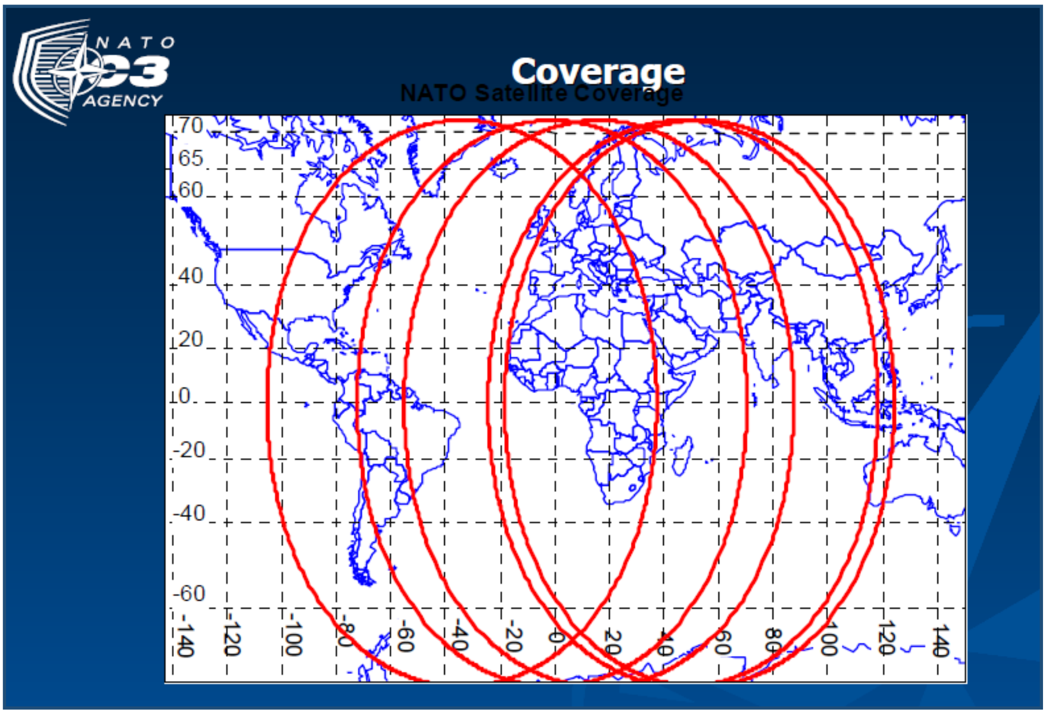

Table 22: NATO Footprint of SatCom services, 2015

Therefore there is an opportunity to establish a ground segment compliant with NATO requirements[126] through industrial cooperation involving the current NATO SatCom Consortium along with the British, French and Italian industrial players such as Airbus (through its national branches in the UK, France and Germany) and Telespazio from Italy. Furthermore, Europe and Japan are involved in various humanitarian, rescue, peacekeeping, and crisis management operations. Areas of increased interest to the EU and Japan are counterterrorism, combating piracy, and international peace cooperation activities. Cooperation with European countries and with the EU strengthens Japan's role in dealing with global challenges, in accordance with the Ministry of Defense's strategy to increase Japan's security through *multi-layered security cooperation in the international community*, as stated in Japan's 2011 Defense White Paper. The 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 effectively exploit the benefits of available Space systems. Enhanced cooperation can help fill existing gaps in crisis management operations, including through the establishment of more responsive multinational forces.

Space-based technologies have initially been introduced for military purposes, mainly during the Cold War when the USA and USSR competed for leadership. These two countries developed a huge amount of technological know-how in Space items. In particular, the USA has been exploiting this heritage in their

2015 at: http://www.nato.int/cps/en/natohq/topics_50092.htm ; NATO Sets Mid-2014 Deadline for Securing Future SatCom Capacity – Last Access in June 2015 at: http://spacenews.com/33025nato-sets-mid-2014-deadline-for-securing-future-satcom-capacity/#sthash.ICje1Q6H.dpuf

[125] In Space, NATO Opts To Rent, Not Own – Source: http://www.afcea.org/content/?q=space-nato-opts-rent-not-own

[126] Tim Waugh, Satellite Communications – NATO Consultation, Command and Control Agency, last access in June 2015 at: http://www.europarl.europa.eu/hearings/20070502/sede/waugh_en.pdf

international relations with third countries within the Space field and other areas of application, such as resource management, climate change, energy, telecommunications, etc. Military roles for Space assets are often problematic because they demand advanced specifications, and consequently a high willingness to pay, while also requiring controlled exploitation for civilian and commercial purposes. The front-running position of the USA and USSR meant they were far more equipped and the rest of the world decided to tie-up with one of them instead of independently developing their own Space-based technologies, therefore creating a situation of strong technology dependence on the USA and USSR/Russia. In the first phase these two countries were reluctant to transfer Space-based technologies to the rest of the world, and export control regulations established heavy barriers to export. The business profile of Space is now increasing, and export is becoming increasingly relevant in asserting industrial competitiveness and related leadership. In this context, the relation between the EU and Japan is partially affected by US export control as both parties use licensed technologies from the USA. There is quite a substantial will on the part of both Europe and Japan to at least have non-dependent[127] Space-based technologies exploited in their industrial value chain. If some US licensed components are present, trade passes through binding US export controls even when Europeans and Japanese export to the rest of the world. For this purpose a joint action shall have the coordination of the leading entities from both sides, namely the European ESA for Space-based technology profiles (with the support of the EDA for military issues and of the EC for political issues), and, from Japan, METI and JAXA for industrial and technological profiles, with an advising role for the Center for Information on Security Trade Control (CISTEC). This action shall consider that the quality of the Electrical, Electronic, and Electromechanical (EEE) components used on a spacecraft is a determining factor for reliability and performance throughout the life of a mission. Facilitating trade and enhancing compliance are the minimum tasks towards cooperation between Space partners: cooperation between ESA and JAXA, addressing Space components and technology non-dependence, focus on productive information exchange of test data, greater access to electronic components, simplified export procedures, and avoidance of duplication of activities. This cooperation, taking place in the framework of an agreement signed between ESA and JAXA in June 2013, has been extended and now covers Space materials and manufacturing and test processes; further enlargement of the agreement promises greater benefits.

Field	Items	Stakeholders	Remarks
Space-based Components	-ITAR free products	Industry consultation upon a joint action of ESA, supported by the EDA, and JAXA for technological profiles, and the EC and METI, supported by CISTEC, for the coordination of the regulatory issues	ESA – JAXA have a WG for this purpose
	- 3D Printer	EU – Japan Industrial clusters	Long term vision

Table 23: Identified actions for the development of space-based systems

The export control regulation to be considered belongs to at least three juridical contexts, the USA, the European Union, and Japan. The following table reports the main aspects of these three different cases.

[127] An EC-ESA-EDA Joint Task Force (JTF) was established in 2008 to address Critical Space Technologies for European Strategic Non-Dependence. Within this context the definitions of "Independence" and of "Non-Dependence" are:

- "Independence" would imply that all needed Space technologies are developed in Europe, and
- "Non-dependence" refers to the possibility for Europe to have free, unrestricted access to any required Space technology.

The US Export Control Regulation	
Legal References and Space Relevance	- The Arms Export Control Act (AECA) and International Traffic In Arms Regulations (ITAR) (US Munition List) - 22 CFR 120 covers items such as Space Launch Vehicles (e.g., the Space Shuttle), rocket engines, certain spacecraft (including all remote sensing satellite systems), missile tracking systems, etc. (both the hardware and the technology) - The Export Administration Act (EAA) and Export Administration Regulations (EAR) - Commerce Control List - 15 CFR 730 covers what is commonly referred to as "dual-use" items, including the Space Station (including hardware and certain technologies)
Entity in charge	- The US Department of State - The US Department of Commerce - Additional governmental entities coordinated by the Export Enforcement Coordination Centre (E2C2) established by President Obama's Executive Order 13558
Definition of export	The transfer of anything to a "FOREIGN PERSON" by any means, anywhere, anytime, or the knowledge that what you are transferring to a "U.S. PERSON" will be further transferred to a "FOREIGN PERSON".
The EU Export Control Regulation	
Legal References and Space Relevance	- Council Regulation n. 428/2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items - Council Joint Action 2000/401/CFSP concerning the control of technical assistance related to certain military end-uses
Entity in charge	- The individual, global and national general export licenses are issued by member states - EU General Export Authorization is issued by the European Union Commission and is valid throughout the European Union
Definition of export	- Transmission of software or technology by electronic media, including by fax, telephone, electronic mail or any other electronic means to a destination outside the European Community; it includes making available in an electronic form such software and technology to legal and natural persons and partnerships outside the Community. Export also applies to oral transmission of technology when the technology is described over the telephone - Article 161 of Regulation (EEC) No 2913/92 - Including case of re-export - Article 182
The Japanese Export Control Regulation	
Legal References and Space Relevance	-The Foreign Exchange and Foreign Trade Act (locally called "Gaitame-ho") is the only law that states the basic framework and the principles of the control on exports of both arms and dual-use items
Entity in charge	- The Ministry of Economy, Trade and Industry (METI), is the competent authority administering export controls - CISTEC – the Center for Information on Security Trade Control – founded in April 1989, is the only non-profit organization dedicated to the promotion of export controls in Japan.
Definition of export	*Any resident or non-resident who intends to conduct a transaction to provide any technology pertaining to the design, production, or use of specific goods set forth in the Cabinet Order as considered obstructing the maintenance of international peace and security (herein after called "specific technology") in a specific foreign country (hereinafter "specific country"), or any resident who intends to conduct a transaction to provide specific technology to a non-resident of a specific country, shall obtain, pursuant to the provision of the order, permission from the Minister of Economy, Trade and Industry* – Art. 25-1 FEFTA

Table 24: Comparative overview of export control regulation in the USA, the EU and Japan

A potential field for initial cooperation is the introduction of 3D printing into the industrial process for aerospace components. 3D printing is emerging as a popular disruptive technology in the Space industry, where it has potential to reduce spacecraft mass and cut launch costs. Streamlining satellite production with 3D printing elements could lead to lower cycle times and thereby reduce cost. The choice to implement a 3D printer should be made taking into account several factors aside from financial investment, such as training of personnel, use of Space within the complex industrial facilities, and dedicated resources for delivering components up to the standards required for Space-based technologies. In order to spread the burden, the investment should be made through industrial consortiums, whereby different industrial partners can reserve slots of time for using the 3D printer. In addition, in order to make the investment more valuable, the 3D printer can be exploited in order to satisfy the different industrial standards in Europe and Japan, thus ensuring that the investment can immediately serve two industrial clusters, one based in Europe and one in Japan.

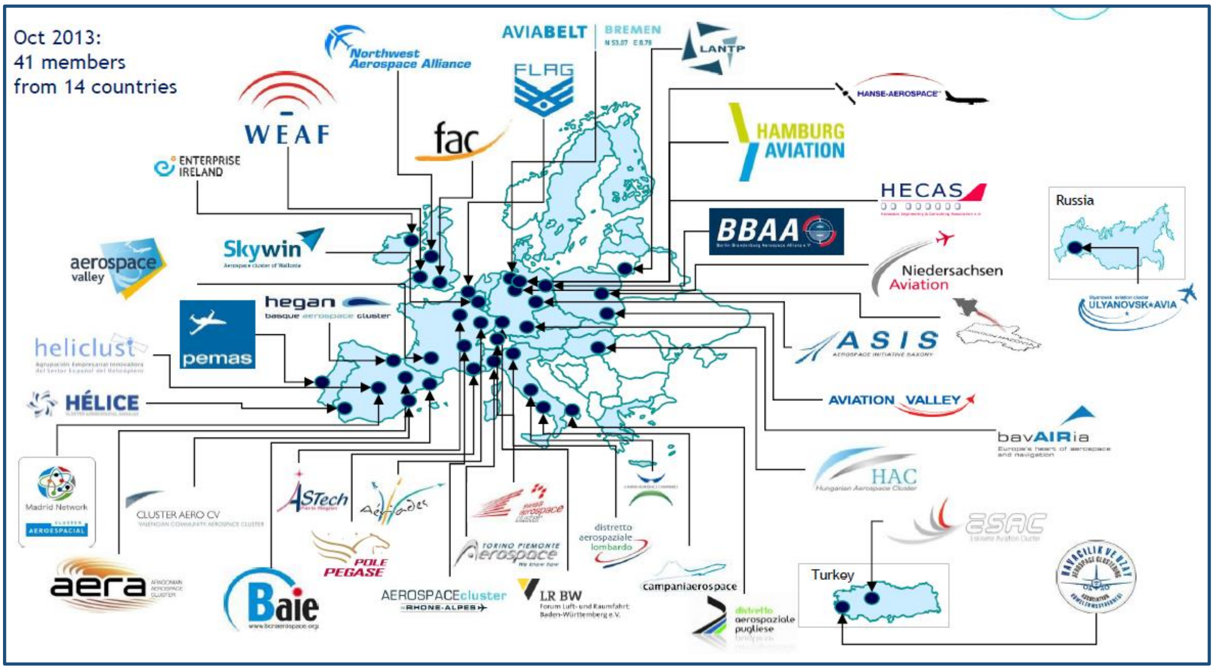

Figure 10: Map of the European aerospace industrial clusters[128]

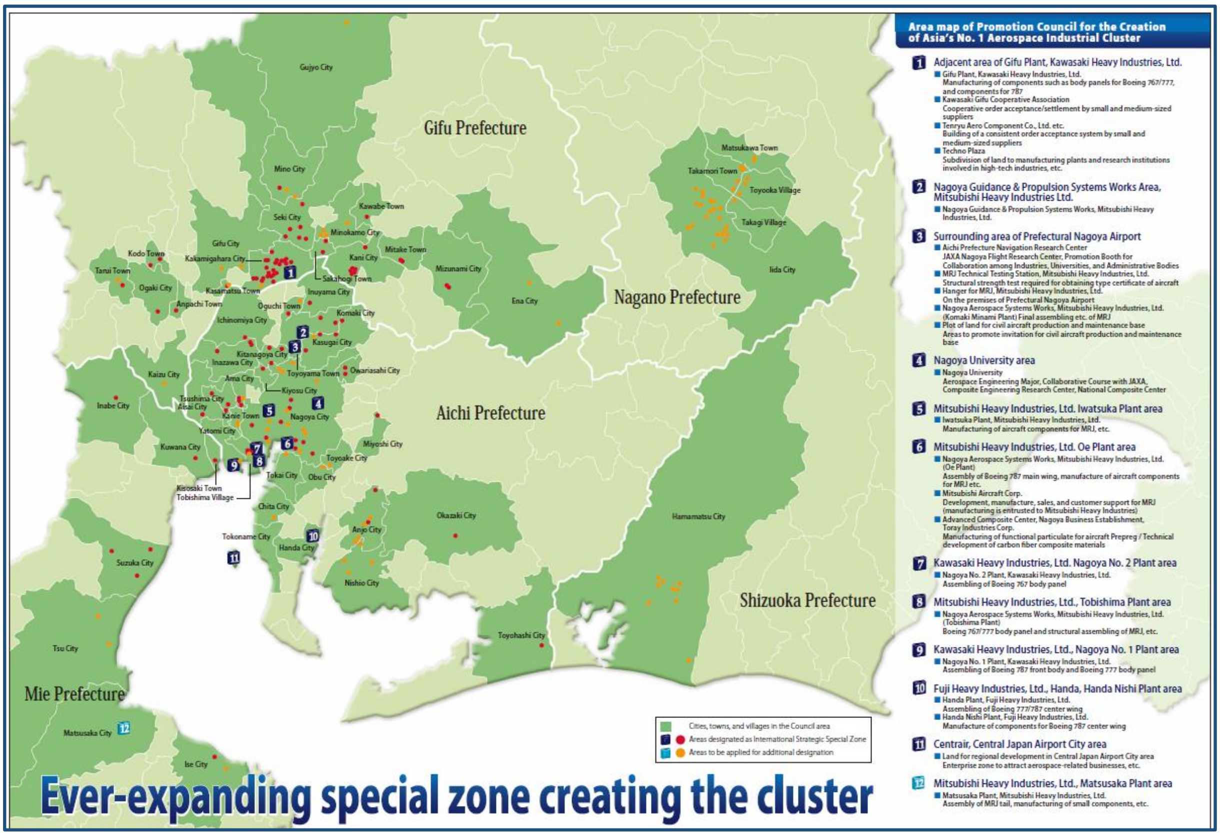

Fig. 11: The aerospace industrial cluster of the Aichi Prefecture, Japan[129]

In the Japanese case, Aichi (in Greater Nagoya) is the regional centre of the aerospace industry[130]. The "big

128 Source: EACP, 2014

129 Source : http://www.pref.aichl.jp/kikaku/sogotokku/

130 The Aichi Industrial Technology Institute provides training to company engineers and technicians on advanced fabrication technology. Aichi provides many incentives to industrial investors, such as direct subsidies for new plants (up to 10% of costs) and R&D laboratories (up to 20% of costs) with 20 employees or more, indirect subsidies (tax rebates up to 10%), fund loan programs and other incentives.

four" Japanese companies (MHI, FHI, IHI, and KHI) are located there, together with some ten research institutes devoted to different technologies involved in aerospace, and almost ten universities.

The cost of a 3D printer can be split between two clusters, one in Europe and one in Japan, and usage can be tested for the two local industrial purposes by sharing usage, for instance on the basis of 6 months per year in each location.

4.4.Downstream applications (SatCom, Earth Observation, SatNav)

The downstream segment has a very different set of drivers, using data (GNSS or earth observation) and infrastructure (satellite communications) for a wide range of services for terrestrial end-users. The major applications that have been developed to date and currently dominate the sector are TV broadcasting (satellite communications), telecommunications infrastructure (satellite communications), maps and satellite imagery (Earth Observation) and satellite navigation (the ubiquitous SatNav). Major international companies dominate these sectors, and while they have seen major growth in the past, future revenues are projected to stagnate as the sectors mature. However, a whole range of new opportunities is opening up and the market is starting to fragment into a plethora of new, niche and bespoke applications. In consumer markets, Google has been expanding services such as Google Earth, while mobile phone software developers are rapidly incorporating SatNav and satellite imaging capabilities into new Apps. As of May 2015, there are over 1800 Apps using satellite capabilities on each of Google Play and the iPhone App Store[131].

A similar picture is emerging in B2B markets. Traditionally dominated by companies selling telecommunications bandwidth (e.g. Inmarsat, Eutelsat, Intelsat) or satellite navigation systems, new markets are now emerging for applications that solve pressing commercial and social problems. Aimed at addressing issues with significant economic value, these new B2B applications are lower in volume, but have a much higher unit value, when compared with consumer applications.

One rapidly developing area in the B2B sector is mixed modality applications (combinations of satellite communications, GNSS, and Earth Observation). A good example is the Intelligent Railways via Integrated Satellite Services (IRISS) project, partially funded by the European Space Agency Integrated Applications Promotion programme (ESA IAP), and led by Nottingham Scientific Ltd. This new capability will allow railway operators to communicate with assets irrespective of location and status, enabling data to be uploaded and offloaded in real time to support decision making processes and to improve the management of operations and incidents. It will generate savings for train operators through energy efficient driving, maintaining timetable performance, enhanced safety and comfort, brand promotion and improved customer satisfaction. New products and applications are also being developed to address national and international issues for governments. The ESA IAP programme, including sustainable water management, remote medical assistance, carbon capture and storage, vegetation monitoring, and demining, is very relevant. A diverse range of potential commercial opportunities has been identified in emerging markets in the fields of Development, Disasters, Energy, Environment, Maritime, Natural Resources, People, Telecommunications, Defence and Security.

To meet these significant commercial and economic opportunities, products and services will need a combination of elements to be successful, including electronics and hardware, software, data, and expertise. In essence, these products work for the user by transforming data through information and knowledge into answers. In order to assess the capacity to exploit the potential market it is worth comparing European and Japanese Space assets related to the three main sectors of satellite communications, Earth Observation and navigation.

[131] Robin Higgons, *Qi3 Insight: Space-Growth Opportunities for Non-Space Companies*, 2015

	SatCom	Earth observation	SatNav
European Union*	- Fleets of satellites owned by private companies in L-, S-, C-, Ku- and Ka-Bands	- Copernicus: the Sentinels and contributing missions [132] boarding Synthetic Aperture Radar (SAR), optical sensors, altimetry systems, radiometers and spectrometers**	- EGNOS: augmentation of US GPS - Galileo
Japan	- Fleets of satellites owned by private companies in C- and Ku-Bands - Wideband InterNetworking engineering test and Demonstration Satellite (WINDS)	- Global Precipitation Measurement/Dual-frequency Precipitation Radar (GPM/DPR) - Global Change Observation Mission - Water "SHIZUKU" (GCOM-W) - Greenhouse gases Observing SATellite "IBUKI" (GOSAT) - "Aqua" Earth Observation Satellite - Tropical Rainfall Measuring Mission (TRMM) - Advanced Land Observing Satellite-2 "DAICHI-2" (ALOS-2) - ASNARO	- MSAS: augmentation of US GPS - QZSS: sustainable systems of US GPS
: including ESA's Space programs** *: Including also private companies as owners of satellites and commercial distributors of data**			

Table 25: European and Japanese orbiting Space assets for SatCom, Earth observation, SatNav

These Space assets enable the development of downstream applications for several purposes. The European and Japanese Space communities both stand to benefit from the market served by these assets. There is now political will supporting the development of downstream applications in the utilization of Space because it provides for an economic return on the initial investments into Space-based systems. In addition, these markets allow SMEs to flourish outside of the Space communities by using their niche competences and know-how to provide end-user solutions. The key advantage of satellite services as a value proposition is uniformity of performance over a wide expanse of operations – coverage footprint – in all conditions. This is a requirement common to the three application domains, thus the recent tendency is for the joint exploitation through integrated applications, such as the items of the ESA ARTES 20 and the emerging synergetic Space utilization promoted in the most recent APRSAF recommendations[133]. Synergetic utilization of Space assets will be realized through European technological expertise, delivering integrated applications under the ESA IAP by combining different types of Space assets to satisfy specific user demands. The developed and tested solutions satisfy almost 110 diversified thematic needs (health, transport, energy, safety and development) with huge market potential in Japan.

Field	Items	Stakeholders	Remarks
Downstream Applications	- Integrated Application or synergetic use of space assets	Dependent on market segment	- Switch towards a B2C approach - ESA IAPs - G-Space × (times) ICT

Table 26: Identified actions for the development of downstream applications

In this regard, European players are in a better commercial position to satisfy user needs in non-Space sectors due to their legacy of ESA integrated applications. Nonetheless, Japan is eager to promote its own capacities in the field of downstream applications. It has recently embarked on a comprehensive and challenging governmental program entitled G-Space × (times) ICT, which aims to revitalize the economy by creating new industries and services, to establish the world's most advanced disaster management systems, and to enhance regional communities through advanced and leading models[134]. Achieving these

[132] ESA, Contributing Missions of Copernicus, 2015. Last access in June 2015 at: https://copernicusdata.esa.int/web/cscda/missions

[133] APRSAF-21, Summary and Recommendations of the 21st Session of the Asia-Pacific Regional Space Agency Forum (APRSAF-21) December 2-5, 2014 Tokyo, Japan; last access in June 2015: https://www.aprsaf.org/annual_meetings/aprsaf21/recommend.php

[134] G-space × ICT promotion council, *bringing novel innovation to our lives by converging G-spatial information and Information Communications Technology*, June 2013. Last access in June 2015 at:

goals requires the utilization of Space assets, especially the QZSS and the US GPS, the wideband satellite as backup for terrestrial telecommunications and satellite images for GIS applications. The following chart displays core activities of involving different technological assets for the development and support of emerging markets.

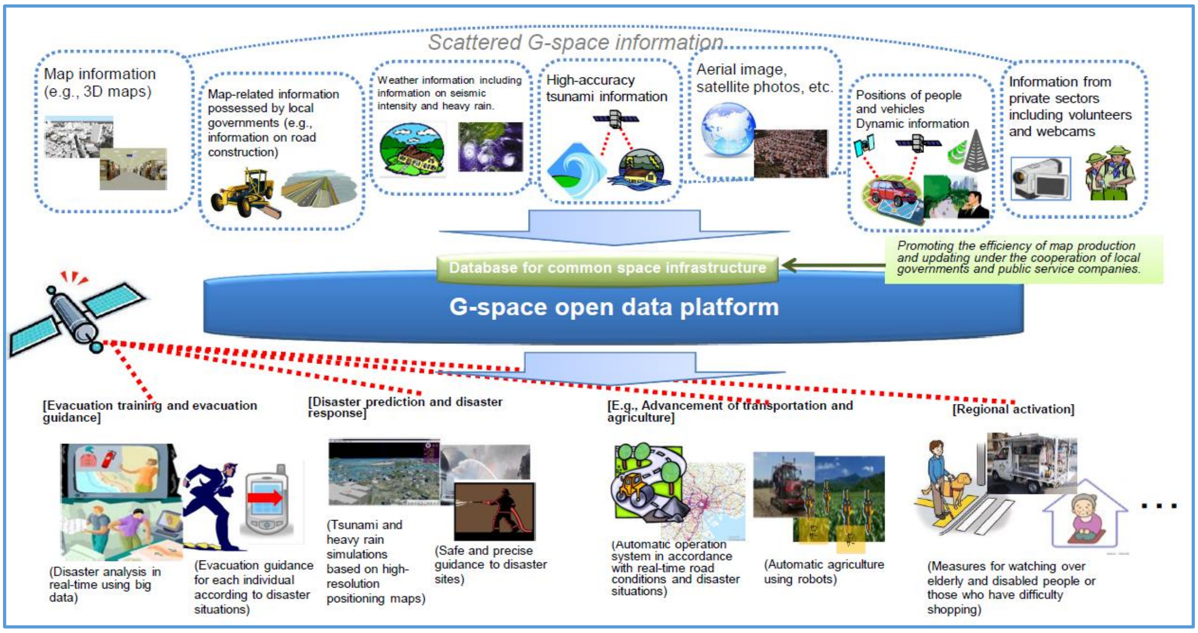

Figure 12: The system architecture of the G-Space × times) ICT[135]

In order to better reach end users, this project is being implemented with the support of regional prefectures. Japanese prefectures make the investment by hosting the initial phases, and from the information-sharing platform, commercial players can then build their own products and services for several purposes, such as using smartphone identification to locate people (valuable in cases of disaster management), smart city and agricultural applications, and intelligent inter-modal transportation. From a policy point of view, the regional prefecture authority attains user requirements. In cases of interest to the European context, the outcomes from the project's prototypes, owned by the prefectures, will be highly valuable for the Network of European Regions Using Space Technologies (NEREUS). In particular, the tracing of people through smartphones is already tested by some Japanese prefectures and will be extended to the international level, even potentially developing into features and standards which may contribute to form a common base.

From the European side, over 100 integrated application projects are already potential commercial solutions, as companies involved have already tested them with identified users. The following list provides potential areas of interest for business development activities from European companies to Japanese customers. Due to the different cultural approach between the two areas, partnerships with local Japanese companies are strategically important for the success of European companies in Japan. The list therefore indicates demonstration projects funded by the ESA, a description of the projects, the pool of European partners and users, but also potential Japanese stakeholders and offers notes on the relevant Japanese market. Additional remarks indicate potentialities in related fields and feasible strategic guidelines for pursuing industrial collaboration. For this purpose only demonstration projects are given as examples of ESA IAPs[136], as they are sufficiently mature to enable commercial development abroad with Japanese partners.

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http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/presentation/pdf/130628_1.pdf

[135] Source: MICT, 2015

[136] ESA –IAP (ARTES 20) is a user driven policy tool that aims to promote Space applications, develop of new operational services for users, gain broader participation by actors on both the demand and supply sides, and to utilize at least two different existing Space-assets such as SatCom, SatEO, SatNav, Human Spaceflight technologies and others. Projects are funded only after a successful application in response to a permanent open

In the case of downstream applications related with ESA, IAPs are a notable enabler for the use of Space technologies in other market segments, such as energy, transportation, security, agriculture, maritime, media and broadcasting. All of these sectors can be served in a more efficient ways through Space assets, e.g. SatCom, Earth Observation and Navigation, because satellites can meet the requirements of spatial and temporal ubiquity and uniformity of performance over a large footprint.

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call. They can be *Feasibility Studies*, which provide the preparatory framework to identify, analyse and define potential new sustainable applications and services within the ARTES 20 IAP programme; and *Demonstration Projects*, dedicated to the implementation of pre-operational demonstration services within the ARTES 20 IAP programme, which thereby comply with the following requirements: they are user driven (including user involvement and contribution), they benefit from the integrated use of multiple Space assets, and they show clear potential to become sustainable in the post project phase.

ESA IAP Project	Description	European Partners	Users	Japanese stakeholders	Japanese Market	Remarks
SURMON: Geophysical Survey and Pipeline Monitoring Services	The key objective of the project is to exploit the Geophysical Survey (GS) and Pipeline Monitoring (PM) services, using remotely piloted aircraft (RPA) flying beyond line of sight, for targeted oil & gas and mining exploration companies as end users.	- Barnard Microsystems Limited - UK - (Prime) - Inmarsat Global Limited (UK) - AnsuR Technologies AS (NW) - Tony Henley Consulting Limited (UK)	- Royal Dutch Shell - Anglo American - BHP Billington	The potential Japanese users are: - INPEX - JAPEX - Nippon Oil - JOGMEC - Idemitsu Oil & Gas Co., Ltd. - Tokyo Gas	Japan contains almost no oil reserves of its own (59 million barrels of proven oil reserves), but it is the world's third largest oil consumer[137].	Efficiency measures are critical for the overall Japanese economy.
INTOGENER: INTegration of EO data and GNSS-R signals for ENERgy applications	Aims at the development and demonstration of a new, operational, water-flow forecast concept, based on the assimilation of near real time measurements of geophysical parameters into a hydrological model.	- Starlab (ES) - FutureWater (NL) - Hispasat (ES)	- Endesa Chile	Potential Japanese stakeholders are: - The Japan Water Agency (regulatory and monitoring agency) - The Federation of Electric Power Companies of Japan - Tokyo Electric Power Company (users) - Tanaka Hydropower Co.	In Japan, the total installed capacity of hydropower as of 1995 is 42,100 MW including 22,300 MW of pumped storage. The number of power stations is about 1800. In the near future, the capacity is expected to expand by 250 MW per year for ordinary hydropower, and 800 MW per year for pumped storage.[138]	Hydropower source is a key source in the current national energy plan.
T4MOD: Remote Assistance for Medical Teams Deployed Abroad	Aims at defining, developing, realizing, qualifying and validating a user-friendly Telemedicine system, through an interoperable IP overlay satellite network associated with an intelligent end-to-end communication platform, capable of supporting different medical specialties.	- Telespazio SpA (IT) - GMV (ES) - ND SatCom (DE) - Covalia (FR) - Dialcom Networks (ES) - DLR (DE)	- Ministries of Defence from France, Germany, Italy and Spain	Potential Japanese stakeholders are: - The Cabinet Secretariat – Civil Protection - The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) - The Ministry of Defence (MoD) - The Japan International Cooperation Agency (JICA) and the International Centre for Water Hazard and Risk Management (ICHARM)	Japan is very prone to natural disasters and is a very large contributor to peacekeeping missions abroad (17 U.N. peacekeeping missions currently abroad).	Japan is also getting closer to NATO, thus if it will be handling the same emerging systems as NATO then it is likely to be interested in this solution, which is already tested in the main NATO European countries.

137 BP Statistical Energy Survey, Japan, 2014

138 IEA Small Hydro, Japan, 2014. Last access in June 2015 at: http://www.small-hydro.com/Participating-Countries/Japan.aspx

ESA IAP Project	Description	European Partners	Users	Japanese stakeholders	Japanese Market	Remarks
TalkingFields: Demonstration Study on Services for Precision Farming	Aims to develop and implement a set of cost-effective end-to-end Precision Farming services for winter wheat, maize and sugar beet that allow the farmer with little effort to adopt a comprehensive site-specific farming system.	- VISTA Geowissenschaftliche Fernerkundung GmbH (DE) - Ludwig-Maximilians-Universität München Department of Geography (DE)	- PC-Agrar GmbH (DE)	Potential Japanese partners are: - Hitachi Zosen Co. - Hitachi, Ltd. - Yanmar Co., Ltd - Topcon Co. - Yamaha Helicopter Co.		
FarmingTruth: Fusion of satellite and ground-based information on soil and crop for optimized crop production	A precision agriculture service that furnishes end users (e.g. farmers, growers, agronomists, agricultural consultants, etc.) with a web-based soil and crop information system to enable the optimisation of land production for increasing yield at reduced input cost.	- Cranfield University (UK) - HITEC Luxembourg S.A. (LX)	- Duck End Farm (UK) - Vindumovergaard (DK) -Douglas Bomford Trust (stakeholder) - Knowledge Centre of Agriculture (stakeholder) - Home Grown Cereal Authority (stakeholder)	Potential Japanese farmers are: - Fujita Seed Co., Ltd - Log House 21 Ltd - Sapporo Chuousuisan Co., Ltd - Shingu Shoko, Ltd - Shalfeieff & Co., Ltd - Apple International Co., Ltd	The market is mainly in the Hokkaido region and the market dynamics are rather complex due to the presence of several family-oriented farming SMEs. The strategic approach is to collaborate locally with the main companies as agriculture service & equipment providers[139].	Almost 20% of the country's land is used for agriculture purposes and it contributes only 1.3% to GDP. Greater efficiency is needed in the sector to raise the productivity of the overall economy[140].
FruitLook: Services to Improve Water Use Efficiency of Vineyards and Deciduous Fruit orchards in South Africa	Aims to promote sustainable and optimal resource utilization, reduce input costs (water, fertilizers, pesticides, labour, and energy), protect the environment, and ultimately increase water use efficiency (WUE) – the production per unit of water – using satellite technologies.	- eLEAF (NL) -University of KwaZulu-Natal (SA) -Department of Agriculture: Western Cape (SA)	- Governmental authorities - Water user organisations - Farmers	Potential Japanese farmers are: - Fujita Seed Co., Ltd - Log House 21 Ltd - Sapporo Chuousuisan Co., Ltd - Shingu Shoko Ltd - Shalfeieff & Co., Ltd - Apple International Co., Ltd		
T4MOD: Remote Assistance for Medical Teams Deployed Abroad	Aims at defining, developing, realizing, qualifying and validating a user-friendly Telemedicine system, through an interoperable IP overlay satellite network associated with an intelligent end-to-end communication platform, capable of supporting different medical specialties.	- Telespazio SpA (IT) - GMV (ES) - ND SatCom (DE) - Covalia (FR) - Dialcom Networks (ES) - DLR (DE)	- Ministries of Defence from France, Germany, Italy and Spain	Potential Japanese stakeholders are: The Cabinet Secretariat – Civil Protection; The Ministry of Land, Infrastructure, Transport and Tourism (MLIT); The Ministry of Defence (MoD) and The Japan International Cooperation Agency (JICA) and the International Centre for Water Hazard and Risk Management (ICHARM).	Japan is very prone to natural disasters and is a very large contributor to peacekeeping missions abroad (17 U.N. peacekeeping missions currently abroad).	Japan is also getting closer to NATO, thus if it will be handling the same emerging systems as NATO then it is likely to be interested in this solution, which is already tested in the main NATO European countries.

139 Nations Encyclopedia, Japan – Agriculture, 2014. Last Access in June 2015 at: http://www.nationsencyclopedia.com/Asia-and-Oceania/Japan-AGRICULTURE.html
140 *Idem supra*

ESA IAP Project	Description	European Partners	Users	Japanese stakeholders	Japanese Market	Remarks
SASISA: Small-Aircraft Service for Instant Situational Awareness	Aims to create hands-on opportunities for winning acceptance and support in emergency and disaster management communities by displaying the capabilities of the system and service.	- Knowledge & Analysis LLP (UK) - Diamond-Executive Aviation Ltd (UK) - Atmosphere GmbH (DE) - ViaSat Inc. (CH) - HITEC Luxembourg S.A. (LX) - Joanneum Research Forschungsgesellschaft mbH (AT)	- Department of Civil Protection and National Defence (Styria, AT) - Department of Fire Service and Civil Protection (Lower Austria) - Emergency.lu (LX) - Ministry of Foreign Affairs (LX)	The Japanese stakeholders are: - Ministry of Foreign Affairs - Cabinet Secretariat Civil Protection - Fire Departments throughout Japan	Japan is very prone to natural disasters, with economic damages reaching almost $US235 billion, and recovery efforts requiring almost $US500 billion[141].	There is a high ratio of at least 1:2 between economic damage and cost of recovery efforts.
VECMAP: Demonstration Project on Services for Mosquito Habitat Mapping	A one-stop shop integrating all the tools needed to produce spatial risk maps from sampling to modelling and data processing and archiving, improving cost effectiveness and providing extensive technical support to users dealing with disease vectors.	- Avia-GIS (BE) - Ergo Ltd. (UK) - MEDES (FR)	- Public Health Users in several countries - Pest control companies and commercial users - Academic users in several countries	Potential Japanese stakeholders are: - main hospitals - health insurance companies	Japan is very prone to vector-borne disease, particularly the *culex*, also known as Japanese encephalitis.	24 countries in the WHO South-East Asia and Western Pacific regions have endemic JE transmission, exposing more than 3 billion people to risks of infection.
Mercury	Aims at a new service that will eliminate medical image security concerns, significantly reduce transfer times; speed up turnaround for clients, reduce on board downtime, increase staff efficiency, reduce the current DNA (Did Not Attend) rate and therefore reduce the cost of screening per woman	-RedFoot Technologies Ltd (UK)	- The British National Health Service	Potential Japanese stakeholders are: - health insurance companies - hospitals - local municipalities - NGOs - social voluntary associations	The Japanese population is an enduring one and the oldest people more often live in peripheral areas where the availability of diagnostics and physicians is reduced.	The business model makes this initiative profitable if there is an optimal use of the equipped medical van.
Amazon	Aims at the development, integration, testing and validation of a tele-assistance service for professional clinical users in remote locations using a highly compact device for vital-sign monitoring and remote diagnosis.	- RTD Ltd. (UK) - International SOS (UK)	- Governments, Military, NGOs, Charities, Mineral and energy companies operate in a multitude of locations	Japanese target customers are corporations and public entities with branches across a variety of locations	There are some Japanese areas with low demographic density where the medical assistance services will be beneficial.	The customer typology demands a typical B2B approach.

[141] Dick K. Nanto et al., Japan’s 2011 Earthquake and Tsunami: Economic Effects and Implications for the United States, Congressional Research Service, 2012

ESA IAP Project	Description	European Partners	Users	Japanese stakeholders	Japanese Market	Remarks
SEMAFORS: Ship Efficiency Monitoring, weAther Forecasting and Optimised Routing Service	Aims to improve ship fuel efficiency by providing the means for better planning, avoiding adverse weather and by making better use of ocean currents.	- BMT ARGOSS Ltd (UK) - University of Reading (UK)	- Vessel Owners/ Operators - Vessel Captains - Charterers - Port Authorities	Potential Japanese stakeholders are: - Japanese Shipowners' Association (includes more than 100 companies) - Ehime Ship Owners - Port Authorities	From the database of the Nippon Kaiji Kyokai, known as ClassNK or NK there are currently 1027 registered ships.	As a nation of islands, Japan has huge potential for this service.
VICOMESTRA	A global mobile solution to stream High Definition (HD) media over satellite for broadcasting quality media to and from regions with insufficient terrestrial infrastructure.	- Quicklink Video Distribution Services Ltd (UK) -Inmarsat Navigation Ventures Ltd (UK)	Users will be located globally and include: - TV Broadcasters - Media operators - Governments -Military organisations -Non-profit organisations	Potential Japanese stakeholders are: - National Association of Commercial Broadcasters (NAB) (Nihon Minkan Hoso Renmei) - Dentsu Co. - Recruit Co.	Japan is the world's second largest media market with a market size of almost US$350 billion[142].	Japanese culture is visually oriented thus high data volume transmission at high quality is a key requirement.
Blue Belt: Space Based AIS complementing Terrestrial AIS Systems	Aims at demonstrating that satellite based services can provide added value as a complement and backup to the terrestrial AIS network, for the provision of services based on this data.	- CLS (FR) - exactEarth Europe (UK) - KSAT (NW) - Luxspace (LX)	- European Maritime Safety Agency (EMSA)	Potential Japanese stakeholders are: MLIT, Japanese Coast Guard, Japan Association of Marine Safety, Tokyo MOU (an inter-governmental co-operative organization on port State control (PSC) in the Asia-Pacific region)		
NG-RMP: Next Generation Recognised Maritime Picture	Aims to implement an automatic decision support system exploiting data captured from multiple data sources to generate a dynamic and improved RMP.	- Skytek (IE) - exactEarth (CA) - Luxspace (LX) - NSC (IE) - University of Cork (IE)	- Irish Naval Services (IE)	The potential Japanese stakeholders are: - MLIT - Japanese Coast Guard - Tokyo MOU for the Asia-Pacific region	Maritime awareness is a key programmatic line of the current Japanese Space Policy in terms of Space assets and utilization.	Due to the geographical position of Japan, with proximity to China and North Korea, AIS is a priority for security purposes.
SAT-AIS DPC: Demonstrator of a Data Processing Centre for Satellite based AIS Services Search form Search	The implemented data centre collects SAT-AIS messages and ancillary information for generating and distributing enhanced data services to the maritime community.	- CLS (FR) - Deimos (PT) - exactEarth Europe (UK) - KSAT (NW) - Norwegian Defence Research Institute (NW) - Spacebel (BE) - TAS (FR)	- European Maritime Safety Agency	The potential Japanese stakeholders are: - MLIT - Japanese Coast Guard - Tokyo MOU for the Asia-Pacific region		

[142] Gerhard Fasol, Japan media analysis report: TV, newspapers advertising, Eurotechnology Report, 2014

ESA IAP Project	Description	European Partners	Users	Japanese stakeholders	Japanese Market	Remarks
SAFEDEM: Space Assets For Enhanced DEMining	Aims at providing a service platform addressing the needs of the Mine Action community to improve and optimize planning and preparation, and to reduce the impact of demining activities.	- e-GEOS (IT) - RadioLabs (IT) - University Sapienza (IT) - MEEO (IT) - Oben (IT) - Vrije Universiteit Brussel (BE) - ÆDEL Aerospace (CH) - Aurea Imaging (BE)	- Bosnia & Herzegovina Mine Action Center - Swiss Foundation for Demining - Agenzia Industrie Difesa (*Italian Defence co.)*	Japanese stakeholders are: - Japan Alliance for Humanitarian Demining Support (JAHDS) - The Ministry of Defense	JAHDS works with many leading companies in various sectors that contribute their own technologies, products, know-how and networks to support activities to remove land mines from former war zones.	Japan leads an international demining programme – Zero Victims – with a multi-year stream of expenditure of $US413 million
FlySafe	A service issuing nowcast and forecast bird-warnings to improve the flight safety of military Air Forces in Northwest Europe.	- KNMI (NL), Institute for Biodiversity and Ecosystem Dynamics - the University of Amsterdam (NL), Belgian Meteorological Institute (BE), Météo-France (FR), SARA (NL), TNO (NL), Robin Radar Systems (NL), TriOpSys (NL), Thales Raytheon Systems (FR),Swiss Ornithological Institute (CH), Institute for Avian Research (DE) and IDA (DE)	Air Forces of The Netherlands, Belgium, France and Germany	Japanese stakeholders are: - MLIT - Ministry of Defense - Airport Regulatory Authorities	Japan reports almost 1900 bird strikes per years with almost 70 damaged aircrafts and potential risks for passengers. The highest number of strikes is in the region of Haneda Airport in Tokyo, which manages a high volume of air traffic for national and international destinations.[143]	NEC has developed a number of solutions for bird strike prevention and mitigation; this system is a complementary one.
XcitID	This service provides a new product providing near-real-time monitoring of temperature, geo-position and timing, of uniquely identified goods travelling along worldwide cold chains, independently from local infrastructure.	- Novacom (FR)	- Sanofi-Aventis (HU) - SVD (FR) - AXA (FR) - UNICEF	Japanese stakeholders are: - Astellas - Takeda - Daiichi Sankyo - Mitsubishi Tanabe - Otsuka - Eisai - Kyowa Hakko Kirin - Dainippon Sumitomo Pharma - Shionogi	The Japan pharmaceutical market is the World's second largest, with 2013 sales estimated at US$115B. Japan accounts for a little less than 10% of the global pharmaceuticals market, compared with 38.4% for the U.S. and 20.7% for Western Europe[144].	The Japanese pharmaceutical industry includes more than 1000 firms of which approximately 20 have annual sales of more than US$500 million.

[143] Tomoya Miyoshi, Bird Strike Control and Reduction in JAPAN, Civil Aviation Bureau (CAB), Ministry of Land, Infrastructure, MLIT, 2014. Last access in June 2015 at: http://www.icao.int/APAC/Meetings/2014%20WildlifeHazard/2014ICAO%20Seminer%28Japan%20Presentation%29.pdf

[144] Industry Report, Healthcare: Japan, The Economist Intelligence Unit, June 2014

ESA IAP Project	Description	European Partners	Users	Japanese stakeholders	Japanese Market	Remarks
3INSAT: Train Integrated Safety Satellite System	Aims to introduce a train monitoring and control system, based on the state of the art European and international regulations, adopting satellite based systems and services.	- Ansaldo STS (IT) - Radiolabs (IT) - A.D.Praha (CZ) - TriaGnoSys (DE) - DLR (DE)	- RFI (IT) - DB Netz (DE)	Rail transport services in Japan are provided by more than 100 private companies, including: - Six Japan Railways Group (JR) regional companies - The nation-wide JR freight company - 16 major regional companies - Dozens of smaller local private railways	There are 27,268 km of rail across the country. Japan's annual number of passenger-kilometres is around 3,939, which is far more than the highest rates in the E.U. and U.S.[145].	The Japanese Hitachi Group has acquired Ansaldo STS. The Japanese rail sector has a very high safety performance, with almost zero fatalities since 1964; thus this is a challenging sector to penetrate.
S²BAS: Demonstration of Space Services Benefits in Aviation Systems	Aims to implement a platform for the provision of an integrated set of satellite-based low-cost services targeted to small and regional airports related to the whole life cycle of a flight.	- Techno Sky (IT) - Nextant (IT) - IDS (IT) - Slamair (IT) - Centro Studi Demetra (IT) - BIP (IT)	- The Italian institution for the management and control of civilian air traffic (ENAV) (IT) - Aircraft Operators - Pilots	Japanese Stakeholders are: - Japan Air Navigation Systems for Overseas Association - Japan Civil Aviation Bureau	Japan is a significant aviation market in terms of passengers (Tokyo is the fourth-ranked international airport for number of passengers) and cargo due its island features.	The penetration of the Japanese aviation market is challenging for EU companies due to the historical presence of US competitors.

Table 27: List of ESA IAP projects with industrial potential in Japan

[145] Yasaburo Hikasa, Railways market and procurement trends- - railway policy-, Railway Bureau, MLIT. Last access in June 2015 at: http://ec.europa.eu/internal_market/publicprocurement/docs/international_access/eu-japan/hikasa_en.pdf

4.5. Spin-offs and Space Technology Transfer Policies

Technology transfer is the process of using technology, expertise, know-how or facilities for a purpose not originally intended by the developing organization. Traditionally, technology transfer was performed at the end of a development programme, but it is now believed that the process should be started much earlier in the development cycle and continue throughout it. This would permit the identification of multi-purpose opportunities as well as the continual enhancement of the technology based on non-Space sector feedback (i.e. real market feedback). It is a fact that the gap has widened between the technologies used for Space applications and the technologies used every day in terrestrial industrial or domestic applications. For instance, the level of technology and computing power embedded in some low-cost consumer products far exceeds what is implemented in today's satellites. Equally, very sophisticated technologies and materials are currently used in many areas such as medicine, automotive engineering, computer gaming, textiles - some of which may have spin-in potential for Space.

There are many dimensions to the term technology transfer; it has often been used to describe the process:

- by which ideas and concepts are moved from the laboratory to marketplace[146];
- of the transfer of knowledge and concepts from developed to less technologically developed countries[147]; and
- of the transfer of incentive activities to secondary users[148].

For current purposes, the last of these three meanings is adopted as the process of transferring technology from Space-based to non-Space applications, including the technical and legal support of Space agencies and the business incubation phase.

In particular, this section explores and describes the related policies in Europe, under ESA, and in Japan, under JAXA. The role of Space technology transfer with successful spin-offs is becoming increasingly relevant in the policy debate, because it enhances the return on investment in Space activities and opens opportunities for collaboration and new markets, which utilize such innovations, as well as improving the competitiveness of small and medium-sized enterprises by providing them with access to advanced technologies.

4.5.1. The Spin-off policy in Europe

The ESA's policy for the Space technology transfer is very comprehensive because it encompasses measures for spin-ins, when terrestrial technologies are adapted for outer Space, and for spin-offs, when Space-based technologies are exploited to meet terrestrial user needs. Transfers of technology from Space to Earth requires a number of adaptations[149], such as supporting the interoperability of technological uses from Space to Earth, building reusability into technology that is no longer intended for one-shot performance in Space missions, and simplification of the technological process in order to make solutions marketable to terrestrial users. Because of the challenge involved in satisfying these three main requirements, some public support is needed to facilitate market entry. In the case of ESA, the spin-off policy brings together a very comprehensive field of action from the business, financial, technical and legal points of view. The following chart displays the four areas of action, consisting of the transfer of Space

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[146] Phillips R., *Technology Business Incubators: How Effective Is Technology Transfer Mechanisms?*, Technology in Society, 24 (3), 2002, 299-316. http://dx.doi.org/10.1016/S0160-791X(02)00010-6
William F., Gibson D. V., *Technology Transfer: A Communication Perspective*, Sage: Beverly Hills, CA, 1990.
[147] Derakhshani S., *Factors affecting success in international transfers of technology — A synthesis, and a test of a new contingency model*, Developing Economies 21, 27–45, 1983; Putranto K., Stewart D., Moore G., *International Technology Transfer of Technology and Distribution of Technology Capabilities: The Case of Railway Development in Indonesia*, Technology in Society, 25 (1), 42-53, 2003, http://dx.doi.org/10.1016/S0160-791X(02)00035-0
[148] Van Gigch J. P., *Applied General Systems Theory*, New York, NY: Harper and Row, 1978.
[149] Tkatchova S., *Space-Based Technologies and Commercialized Development: Economic Implications and Benefits*, IGI Global, 2011

technology, business incubation, intellectual property and investment support. The ESA Technology Transfer Program (TTP) Office is a dedicated ESA department managing these activities.

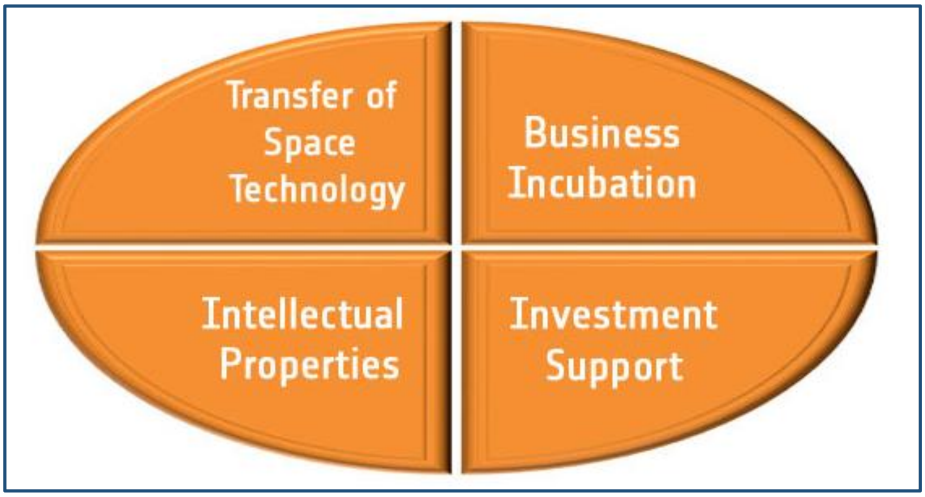

Figure 13: The areas of intervention of the ESA's technology transfer policy[150]

Support for technology transfer is provided in a number of different ways, through:

- the Technology Transfer Network (TTN) and its technology broker companies throughout Europe;
- collaboration with national technology transfer initiatives in ESA Member States;
- a number of TTP business opportunities via open calls for proposals;
- TTPO's Business Incubation Centers;
- a number of Space Solutions initiatives and specific events; and
- making a number of ESA's intellectual properties (patents) available for commercialization.

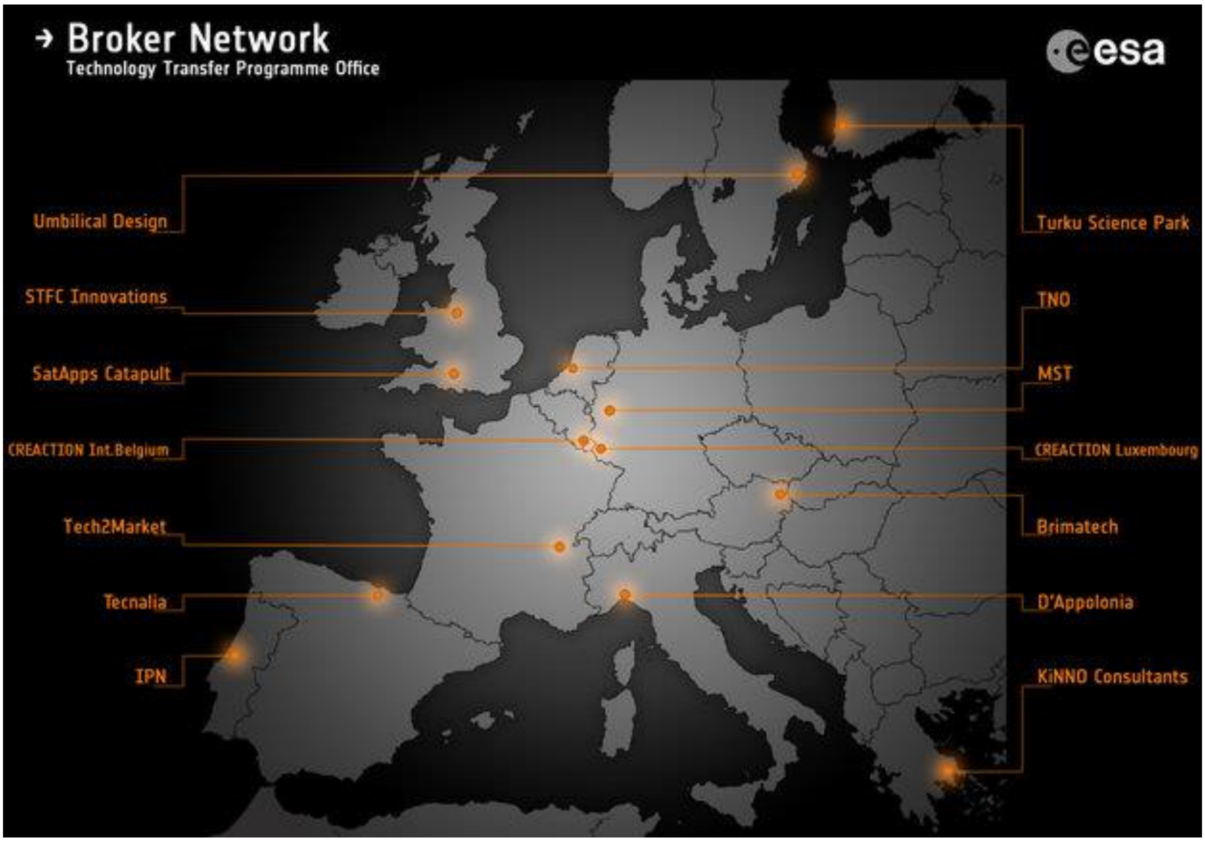

Figure 14: The ESA TTP – Broker Network[151]

[150] Source: © ESA

ESA now has a wide broker network, as displayed in Figure 14, with agreements in place for these broker companies to assess market needs in areas where there is potential for the exploitation of Space technologies. In addition, ESA employs an additional company, MST Aerospace GmbH (DE), because of its specialisations in brokerage and in the provision of technical and commercial expertise for Space technology exploitation. The brokerage initiative has now been in place for almost 20 years and from the beginning has supported spin-in and spin-off processes. The role of brokers is pro-active; they scout potential opportunities available then serve as a bridge between the owner, the related industries, and ESA, which funds the start-up phases and offers a technical coaching service. In 2007, ESA also introduced the Business Incubation Centre (BIC) initiative, where ESA deals with existing business innovation centres in Europe to host start-ups that are exploiting Space-based technologies for terrestrial uses. Recently, the ESA BICs also began to help incubate start-up companies delivering spin-offs and integrated applications to the market: it is open to discussion if there is a difference between Space utilization and spin-offs. The following Figure 15 shows the BICs located throughout Europe.

Figure 15: The TTP ESA's network of Business Incubation Centres[152]

The network is also growing with the recent establishment of an ESA BIC in Sweden. In order to become incubated the start-up team applies to the local BIC where a joint committee with local stakeholders and ESA representatives evaluate the technological ideas and the market potential of the development within a period of two years. There is a common framework binding the BICs concerning relations with ESA, and at the same time there could also be additional benefits arising from local stakeholders. The following list in

[151] Source: © ESA
[152] Source: © ESA

ESA BIC	Start-up	Technological field of origin	Technological field of destination
Noordwijk (NL)	BlackShore: Cerberus game, e-learning and crowd-sourcing to enrich Mars satellite images	Mars Exploration	Entertainment
Noordwijk (NL)	iOpener: Racing game to compete real-time against professional drivers in actual live races	GNSS downstream	Entertainment
Noordwijk (NL)	Space Synapse: the vision to communicate the experience of space travel by inventing products and events that allow people on Earth to enjoy the experience of being in Space	Space Flight	Entertainment
Noordwijk (NL)	Carbon Diem (Carbon Hero): The smartphone is used as sensor and computer to measure your carbon footprints. Company web portal collects and aggregates individual carbon profiles, providing immediacy to enterprise emissions reporting	GNSS downstream	Environment
Noordwijk (NL)	Coltratech: Insulation panels for environmentally-friendly containers for road and sea freight	Space-based hardware	Environment
Noordwijk (NL)	Giaura: Generate CO2 by capturing it directly from the atmosphere for several usages, e.g. plants, drinks, etc.	International Space Station	Environment
Noordwijk (NL)	LeoSphere: Lidar system to measure pollution and wind speed	ESA Mission: Aeolus Earth Explorer Atmospheric Dynamics Mission	Environment
Noordwijk (NL)	MetaSensing: SAR data acquisition imaging services	ESA Missions with Synthetic Aperture Radar (SAR)	Environment
Noordwijk (NL)	Miramap: Monitoring of dykes, using Space-based sensor technology	ESA Mission with Passive Microwave Radiometry (PMR)	Environment
Noordwijk (NL)	Novimet SARL: Measurement system for rainfall	ESA Missions with Synthetic Aperture Radar (SAR)	Environment
Noordwijk (NL)	Star2Earth: Measurement system for coastal tide measurements (Oceanpal)	GNSS downstream	Environment
Noordwijk (NL)	Active Space Technologies: Intelligent clothing for continuous personal climate control	International Space Station	Health
Noordwijk (NL)	Bradford Instruments: Sterilization device for dentists' tools	International Space Station	Health
Noordwijk (NL)	DiSAPS (INTECS, Italy): Guiding-system for blind people	GNSS downstream	Health
Noordwijk (NL)	Emxys: Biomedical shirts with built-in instruments combined with GNSS location	GNSS downstream	Health
Noordwijk (NL)	HISTAR Solutions: Early-warning malaria system using satellite Earth Observation and ground sensors	Earth Observation downstream	Health
Noordwijk (NL)	Ipotuba: Transport system for frozen tissue samples	International Space Station	Health
ESA BIC	**Start-up**	**Technological field of origin**	**Technological field of destination**
Noordwijk (NL)	Mathcomp Medical Systems: Ultrasound Breast Cancer Treatment	International Space Station	Health

	Device: ActiveFU		
Noordwijk (NL)	Selene Baby Care Innovations: Preventive monitor for Sudden Infant Death Syndrome (BabyGuard)	GNSS downstream	Health
Noordwijk (NL)	MDUSpace: Automatic docking system to simplify car manufacturing plants	International Space Station	Industry
Noordwijk (NL)	Space Colour Systems: High speed camera system to digitally identify colours	Earth Observation sensors	Industry
Noordwijk (NL)	AC Sport/PROrace: Innovative pedalling system using a new crankset	International Space Station	Life style
Noordwijk (NL)	bliin BV: a mobile and online social network that enables users to share location-based content, and community and commercial services (bliin YourLIVE)	GNSS and Earth Observation downstream	Life style
Noordwijk (NL)	Mobzili: Location based advertising solution	Earth Observation and GNSS downstream	Life style
Noordwijk (NL)	Solar Sailor: Development of a solar/wind energy based boat	Space-based components	Life style
Noordwijk (NL)	Agribase: Services for farmers	GNSS downstream	Localization Based Services
Noordwijk (NL)	CityNavigators: Navigation devices for foreign visitors in EU cities	GNSS downstream	Localization Based Services
Noordwijk (NL)	Insiteo: Indoor navigation solutions for museums and large fair facilities	GNSS downstream	Localization Based Services
Noordwijk (NL)	EATOPS: Monitor and control software to pilot complex processes in offshore installations	Ground segment of Space-based system	Software solutions
Noordwijk (NL)	J-CDS BV (Jaqar spin-off): New concurrent design software and services	Ground segment of Space-based system	Software solutions
Noordwijk (NL)	EstrellaSat: Broadband communication for heavy equipment monitoring and control	SatCom	VAS - SatCom
Noordwijk (NL)	SATMOS: Satellite telecommunication service for remote surveillance and data acquisition	SatCom	VAS - SatCom
Noordwijk (NL)	ezCol: Cholesterol reduction bacteria for pets food (Melissa spin off)	International Space Station	Food
Noordwijk (NL)	IP Star: Service for the use of Melissa-based technologies. Melissa is a bio-recycling system to help sustain people in remote areas.	International Space Station	Life style
Darmstadt (DE)	ALL4IP Technologies: location based services in the field of electromobility	GNSS downstream	Localization Based Services
ESA BIC	**Start-up**	**Technological field of origin**	**Technological field of destination**
Darmstadt (DE)	ANLU Navigation: Real-time multipath determination and reduction	Space antenna and GNSS	Industry
Darmstadt (DE)	Benjamin: Fluid logistics management for industrial products storage, handling and manufacturing	Space-based technology	Industry
Darmstadt (DE)	Convinum: Internet-based platform for businesses and consumers in the wine industry	Earth Observation downstream	Life style
Darmstadt (DE)	etamax space: Satellite navigation for flood monitoring	GNSS downstream	Environment
Darmstadt (DE)	Electronic Machines: skimming prevention for Automatic Teller	Space-based materials	Industry

	Machines (ATMs)		
Darmstadt (DE)	Flinc: Social mobility network	GNSS downstream	Localization Based Services
Darmstadt (DE)	INTEND Geoinformatik: Mobile GIS for the forest industry	Earth Observation downstream	Life style
Darmstadt (DE)	IP-Wetter: Local weather forecast for mobile phones	Earth Observation downstream	Environment
Darmstadt (DE)	IPAYMO: Data from multi-GNSS constellations for localization	GNSS downstream	Localization Based Services
Darmstadt (DE)	LatitudeN: Intelligent mobile solutions for tourism	GNSS downstream	Localization Based Services
Darmstadt (DE)	MAVinci: Micro air vehicles for acquisition of aerial images and orthophotos	SatCom and Earth Observation downstream	Environment
Darmstadt (DE)	Mobile Life: Networked multi-sensory system	GNSS downstream	Localization Based Services
Darmstadt (DE)	PosiTim: High precision positioning due to multi-GNSS signals	GNSS downstream	Localization Based Services
Darmstadt (DE)	PunchByte: Satellite navigation and remote monitoring	Earth Observation and GNSS downstream	Environment
Darmstadt (DE)	Samango: Common interface for geo-information	Earth Observation downstream	Environment
Darmstadt (DE)	SOCRATEC Telematic: Positioning of airfreight	GNSS downstream	Localization Based Services
Darmstadt (DE)	Solenix GmbH: indoor navigation	GNSS downstream	Localization Based Services
Darmstadt (DE)	Wer denkt Was: Digital civic participation	GNSS downstream	Localization Based Services
Darmstadt (DE)	Wo ist Wer 24: Real time positioning via internet and mobile phone	GNSS downstream	Localization Based Services
Rome (IT)	Blue Thread: Navigation solutions for nautical sector, based on navigation satellite technology	GNSS downstream	Localization Based Services
Rome (IT)	B-Open Solutions: Geospatial data management and related data standardisation and interoperability	GNSS downstream	Industry
Rome (IT)	CarFleet: Device for remote real time diagnostic of car engine status and failure	GNSS Equipment	Localization Based Services
Rome (IT)	FS-a: Use fluid mechanics methods to improve the understanding of the environment	Earth Observation and GNSS downstream	Environment
ESA BIC	**Start-up**	**Technological field of origin**	**Technological field of destination**
Rome (IT)	Galilean Plus: Identification and classification of features and infrastructures in urban and rural areas (Merged with ESRI IT)	Earth Observation downstream	Environment
Rome (IT)	Geosystems Group: Monitoring station for real time check between satellite data and in situ data	Earth Observation downstream	Environment
Rome (IT)	NHAZCA: Monitoring of geological risks in construction and infrastructure using terrestrial SAR	Earth Observation downstream	Environment
Rome (IT)	Raptech: Wireless sensor network for monitoring of photovoltaic systems	Space components	Industry
Rome (IT)	Wixta: Heat generation and water treatment with "hydrodynamic cavitation" technology	Space-based subsystem	Industry

Gilching (DE)	AEVO: Products and services for the intelligent optimization of computer models, targeted to efficiency improvements of real problems.	Space-based subsystem	Industry
Gilching (DE)	Agrista: Transparent standardized global system to reduce risks and costs of investing in agricultural production in emerging economies	Earth Observation and GNSS downstream	Industry
Gilching (DE)	ANAVS: Galileo and GPS multi-frequency differential carrier phase receiver systems providing centimetre-level accuracy	GNSS receivers	Localization Based Services
Gilching (DE)	ATMOSPHERE: Providing pre-flight weather data via the GSM mobile network, to be extended with satellite connectivity for in-flight services	Earth Observation and GNSS downstream	Industry
Gilching (DE)	avionTek: System to assist general aviation pilots in landing safely on small and poorly equipped fields under bad weather and low visibility	Earth Observation and GNSS downstream	Industry
Gilching (DE)	Modelon: Computer simulation of multi-physical technical systems, especially focused on electric and hybrid cars	Space-based subsystems	Industry
Gilching (DE)	nogago: Mobile phone software to combine information relevant to the user's position and deliver according to users' needs	GNSS downstream	Localization Based Services
Gilching (DE)	PiMON: Fiber optic based pipeline monitoring technology for real time incident detection and pinpoint localization	Earth Observation and GNSS downstream	Industry
Gilching (DE)	progenoX: Develops unmanned vehicle systems and services for fire-fighters and emergency services in disaster situations	Space based robotics	Industry
Gilching (DE)	SARMORE: From SAR data generates carbon storage and biomass estimation for tropical forests, glacier movement, urban and mining areas	Earth Observation and GNSS downstream	Industry

ESA BIC	**Start-up**	**Technological field of origin**	**Technological field of destination**
Gilching (DE)	SemsoTec: ReadMe Series using innovative and new display technology in combination with biometrics and satellite positioning	GNSS downstream	Industry
Gilching (DE)	SportsCurve: a real-time GNSS-based tracking and tracing platform	GNSS downstream	Localization Based Services
Gilching (DE)	TANKERING.com: Advanced flight performance optimization methods to reduce aircraft fuel consumption and cost	SatCom and GNSS downstream	Industry
Gilching (DE)	Tiramizoo: Online booking platform for local same-day couriers, with route planner for faster delivery	GNSS downstream	Industry
Gilching (DE)	Treems: Forest protection by a market based solution where anyone can buy existing protected trees and participate in saving our world	Earth Observation downstream	Environment

Gilching (DE)	ViaLight Communication: Laser data transmission between unmanned aerial vehicles, aircraft and high altitude platforms, and to the ground	Space-based payload (LASER)	Industry
Harwell (UK)	Insect Research Systems Ltd: technology for monitoring bed bugs in hotel rooms for the near-real time detection of their diagnostic chemical signatures.	ESA Mission ROSETTA	Health
Harwell (UK)	Geospatial Insight: launching CopperWatch, an innovative product using a range of EO data sources to monitor the status of the copper supply chain	Earth Observation	Industry
Harwell (UK)	Mapskey: using GPS and smartphone technology to produce intelligent personalized itineraries of activities or goods and services	GNSS downstream	Industry
Harwell (UK)	Rescon: researches, develops and delivers human performance technologies and services to help individuals, populations and communities to be better and at their best	GNSS downstream	Health
Harwell (UK)	Cornerstone Oxford conducts venture research and innovation, developing products and services that incorporate advanced engineering and computer technologies from Space, science and technology sectors	Space-based sensors	Industry
Harwell (UK)	S&AO provides products and services based around atmospheric observations using methods based on radio waves and light such as cloud radars, radar wind profilers and light radars (lidars)	Earth Observation downstream	Environment
ESA BIC	**Start-up**	**Technological field of origin**	**Technological field of destination**
Harwell (UK)	Democrata: using the powerful analytics of the Hartree Centre to automate environmental impact assessments and better predict risk	Earth Observation downstream	Environment
Harwell (UK)	Oxiway – MeVitae: the first-ever cognitive recruitment agency that makes intelligent and personalised hiring decisions, acting as a recruiter's sixth sense	Space-based sensors for pattern recognition	Industry
Harwell (UK)	Electric Wonderland is working on the creation of an innovative and comprehensive gig searching app known as Gigbug	GNSS downstream	Entertainment
Harwell (UK)	Esplorio: travel start-up, who through mobile application technology aim to provide an easy way for people to record, relive and share their travels	GNSS downstream	Localization Based Services
Harwell (UK)	IPF Africa: the seeCrop app to allow farmers in southern Africa to monitor their crops for damage using satellite imagery	Earth Observation and GNSS downstream	Industry
Geel (BE)	Navtronics: Applications to track items	Earth Observation and	Industry

	in logistics and for safety, as well as in health care, e.g. tracking of people with dementia	GNSS downstream

Table 28 presents the start-ups incubated at ESA BICs, presented by technological field of origin and technological field of destination. In these cases a Space-based technology initially developed for the upstream of Space-based systems (satellite, launch, International Space Station and deep Space mission) is exploited for new purposes such as the environment, health, industrial chains, life style, localization based services, software and telecommunications. The technological field of origin most fruitful for start-ups is related to the Space utilization, thus most of the start-ups are exploiting Space assets for services provision in telecommunications, Earth Observation and navigation services. This is followed by the upstream segment, from which sensors, robotics and systems architectures inspire new business ideas. In terms of the field of destination, these start-ups contribute to solving problems mostly related with non-Space industrial value chains, e.g. logistic issues and the thermal management of assets. Innovative ideas also improve the management of several environmental concerns, e.g. polluting emissions, nowcasting and near-real time information for decision support, monitoring of renewable resources, etc. All of these new technologies have the potential to help raise quality of life and spur economic growth, notwithstanding their role in justifying public expenditure on Space affairs for which there is no security purpose.

ESA BIC	Start-up	Technological field of origin	Technological field of destination
Noordwijk (NL)	BlackShore: Cerberus game, e-learning and crowd-sourcing to enrich Mars satellite images	Mars Exploration	Entertainment
Noordwijk (NL)	iOpener: Racing game to compete real-time against professional drivers in actual live races	GNSS downstream	Entertainment
Noordwijk (NL)	Space Synapse: the vision to communicate the experience of space travel by inventing products and events that allow people on Earth to enjoy the experience of being in Space	Space Flight	Entertainment
Noordwijk (NL)	Carbon Diem (Carbon Hero): The smartphone is used as sensor and computer to measure your carbon footprints. Company web portal collects and aggregates individual carbon profiles, providing immediacy to enterprise emissions reporting	GNSS downstream	Environment
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Noordwijk (NL)	Giaura: Generate CO2 by capturing it directly from the atmosphere for several usages, e.g. plants, drinks, etc.	International Space Station	Environment
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ESA BIC	Start-up	Technological field of origin	Technological field of destination
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Noordwijk (NL)	Selene Baby Care Innovations: Preventive monitor for Sudden Infant Death Syndrome (BabyGuard)	GNSS downstream	Health
Noordwijk (NL)	MDUSpace: Automatic docking system to simplify car manufacturing plants	International Space Station	Industry
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Noordwijk (NL)	AC Sport/PROrace: Innovative pedalling system using a new crankset	International Space Station	Life style
Noordwijk (NL)	bliin BV: a mobile and online social network that enables users to share location-based content, and community and commercial services (bliin YourLIVE)	GNSS and Earth Observation downstream	Life style
Noordwijk (NL)	Mobzili: Location based advertising solution	Earth Observation and GNSS downstream	Life style
Noordwijk (NL)	Solar Sailor: Development of a solar/wind energy based boat	Space-based components	Life style
Noordwijk (NL)	Agribase: Services for farmers	GNSS downstream	Localization Based Services
Noordwijk (NL)	CityNavigators: Navigation devices for foreign visitors in EU cities	GNSS downstream	Localization Based Services
Noordwijk (NL)	Insiteo: Indoor navigation solutions for museums and large fair facilities	GNSS downstream	Localization Based Services
Noordwijk (NL)	EATOPS: Monitor and control software to pilot complex processes in offshore installations	Ground segment of Space-based system	Software solutions
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Noordwijk (NL)	IP Star: Service for the use of Melissa-based technologies. Melissa is a bio-recycling system to help sustain people in remote areas.	International Space Station	Life style
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ESA BIC	Start-up	Technological field of origin	Technological field of destination
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Darmstadt (DE)	Benjamin: Fluid logistics management for industrial products storage, handling and manufacturing	Space-based technology	Industry
Darmstadt (DE)	Convinum: Internet-based platform for businesses and consumers in the wine industry	Earth Observation downstream	Life style
Darmstadt (DE)	etamax space: Satellite navigation for flood monitoring	GNSS downstream	Environment
Darmstadt (DE)	Electronic Machines: skimming prevention for Automatic Teller Machines (ATMs)	Space-based materials	Industry
Darmstadt (DE)	Flinc: Social mobility network	GNSS downstream	Localization Based Services
Darmstadt (DE)	INTEND Geoinformatik: Mobile GIS for the forest industry	Earth Observation downstream	Life style
Darmstadt (DE)	IP-Wetter: Local weather forecast for mobile phones	Earth Observation downstream	Environment
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Darmstadt (DE)	PosiTim: High precision positioning due to multi-GNSS signals	GNSS downstream	Localization Based Services
Darmstadt (DE)	PunchByte: Satellite navigation and remote monitoring	Earth Observation and GNSS downstream	Environment
Darmstadt (DE)	Samango: Common interface for geo-information	Earth Observation downstream	Environment
Darmstadt (DE)	SOCRATEC Telematic: Positioning of airfreight	GNSS downstream	Localization Based Services
Darmstadt (DE)	Solenix GmbH: indoor navigation	GNSS downstream	Localization Based Services
Darmstadt (DE)	Wer denkt Was: Digital civic participation	GNSS downstream	Localization Based Services
Darmstadt (DE)	Wo ist Wer 24: Real time positioning via internet and mobile phone	GNSS downstream	Localization Based Services
Rome (IT)	Blue Thread: Navigation solutions for nautical sector, based on navigation satellite technology	GNSS downstream	Localization Based Services
Rome (IT)	B-Open Solutions: Geospatial data management and related data standardisation and interoperability	GNSS downstream	Industry
Rome (IT)	CarFleet: Device for remote real time diagnostic of car engine status and failure	GNSS Equipment	Localization Based Services
Rome (IT)	FS-a: Use fluid mechanics methods to improve the understanding of the environment	Earth Observation and GNSS downstream	Environment

ESA BIC	Start-up	Technological field of origin	Technological field of destination
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Rome (IT)	Geosystems Group: Monitoring station for real time check between satellite data and in situ data	Earth Observation downstream	Environment
Rome (IT)	NHAZCA: Monitoring of geological risks in construction and infrastructure using terrestrial SAR	Earth Observation downstream	Environment
Rome (IT)	Raptech: Wireless sensor network for monitoring of photovoltaic systems	Space components	Industry
Rome (IT)	Wixta: Heat generation and water treatment with "hydrodynamic cavitation" technology	Space-based subsystem	Industry
Gilching (DE)	AEVO: Products and services for the intelligent optimization of computer models, targeted to efficiency improvements of real problems.	Space-based subsystem	Industry
Gilching (DE)	Agrista: Transparent standardized global system to reduce risks and costs of investing in agricultural production in emerging economies	Earth Observation and GNSS downstream	Industry
Gilching (DE)	ANAVS: Galileo and GPS multi-frequency differential carrier phase receiver systems providing centimetre-level accuracy	GNSS receivers	Localization Based Services
Gilching (DE)	ATMOSPHERE: Providing pre-flight weather data via the GSM mobile network, to be extended with satellite connectivity for in-flight services	Earth Observation and GNSS downstream	Industry
Gilching (DE)	avionTek: System to assist general aviation pilots in landing safely on small and poorly equipped fields under bad weather and low visibility	Earth Observation and GNSS downstream	Industry
Gilching (DE)	Modelon: Computer simulation of multi-physical technical systems, especially focused on electric and hybrid cars	Space-based subsystems	Industry
Gilching (DE)	nogago: Mobile phone software to combine information relevant to the user's position and deliver according to users' needs	GNSS downstream	Localization Based Services
Gilching (DE)	PiMON: Fiber optic based pipeline monitoring technology for real time incident detection and pinpoint localization	Earth Observation and GNSS downstream	Industry
Gilching (DE)	progenoX: Develops unmanned vehicle systems and services for fire-fighters and emergency services in disaster situations	Space based robotics	Industry
Gilching (DE)	SARMORE: From SAR data generates carbon storage and biomass estimation for tropical forests, glacier movement, urban and mining areas	Earth Observation and GNSS downstream	Industry

ESA BIC	Start-up	Technological field of origin	Technological field of destination
Gilching (DE)	SemsoTec: ReadMe Series using innovative and new display technology in combination with biometrics and satellite positioning	GNSS downstream	Industry
Gilching (DE)	SportsCurve: a real-time GNSS-based tracking and tracing platform	GNSS downstream	Localization Based Services
Gilching (DE)	TANKERING.com: Advanced flight performance optimization methods to reduce aircraft fuel consumption and cost	SatCom and GNSS downstream	Industry
Gilching (DE)	Tiramizoo: Online booking platform for local same-day couriers, with route planner for faster delivery	GNSS downstream	Industry
Gilching (DE)	Treems: Forest protection by a market based solution where anyone can buy existing protected trees and participate in saving our world	Earth Observation downstream	Environment
Gilching (DE)	ViaLight Communication: Laser data transmission between unmanned aerial vehicles, aircraft and high altitude platforms, and to the ground	Space-based payload (LASER)	Industry
Harwell (UK)	Insect Research Systems Ltd: technology for monitoring bed bugs in hotel rooms for the near-real time detection of their diagnostic chemical signatures.	ESA Mission ROSETTA	Health
Harwell (UK)	Geospatial Insight: launching CopperWatch, an innovative product using a range of EO data sources to monitor the status of the copper supply chain	Earth Observation	Industry
Harwell (UK)	Mapskey: using GPS and smartphone technology to produce intelligent personalized itineraries of activities or goods and services	GNSS downstream	Industry
Harwell (UK)	Rescon: researches, develops and delivers human performance technologies and services to help individuals, populations and communities to be better and at their best	GNSS downstream	Health
Harwell (UK)	Cornerstone Oxford conducts venture research and innovation, developing products and services that incorporate advanced engineering and computer technologies from Space, science and technology sectors	Space-based sensors	Industry
Harwell (UK)	S&AO provides products and services based around atmospheric observations using methods based on radio waves and light such as cloud radars, radar wind profilers and light radars (lidars)	Earth Observation downstream	Environment

ESA BIC	Start-up	Technological field of origin	Technological field of destination
Harwell (UK)	Democrata: using the powerful analytics of the Hartree Centre to automate environmental impact assessments and better predict risk	Earth Observation downstream	Environment
Harwell (UK)	Oxiway – MeVitae: the first-ever cognitive recruitment agency that makes intelligent and personalised hiring decisions, acting as a recruiter's sixth sense	Space-based sensors for pattern recognition	Industry
Harwell (UK)	Electric Wonderland is working on the creation of an innovative and comprehensive gig searching app known as Gigbug	GNSS downstream	Entertainment
Harwell (UK)	Esplorio: travel start-up, who through mobile application technology aim to provide an easy way for people to record, relive and share their travels	GNSS downstream	Localization Based Services
Harwell (UK)	IPF Africa: the seeCrop app to allow farmers in southern Africa to monitor their crops for damage using satellite imagery	Earth Observation and GNSS downstream	Industry
Geel (BE)	Navtronics: Applications to track items in logistics and for safety, as well as in health care, e.g. tracking of people with dementia	Earth Observation and GNSS downstream	Industry

Table 28: ESA BICs' incubated projects sorted by technological field of origin and destination [153]

[153] The list comes from the publicly available database retrievable from web at (last access in June 2015): http://www.esa.int/Our_Activities/Space_Engineering_Technology/Business_Incubation/ESA_Business_Incubation_Centres12

4.5.2. The Spin-off policy in Japan

JAXA's main strategic goal through supporting spin-offs is to enhance the national industrial system by developing access, exploration and navigation programs, while a complementary activity is the development, through technology transfer programs, of civilian applications with SatCom, Earth Observation and navigation elements. JAXA has a well-organized structure for research and for the design of missions and Space instruments: in addition, joint initiatives have been launched with universities, public and private research centres and the chain of suppliers. These ventures are a result of the close relationships JAXA has developed with METI and the recent involvement of the Japan Science and Technology Agency, which is in charge of supporting R&D from academia to industry. JAXA is also trying to energize the Japanese economy by creating and making use of its own Intellectual Property (IP). The role of the Technology Transfer Program is to mitigate risks and development problems for private companies by promoting practical applications drawing upon JAXA's IP. Through this program, JAXA helps private companies with the research and development of commercial products[154]. JAXA has also classified the various types of spin-off[155] according to whether they are JAXA's own patents (granted under license) or technologies that belong to other companies. The following list encompasses cases labelled under this classification scheme as A, B, C and D:

A. Spin-offs transferred from JAXA's technology and based on license agreements;
B. Spin-offs transferred from JAXA's technology but not based on license agreements (paper publication, etc.);
C. Spin-offs transferred from technology shared between JAXA and commercial firms and then implemented by other firms, and
D. Spin-offs transferred from Space technology owned by Japanese firms.

The list in Table 26 also indicates the field of destination, the original technical segment, and the commercial company leading the commercialisation. JAXA does not have a dedicated program of business incubation centres; incubation is handled directly by the particular industry that is commercially exploiting Space-based technologies.

In the case of Japan, Space utilization is a less powerful driver of technology transfer; the main source of innovation comes from upstream (Space missions, sensors on board of outer Space objects and the ISS), followed by launching technologies inspiring joint IP ventures between JAXA and commercial firms (Type D).

[154] JAXA, Industrial Collaboration Department. Jaxa's activities for spin-off (2006). Last access in June 2015 at: http://www.oosa.unvienna.org/pdf/pres/copuos2006/08.pdf

[155] JAXA. Spin-off cases of Space technology in Japan (2009). Last access in June 2015 at: http://repository.tksc.jaxa.jp/dr/prc/japan/contents/AA0064302000/64302000.pdf

Type	Spin-off	Field of origin	Field of destination	Commercial company
A	Water Renewal Technology for Space Water Purification System	ISS	Contribution to living	New Median Tech Corporation.
B	Structural Design Technology for Space Engineering – Diamond Cut can	ISS	Contribution to living	Kirin Brewery Co., Ltd, Toyo Seikan Kaisha, Ltd.
B	Material technology for Space Plane – Functionally Graded Material	Space materials	Contribution to living	Mizuno Corporation, Citizen Holdings Co., Ltd.
B	Deployment Technology of Solar Array Paddle in Space – Miura Fold (Map)	Space-based system	Contribution to living	Orupa Co., Ltd.
D	Image Analysis Technology Associated with Optical Sensor for Earth Observation Satellites – Sugar Content Sensor for Fruits	Earth observation satellite JERS-1	Contribution to living	Mitsui Smelting and Mining Co., Ltd.
D	Rose on-board Space Shuttle Discovery - Perfume of Smell of Rose Blossomed in Space	ISS	Contribution to living	Shisheido Co., Ltd.
A	Sensor for X-ray Astronomical Satellite – Realisation of Next Generation radiation imager used for security checks in Airports	Space-based system	Contribution to Safety and Security	Acrorad Co., Ltd.
D	Basic Material of Rocket Nozzle and Heat Resistance – Fire proof Screen and Fire extinguishing Cloth	Launching technology	Contribution to Safety and Security	Nippon Muki Co., Ltd.
D	Pyrotechnic Technology to Ignite Solid Motors – Initiator Technology for Gas Generator of Air Bag	Launching technology	Contribution to Safety and Security	IHI Aerospace Co., Ltd, Nissan Motor Co., Ltd.
C	Spectro-Polariradiometer for Earth Environment Observation – Road Surface Freezing Monitoring System	Earth Observation satellite	Contribution to Safety and Security	Yokogawa Bridge Corp.
B	Blast Simulation Programme at Rocket Launch –Design of Lead Vehicle of 500-Serise Nozomi, Linear Motor Car	Launching technologies	Contribution to Safety and Security	Railway Technical Research Institute, Central Japan Railway Company.
D	Technology on Flexible Joint of Rocket – Laminated Rubber Bearing for Seismic Isolation for Construction	Launching technologies	Contribution to Safety and Security	Bridgestone Corp.
D	OmniDirectional Camera for Monitoring of Solar Array on board ADEOS-II Monitoring Camera on Ground	Space-based system	Contribution to Safety and Security	Mitsubishi Electric Co., Nagasaki Ryoden Technica Co., Ltd.
A	Network Security of Super Computers –Internal Security Protection Management System	Ground segment	Contribution to Safety and Security	Seer Insight Security Inc.
A	Recovery Technology on Sea of Stratosphere Platform Airship – GPS-Based Wave Measuring System	GNSS downstream	Contribution to Safety and Security	Zeni Lite Buoy Co., Ltd.
A	Combustor Technology for Aircraft Engine – Dioxin Reduction Device/Burned Ash Detoxifying Device	Space-based technologies	Contribution to Environmental Issues	Materials and Energy Research Institute Tokyo (MERIT), Ltd.
A	Combustor Technology for Aircraft Engine – High-Performance Detoxifying Burner for manufacturing of Liquid Crystal Panel	Space-based technologies	Contribution to Environmental Issues	Koganei Tex Co., Ltd.
A	Thermal Insulation Material of Rocket Fairing – Coating-Type Thermal Insulation Material for Buildings	Launching technologies	Contribution to Environmental Issues	Nissin-Sangyo Co.
A	Processing technology for Organic Waste in Space – Waste processing Facility (Animal Manure)	ISS	Contribution to Environmental Issues	Tokyo Koatsu Co.
C	Power Generation system for Space (Stirling Engine) – Low-Pollution High Efficiency Power Generation System	Launching technologies	Contribution to Environmental Issues	Matsushita Electric Industrial Co., Ltd.

Type	Spin-off	Field of origin	Field of destination	Commercial company
A, C	Jet Engine for Aircraft – Low-Pollution Gas Turbine for Power Generation	Space value chain	Contribution to Environmental Issues	Niigata Power Systems Co., Ltd.
A	Protein Crystal Creation Equipment in the International Space Station – Crystal Creation Experimental Equipment and Service for Dual-Use in Ground and Space	ISS	Contribution to Medical Service and Welfare	Confocal Science Inc.
A	Sensors for X-ray Astronomical Satellite – Realization of precise Gamma-Ray Sensor for Medical Service and Security	Space-based system	Contribution to Medical Service and Welfare	Howa Sangyo Co., Ltd.
D	Special Optical Filter Technology for Satellites – Surgery Microscope Capable in Identifying Cancer Cells	Space-based system	Contribution to Medical Service and Welfare	Mitaka Kohki Co., Ltd.
D	Optical Instrument Technology for Satellites – High-Resolution Stereoscopic microscope for Surgery	Infrared astronomical satellite ASTRO-F	Contribution to Medical Service and Welfare	Mitaka Kohki Co., Ltd.
D	Balancing Technology of Camera Driving System for X-ray Doppler Telescope on-board Satellite – Medical Microscope/Stand	Solar Observation satellite SOLAR – A	Contribution to Medical Service and Welfare	Mitaka Kohki Co., Ltd.
A	Numerical Simulation Technology/ Visualisation Technology – Medical Image Processing System	Ground segment	Contribution to Medical Service and Welfare	SGI Japan, Ltd.
A	Cell Culture System to be on board the International Space Station – Cell Culture System for Medical Research	ISS	Contribution to Medical Service and Welfare	Chiyoda Advanced Solutions Corp.
A, C	Design and Analysis Supporting System for Electronics Equipment on board Satellites – Solution for Embedded Software in the Ubiquitous Society	Space-based system (mission design)	Contribution to Industry	InterDesign Technology Co., Ltd.
A	Next Generation Network Standard for Space Vehicle – Micro Network	Space-based system	Contribution to Industry	Shimafuji Electric Ltd.
B	Space Semiconductor Chip (SOI) – Applications to Electronic Equipment in Commercial Sector	Space-based system	Contribution to Industry	Mitsubishi Heavy Industries, Ltd. Oki Electric Industry Co., Ltd.
A	SSPS (Space Solar Power System) – Solar Light and Heat Combined Power Generation System	Space-based system	Contribution to Industry	Ryokushu Co., Ltd.
D	Precise Coordinate Measurement Technology for Stars by Telescope – Precise Measurement of Camera Lens Mounted on Mobile Phone	Space-based system	Contribution to Industry	Mitaka Kohki Co., Ltd.
B	Large Capacity Condenser on board MUSES-C – Toy, Digital Camera and Liquid Crystal Projector	Space-based system (HAYABUSA)	Contribution to Industry	ELNA Co., Ltd.
A	Space Power Generation System (Stirling Engine) – Stirling Engine Kit for Educational Material	Launching technologies	Contribution to Education, Hobby and Entertainment	Concept Plus Corporation
A, C	Minute Space Debris Detection Technology – Star Detection Kit for Amateur Astronomer	Ground segment	Contribution to Education, Hobby and Entertainment	AstroArts Inc.
A	Bio-Filter for Experiment in Space – Bio-Filter for Tropical Fish Aquarium Purification Material	ISS	Contribution to Education, Hobby and Entertainment	AES Co., Ltd.
D	Planetary Orbital Data – Fishing Result Prediction Program	Launching technologies	Contribution to Education, Hobby and Entertainment	NOI Co., Ltd.

Table 29: The list of JAXA's spin-offs[156]

[156] The mentioned spin-offs come from the publicly available JAXA directory retrievable from the web at: http://aerospacebiz.jaxa.jp/en/spinoff/

Field	Items	Stakeholders	Remarks
Spin-offs	- Joint ISS Experiments	JAXA & ESA	IPR Strategy

Table 30: Identified actions pursuing EU – Japan industrial cooperation for the development of spin-offs

In conclusion, both the EU and Japan and are striving to increase socio-economic returns from their Space investment, and a favourable policy supporting spin-off development is a valuable tool for pursuing this objective. The two regions present different approaches, with licensing agreements between the Space agency and firms leading the spin-offs in the Japanese case, and the Business Incubation Centre program in the case of the EU. The JAXA approach is less market oriented in addressing the challenges related to market entry, and is appealing to large corporations as they already know how to penetrate the market and are large enough to handle unsuccessful outcomes. In contrast, the ESA BIC program promotes newcomers to the market in order to increase competitiveness and thus represents a more open market approach. Joint action between the ESA and JAXA should consider IP policy and related strategies for licensing to commercial firms; this would be mutually beneficial in boosting the economic returns from the very large investments both sides make every year into the ISS.

4.6. Future challenges

Space always draws upon future visions, e.g. reaching Mars, human Space exploration, improving the understanding of the Cosmos, interstellar routes, etc. In order to keep a group of visionary people involved it is crucial to establish a landscape where people can debate, compare their approaches, share their achievements and failures to build new awareness for the future. Recently, the Prefecture of Okinawa announced the launch of an opportunity to exploit the island's resources for economic growth. In response, the Spaceport Asia Consortium[157] applied with a proposal to use the abandoned Shimojishima Airport to build a unique university campus for Space capacity building programs. The venture has the shape of a Public-Private-Partnership following a scheme of "Design, Build, Operate and Use". The initial public investment will become profitable with the establishment of six business types: parabolic flight, a flight school, a test launch pad, a Space school, an incubation centre and suborbital spaceflight. The idea is to bring people concerned with Space together for training and technology testing purposes. In addition, due to its location on a tourist island, it is expected to enhance the tourism industry by inducing people interested in Space to visit the venue as part of their holidays.

Field	Items	Stakeholders	Remarks
Future Challenges	- Okinawa Space Port	Investors, Tourist operators, Education managers and Technology demonstrators	Cash flow risks

Table 31: Identified actions pursuing EU – Japan industrial cooperation for meeting future challenges

The idea could be welcomed by European companies interested in pursuing their visions about Space, for instance Space Innovations[158] from the Czech Republic and Space Synapse[159] from The Netherlands. Companies such as these could bring content and ideas to the Spaceport Asia Consortium. Nevertheless, this interesting idea is in need of investors to bridge the future vision with daily management of cash flow. The Japanese finance world is not very responsive to advanced futuristic visions; so financial investors from Europe can take the floor. On the other hand, Japanese policy makers are very trustworthy; so if Okinawa funds the start-up phase this will establish a secure framework for private investors.

[157] The proposal was presented at the APRSAF-21 Annual Meeting in Tokyo on 3 December 2014 in the New Cooperation Session (last access in June 2015):
http://www.aprsaf.org/annual_meetings/aprsaf21/pdf/program/NewCooperation_Agenda.pdf

[158] Space Innovations, http://www.spaceinnovations.net/about

[159] Space Synapse, http://www.earthrider.eu/spaceSynapse/

5. The International Dimension

Space and international relations are interrelated; it is therefore important to examine how the two parties, the EU and Japan, are shaping their international relations and diplomacy in the field of Space. Japan is a sovereign state recognised within the international community, while the EU is a supranational entity with a diplomatic vocation. This section presents the "Space Diplomacy" of both the EU and Japan.

5.1. Japan "Space Diplomacy"

The Japanese Space industry has faced a number of obstacles in relation to export, due to binding national regulations not permitting the provision of Space-based technologies to certain countries in the Asia Pacific and beyond. Since World War II, and specifically under the Japanese Diet of 1967[160] and the Super 301 trade Agreement on Satellite Procurement of 1990[161], Japanese corporations have been subject to regulatory constraints on business expansion, which have made the commercial Space industry unprofitable and pushed allies to encourage the government to develop military Space projects. Japanese Space diplomacy is now making a comprehensive effort to create favourable conditions for the Space industry both in and outside of the Asia Pacific region.

JAXA and MEXT have an active leadership role in Space capacity building initiatives for the utilisation of satellite imagery for disaster management (Sentinel – Asia), GNSS initiatives (multi-GNSS Asia) strategically endorsing the use of QZSS among other navigation systems, and the exploitation of the Japanese module KIBO on the ISS under the APRSAF. METI and the Cabinet Office are directly promoting industry exports, coordinating their actions with MOFA, which supports the economic and political integration dimension within the Association of Southeast Asian Nations (ASEAN). In addition, JICA is supporting capacity-building programs in Asia.

International entity	Initial	Footprint	Approach
APRSAF	1993	~ 25 States	Promoting Space utilization (MEXT & JAXA)
ASEAN	1967	10 States	Supporting Space capacity (MOFA)

Table 32: The multilateral forums where Japan promotes its Space affairs

The APRSAF is an open forum to which each Space agency can join in order to share its programs, best practices and any new or emerging challenges and concerns. It was established in 1993 by the Japanese MEXT and JAXA in response to the declaration adopted by the Asia-Pacific International Space Year Conference (APIC) in 1992. The APRSAF secretariat is based in Tokyo and provided by JAXA. APRSAF holds an annual forum gathering representatives from Space agencies and international organisations in the Asia Pacific region, to exchange information on national Space programmes and Space resources, to discuss possibilities for future cooperation amongst Space technology developers and Space technology users in the region, and to consider cooperation with Space agencies and organisations outside of the Asia Pacific that support APRSAF objectives.

APRSAF has four organised working groups:

1. The Space Applications Working Group, which integrates the applied areas of the former Earth Observation Working Group and parts of the Communications Satellite Applications Working Group;
2. The Space Technology Working Group, established from the Communications Satellite Applications Working Group in response to the national need for space technology development;

[160] It banned arms' exports, including some aerospace good and services, to communist bloc countries, countries subject to arms exports embargo under the UN Security Council resolutions, and countries involved in or likely to be involved in international conflicts. Japan's Policies on the Control of Arms Exports: http://www.mofa.go.jp/policy/un/disarmament/policy/ (Last access in June 015)

[161] It prevents Japan from protecting commercial satellite procurements from foreign competition. This agreement opened Japanese markets to US satellite manufacturers and blunted the ability of Japanese manufacturers to gain international market share. US – Japan Trade conflicts: super conductors and Super 301: https://www.press.umich.edu/pdf/0472113585-ch5.pdf (Last access in June 015)

3. The Space Environment Utilisation Working Group; and
4. The Space Education Working Group.

The most recent APRSAF session was the 21st Asia-Pacific Regional Space Agency Forum (APRSAF-21) held in December 2014 in Tokyo under the theme "Leap to the next stage: delivering innovative ideas and solutions". The session was attended by 580 participants from 33 countries[162] from the Asia Pacific region and outside (e.g. France, UK, USA, UAE), along with 12 regional and international organisations (e.g. ESA, UNCOPUOS, IAF, GEO, Asian Development Bank). About 100 Japanese representatives were present, from JAXA, MEXT, METI, Japanese industry (NEC, MELCO, JAMSS, etc.) and universities.

The main APRSAF activities are as follows:

- The first activity, initiated by APRSAF in 2005, is Sentinel Asia. Sentinel Asia involves a growing number of players (95 organisations from 25 countries) and has established a disaster management support system in which Space and disaster management agencies are collaborating with each other. Sentinel Asia was created following the World Conference on Disaster Reduction in 2005 Kobe held just after the Tsunami, and operations began in October 2006. It is a regional replication of the International Charter for Space and Major Disasters, of which Japan is also a member. Japan is using both Sentinel Asia and the International Charter for capacity building targeted at Asia Pacific countries. Sentinel Asia is a voluntary, 'best-effort-basis' activity. The initiative was met with enthusiasm by Asia Pacific countries keen to improve the services of the Sentinel Asia platform and to use Earth observation satellites from the region. Sentinel Asia is currently enhancing activities in the prevention and recovery phases of natural disasters. There is an agreement between the International Charter and Sentinel Asia to use both initiatives when needed.
- UNIFORM is a new initiative aiming to train engineers and develop microsatellites for Earth observation applications in service of the region's needs in this area. JAXA, KARI, ISRO, VAST, GISTDA, LAPAN and ANGKASA are all involved in this new initiative, which is coordinated by the University of Wakayama and MEXT. UNIFORM-1 (a 50kg microsatellite) was launched in May 2014 along with JAXA's ALOS-2 Earth observation satellite and is used for forest fire applications.
- SAFE (Sentinel Asia for Environment) was initiated in 2009 to use Earth observation data not only for disasters but also for environmental monitoring, in particular to assess the impact of climate change in the Asia Pacific region. JAXA organised a 6th SAFE workshop in Malaysia in April 2014 and has launched 6 new pilot projects, for example with the Mekong River Commission, the Indonesian Ministry of Agriculture and Bangladesh's local government Engineering Department. A total of 14 pilot projects have already been concluded, mainly with the area's less developed regions or countries. The main objective is to expand cooperation with relevant user organisations and development aid agencies (such as the Asian Development Bank in Manila).
- Climate R3 (Regional Readiness Review for Key Climate Missions) is another initiative launched by Australia in 2011, which aims at promoting and coordinating satellite data needs and applications for climate monitoring in the Asia Pacific region through dedicated workshops and research activities.
- KIBO-ABC (Regional Beneficial Collaboration through Kibo utilisation) is focused on facilitating microgravity experiments using the Japanese Experiment Module "Kibo" on board the ISS, and the implementation of a plant growth observation study via workshops (e.g. Space Seeds for Asian Future conducted in 2015, Asian Herb in Space, etc.) mainly with ANGKASA and LAPAN with the support of JAXA. A Kibo Utilisation Office for Asia (KUOA) has been created for this and facilitates access to microgravity facilities like drop towers and Zero G flights.

The Space Applications Working Group addresses various Space application areas in support of societal issues within the Asia Pacific region through the use of Space capabilities (Earth observation, telecommunications and navigation) and ground segment activities (e.g. cloud computing, data cube) via

[162] The most currently active States represented in the APRSAF are: Australia (Department of Industry: DOI), India India (Indian Space Research Organization: ISRO), Indonesia (National Institute of Aeronautics and Space: LAPAN), Japan (JAXA), Kazakhstan (Aerospace Committee: KAZCOSMOS), Malaysia (National Space Agency: ANGKASA), Mongolia (Information Communications Technology and Post Authority: ICTPA), Pakistan (National Space Agency: SUPARCO), the Philippines (Department of Science and Technology: DOST), Republic of Korea (Korea Aerospace Research Institute: KARI), Singapore (Centre for Remote Imaging, Sensing and Processing: CRISP), the United Arab Emirates (Emirates Institution for Advanced Science and Technology: EIAST), and Vietnam (Vietnam Academy of Science and Technology: VAST).

cooperation among Space agencies, user government agencies, development aid agencies and the Japanese private sector. It also encourages joint activities with the Japan International Cooperation Agency (JICA) and the Asian Development Bank. Further cooperation takes place in the context of the GEOSS Asia Pacific Symposia organised by Japan since 2007 and partnerships with international organisations such as UN-ESCAP and ASEAN.

The Space Technology Working Group focuses on small satellite development and on other areas such as Space operations, ground facilities, engineering management and advanced technologies. It has discussed the importance of Space debris issues from the perspective of the long-term sustainability of Space activities and encouraged information exchange on mitigation technologies. It has also been interested in a range of other topics, such as GNSS and payload technologies for science missions. JAXA, KARI and ISRO are the main contributors to this Working Group, which is also used by Japanese industry to promote its products and services.

Another international multilateral forum in which Japan is playing a leading role is the Association of Southeast Asian Nations (ASEAN). ASEAN and Japan first established informal dialogue relations in 1973, which was later formalised in March 1977 with the convening of the ASEAN-Japan Forum. Since then, significant progress has been made in ASEAN-Japan relations and cooperation in the areas of political security, economics and finance, and society and culture. The signing of the "Tokyo Declaration for the Dynamic and Enduring ASEAN-Japan Partnership in the New Millennium" together with the "ASEAN-Japan Plan of Action" (ASEAN-Japan POA) at the ASEAN-Japan Commemorative Summit, held in December 2003 in Tokyo, have contributed to the strengthening of relations between the two sides.

The Association of Southeast Asian Nations (ASEAN) was established by the ASEAN Declaration of 8 August 1967. The mandate for ASEAN cooperation in science and technology can be found in the ASEAN Declaration, which states that ASEAN shall "promote active collaboration and mutual assistance on matters of common interest in the economic, social, cultural, technical, scientific and administrative fields [and] … provide assistance to each other in the form of training and research facilities in the educational, professional, technical and administrative spheres".[163] Sub-committees, established across all of the major programme areas, are responsible for the management, coordination, evaluation and implementation of regional programmes and projects. The sub-committees are also entrusted to review on-going projects under their purview, and assess the effectiveness and impact of their projects in strengthening regional science and technology capabilities. Currently, ASEAN has a Sub-Committee on Space Technology and Applications (SCOSA), which has as its main objectives to formulate the framework for enhancing collaboration in Space technology and its applications and to implement programmes and projects towards operationalization of these technologies for sustainable development in the ASEAN region. All ASEAN member countries[164] are represented in SCOSA and each country appoints one focal point for coordination purposes. Chairmanship rotates among ASEAN member countries in line with current ASEAN procedures and practices. SCOSA meets annually at the occasion of the ASEAN Science and Technology Week; it is through this mechanism that ESA may form a relation to these focal points. The source of funding for activities to be implemented by SCOSA is voluntary contributions by ASEAN member countries.

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[163] ASEAN, The Asean Declaration (Bangkok Declaration) Bangkok, 8 August 1967. Last Access in June 2015 at: http://www.asean.org/news/item/the-asean-declaration-bangkok-declaration

[164] The ASEAN Member States are Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. Then ASEAN established dialogue with Australia, Canada, EU, India, Japan, Republic of Korea, New Zealand, USA, United Nations Development Programme and Pakistan. The EU – ASEAN cooperation was formalised at the 10th ASEAN Foreign Ministers Meeting (AMM), held on 5-8 July 1977, which agreed on ASEAN's formal cooperation and relationship with the European Economic Community (EEC), including the Council of Ministers of the EEC, the Permanent Representative of the EEC countries and the EEC Commission. ASEAN-EU dialogue relations were the institutionalised with the signing of the ASEAN-EEC Cooperation Agreement on 7 March 1980. Dialogue relations have since rapidly grown and expanded to cover a wide range of areas including political and security, economics and trade, social and cultural matters, and development cooperation. ASEAN-EU dialogue relations are guided by the Nuremberg Declaration for an EU-ASEAN Enhanced Partnership, which was adopted in 2007. The Declaration sets out a long-term vision and commitment by both sides to work together into the future towards common goals and objectives. They cooperate in the fields of politics and security, economics, and society and culture.

Additionally, assistance may also be sought from partners, donor countries, financial institutions and international agencies. SCOSA invites non-ASEAN participants when necessary, and ESA has been invited and approached in the past to fund specific activities and to share its expertise (mainly in remote sensing) through training courses. ASEAN nations are in particular seeking partners in altimetry and radar expertise as well as for marine applications. ASEAN manages two relevant centres of interest: the ASEAN Specialised Meteorological Centre (ASMC) and the ASEAN Earthquake Information Centre (AEIC).

Apart from these two entities where Japan is playing a leading role promoting its Space activities, the most significant regional space mechanisms and organisations in the Asia Pacific region are as follows: the Regional Space Applications Programme for Sustainable Development (RESAP) from the United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP)[165], the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTE-AP)[166] of the United Nations-Office of Outer Space Applications (UN-OOSA) and the South Asian Association for Regional Cooperation (SAARC)[167], both led by India, and the Asia Pacific Space Cooperation Organisation (APSCO)[168], led by China.

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[165] The Space Applications Programme of the United Nations Economic and Social Commission for Asia and the Pacific is a regional mechanism with 20 agencies in the Asia Pacific region in addition to other international agencies. Information/communications technologies and disaster management are the two main fields of interest to this entity. The Regional Space Applications Programme for Sustainable Development (RESAP) is giving support to its member states in the Asia Pacific region on satellite telecommunications (with ITU support) and on capacity development for Earth Observation in the field of disaster management. The first session of the committee on disaster risk reduction took place at UN-ESCAP in March 2009. A framework for cooperation between UN-ESCAP and JAXA on Sentinel Asia (through a partnership making use of the Asia Pacific Regional Space Agency Forum) has been operational since 2006 to promote this Earth observation mechanism and integrate telecommunication satellites (e.g. WINDS from JAXA) for environment, climate change, water resource management in the framework of disaster management. The ESA has been approached about prospects for participation in some of the initiatives in the Asia Pacific region under the UN-ESCAP umbrella (e.g. participation in the next Ministerial meeting on Space Applications, participation in RESAP projects, etc.).

[166] In response to the UN General Assembly Resolution 45/72, dated 11 December 1990 and endorsing the recommendations of UNISPACE-82, the United Nations Office of Outer Space Affairs (UN-OOSA) prepared a project document envisaging the establishment of Centres for Space Science and Technology Education in developing countries. India was chosen to host the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTE-AP). The Centre was established in India on 1 November 1995 under an agreement signed initially by 10 countries of the region. Today, the Indian Department of Space (DOS) hosts this Centre and it has made available appropriate facilities and expertise through the Indian Institute of Remote Sensing (IIRS) and through the Indian Space Research Organisation's Space Applications Centre (SAC) and Physical Research Laboratory (PRL). The goal of the centre is to develop, through in-depth training, indigenous capability for research and applications in the core disciplines of: remote sensing and Geographic Information Systems, satellite communications, satellite meteorology and global climate, Space and atmospheric sciences and data management. The programme is intended to result in the development and growth of capacities that will enhance knowledge, understanding, and practical experience of member countries in these areas. The regular participants of CSSTEAP include the Republic of Korea, Democratic People's Republic of China, Mongolia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, India, Nepal, Sri Lanka, Kazakhstan, Kyrgyzstan, Turkmenistan, and Nauru.

[167] The South Asian Association for Regional Cooperation (SAARC) was established in 1985. This organization has a key focus on economic and developmental issues. SAARC has eight members: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. Additionally, there are some nations with observer status, including the United States, Australia, Japan, and China. Myanmar also has the status of an observer, but is keen to become a full member. Over the years, SAARC has evolved various areas of cooperation, and science and technology is one such area of interest. They have developed a cooperation mechanism that includes areas like environment, energy, education, and media. In the area of science and technology cooperation, SAARC established a Meteorological Research Centre (SMRC) in 1995, and undertakes collective research in meteorology in the SAARC region. It has a modern and advanced observing system with a reliable and timely communications network. Also, there is a network for regional cooperation on subjects like hydrology, oceanography, seismology, and atmospheric science; obviously, such networks rely on satellite-derived data. Rong Du, *Space Cooperation in Asia: a Mystery*, IAC-14.E3.1.4, Montreal, Canada, 2014.

[168] Three Asia Pacific countries, namely China, Pakistan and Thailand, signed a Memorandum of Understanding (MoU) in February 1992 to create the Asia-Pacific Multilateral Cooperation in Space Technology and Applications (AP-MCSTA). Under the aegis of the AP-MCSTA, a first workshop was organised in Beijing in

5.2. The European "Space Diplomacy"

The emerging role of the European Union is relevant also in expressing its legal personality within the international community. Through customary behaviours, third countries are continuously recognising the EU as a new actor with whom to make agreements and form binding pacts. The ESP is guided by two political principles: the necessity for Europe to be strategically independent, and to hold on to the possibility for autonomous decision-making[169]. The EU therefore wants to operate as an actor in its own right, independent from its member states, and taking direct initiatives with other countries.

At present, the EU has established seven Space dialogues, with the USA, Russia, China, South Africa, Africa, Japan, and Brazil. The European Commission through the EEAS is currently leading the Space dialogues, which include ESA as a member of the delegation, benefiting from its long tradition of scientific and technological cooperation with third countries. In addition, particular topics require coordination with other European entities, appointed on an ad hoc basis.

Case	Summit	Space Dialogue	Approach
Africa[170]	2000	2000	Promoting downstream
Brazil[171]	2007	2010	Promoting downstream

December 1992 joined by 120 government officials, decision-makers, experts and scholars from 16 countries including Australia, China, Pakistan, India, Indonesia, Japan, Republic of Korea, Thailand and other Asia-Pacific countries and international organisations. In order to expand and intensify cooperation in Space activities in the region, seven conferences of the AP-MCSTA were organised between 1994 and 2003 in Thailand, Pakistan, Korea, Bahrain, Iran, China and Thailand respectively. The participants attending the 6th conference held in Beijing in 2003 unanimously recommended to speed up the process of institutionalisation of a regional cooperation mechanism.
On 28 October 2005, the Asia Pacific Space Cooperation Organization (APSCO) Convention was signed and the inauguration ceremony was held in December 2008. At present, APSCO has eight Member States (namely Bangladesh, China, Iran, Mongolia, Pakistan, Peru, Thailand and Turkey) and one Signatory State (Indonesia). The Headquarters of APSCO are located in Beijing, using buildings and equipment donated by People's Republic of China. From 2009 to 2011, under the leadership of the APSCO Council and through five ministerial-level Council meetings, the Secretariat of APSCO has improved its internal administration, pushed forward cooperative programmes among member states in the area of Space applications, Space technology, Space science, education/training, and organised international symposia.
Today APSCO is composed of a Secretariat General appointed by the APSCO Council for 5 years and of a secretariat that consists of four departments namely the Department of External Relations and Legal Affairs, the Department of Strategic Plan and Program Management, the Department of Education and Training and Database Management and the Department of Administration and Finance. APSCO has approved a Development Plan, which focuses on four fields: (1) a Data Sharing Service Platform (DSSP) for remote sensing data sharing and Earth observation applications development, (2) the Applied High Resolution Satellite Project (APRS) aiming at the development of two optical remote sensing satellites, (3) research and development for future telecommunications by satellite, and (4) the Asia Pacific Optical Satellite Observation System (APOSOS) regarding a possible optical network to track objects and space debris in orbit. Rong Du, *Space Cooperation in Asia: a Mystery*, IAC-14.E3.1.4, Montreal, Canada, 2014.

[169] Eligar Sadeh, *Space Strategy in the 21st Century – Theory and policy*, Routledge, Oxon, 2013

[170] Space has been an agenda item since the first EU-Africa Summit, held in 2000. The First Action Plan (2008-2010) and the Second Action Plan (2011-2013) of the Joint Africa-EU Strategy focused on 8 priority areas of cooperation, with space constituting an element of two such areas: Trade, Regional Integration & Infrastructure, and Science, Information Society & Space. Africa is an EU cooperation and development priority. Two European Space programmes have a specific African dimension: the deployment of EGNOS (the European Space-based augmentation of the US Global Positioning System) navigation systems in Africa, and the GMES & Africa programme engaging Africans in the use of earth observation services for their own needs. Other priorities under discussion with Africa include the creation of an African Space agency and the establishment of Space research centres at the Pan-African University. In Europe, the European Commission directly cooperates with the African Union on various levels, with the involvement of the ESA and EUMETSAT (the European Organisation for the Exploitation of Meteorological Satellites). African actors include organisations operating at a continental level (such as the African Union), regional organisations (typically the Regional Economic Communities (RECs)), and technical organisations, such as African Space agencies and other agencies and institutes specialising in particular areas.

China[172]	1998	2006	Coordination
Japan	1991	2014	*TBD*
Russia[173]	1997	2006	Coordination
South-Africa[174]	2008	2009	Promoting downstream
USA[175]	1990	2009	Coordination

[171] The Space policy dialogue's annual meetings involve DG Transport – MOVE – of the European Commission and the ESA from the EU side, and, from the Brazilian side, the Ministry of Science, Technology and Innovation (MCTI) and the Brazilian Space Agency (AEB). Both parties signed a letter of intent in 2011, although the dialogue must still be re-activated annually. A Steering Board should supervise the dialogue, and several working groups are to be established. The areas of interest are Earth Observation and earth science, the contribution to the Group on Earth Observation (GEOSS) and the Committee on Earth Observation Satellites (CEOS), Global Navigation Satellite Systems (GNSS), satellite communications, and Space science and exploration. European Union-Brazil (2012), 14th Meeting of the Brazil – European Union, Joint Communication, Brasilia, 1 June 2012.

[172] The EU-China Space dialogue was initiated only recently, in August 2012, with the participation of the European Space Agency. China represents an important opportunity for the EU to engage in key issues related to Space, including Space exploration, satellite navigation, earth observation and Space science. In addition, China is an important market for European telecommunications satellites. The EU-China Summit 2012 explicitly mentioned Space as a domain for cooperation, highlighting the coordination to be undertaken in the GNSS field and in outlining a transparent and comprehensive plan for Earth observation. The Summit recommends establishing a roadmap identifying cooperation projects and actions of mutual interest (EU – China Summit 2012). The EU-China 2020 Strategic Agenda for Cooperation establishes three pillars: exchange of information in the field of earth observation, identification of a long-term plan of mutual interests, and the promotion of consultations regarding Galileo and BeiDou (the Chinese satellite navigation system), Copernicus and China's earth observing programme (HDEOS) and the development of human Space flight technologies. In addition, commercial and industrial prospects are to be supported by each party (European Union – China 2013). The most recent EU – China Summit of 2014 added additional fields of cooperation related to Space weather, Near Earth Objects (NEO), solar system exploration and Space science. In the case of China, Space-related cooperation has been conducted as a coordination action between the EU and China, rather than bilateral action between national governments. China and European partners have significantly stepped up Space-related cooperation in recent years, especially in the areas of earth observation satellites and training initiatives involving scientists from China visiting Europe and vice versa.

[173] The main topics in the EU-Russia Space dialogue are the compatibility and interoperability between Galileo and GLONASS (the Russian satellite navigation system) and Russia's participation in EU Space research projects, such as in the field of Earth observation. The EU-Russia Space dialogue also builds on the historical cooperation between the ESA and Roscosmos (the Russian space agency), covering topics ranging from launchers and scientific missions to manned spaceflight. This Space Dialogue was established in 2006 by the European Commission, represented by the Directorate-General for Enterprise and Industry (DG ENTR), the ESA and Roscosmos (European Union – Russia 2006). Subsequently, seven working groups have been established covering all fields of Space activity. Three approaches to cooperation can be identified: first, synergies and cooperation involving similar Space assets such as GLONASS and Galileo, Soyuz and Ariane; secondly, coordination for the sharing of assets belonging to only one party, such as Copernicus of the EU and the International Space Station (ISS) modules and manned launch systems held by Russia; and thirdly, ensuring mutual policy consultations by presenting a consensus at common international forums, such as GEOSS (Global Earth Observation System of Systems), and ISEG (International Space Exploration Coordination Group).

[174] The annual EU-SA Dialogue on Space Cooperation was initiated in January 2009. The dialogue involves the EU's Directorate-General for Enterprise (DG ENTR), the SA Department of Science and Technology (DST), the European Space Agency (ESA) and, since 2011, the SA National Space Agency (SANSA) (Box, L. and Engelhard, R., *Science and Technology Policy for Development: Dialogues at the Interface*, London: Anthem. (2006): p. 45). South Africa is particularly relevant, because it hosts the Square Kilometre Array (SKA) radio telescope project, which will be one of the largest Space installations in the world to observe different pieces of the sky simultaneously. The Space dialogues since 2008 have identified three priorities: the development of ground segments for Copernicus and one of the Ground Stations for Galileo; the extension of European Geostationary Navigation Overlay System (EGNOS) coverage of Southern Africa; and a data exchange system for earth observations, focusing on water monitoring and management and Space-based observations for managing malaria. In addition, the EU and South Africa have been jointly cooperating under the EU Framework Programmes, the Committee on Earth Observation Satellites (CEOS) and GEOSS. A substantial collaboration exists between the European Joint Research Centre (EU JRC) and South African institutions on specific topics including desertification, soil mapping, water management, crop monitoring and agriculture statistics, land management, biodiversity, and the production and validation of remote sensing parameters. Forthcoming cooperation initiatives are expected to increase the exchange of personnel such as engineers and entrepreneurs.

Tab. 33: The Seven EU Space Policy Dialogues with Third Countries[176]

The comprehensive landscape of international cooperation involving the EU in the Space sector is mainly based on a bilateral approach – except for the collaboration with the African Union. Only the Asia Pacific region is missing from a comprehensive global scenario for European Space cooperation, with interactions with Asia occurring through relations with the two competing nations of China and Japan. The gap between the first summit and the first Space dialogue varies between zero and 23 years. The shortest gap is with Africa, with the EU-Africa Summit starting in 2000 and the related Space dialogue starting in the same year. In contrast, the longest gap is with Japan, with which the summit was one of the earliest, commencing in 1991, and the Space dialogue did not get underway until 2014.

In addition, the EU has relations even with international multi-lateral actors, such as the United Nations for the Code of Conduct to enhance the safety, security and sustainability of activities in outer Space and Galileo coordination, and the Group on Earth Observation System of Systems (GEOSS) for Copernicus issues. EU framing dynamics have shaped international relations when the main Space flagship programmes have been approved and already deployed. In the 1990s, the EU was looking for partners for Galileo and Copernicus. The EU has since been coordinating with countries that have similar Space-based systems while promoting down-stream development with countries without their own Space assets.

The beginning of EU space affairs saw the intention to propose Space as content for cooperation with Eastern European countries on their integration paths. Cooperation is intended to support the integration of these countries into trans-European networks, e.g. Information Communication Technology (ICT) infrastructures, smart grids, equipment standards, etc. Attention is also given to other issues, including industrial and technological cooperation with the established Space nations, e.g. USA, Russia, China and Japan, and collaboration with the emerging countries India and Brazil. The Euro-Mediterranean area is a region of Space cooperation where European industry, supported by the EU, can serve the information and communication needs of these nations. The EC communication of 1999[177] places inside the scope of international cooperation the development of an independent satellite navigation system, starting with cooperation with existing US and Russian systems, through to the coordination of the augmentation systems, i.e. EGNOS (the European augmentation system for navigation) with the Japanese Multi-functional Satellite Augmentation System (MSAS). These messages are redundantly supported in different policy statements of European institutions[178] and reported in the resolution of the European Parliament[179], which:

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[175] The Space dialogue with the United States is the most comprehensive and addresses all Space-related concerns, including those related to security and defence, in a synergetic configuration with Space issues (Steffenson, R., *Managing EU-US Relations: Actors, Institutions and the New Transatlantic Agenda*, Manchester: Manchester University Press, 2005: p. 6; Delcour, L., *Shaping the Post-Soviet Space?: EU Policies and Approaches to Region-Building*, Surrey: Ashgate, 2013: 84; Al-Rodhan, N. R. F., *Meta-Geopolitics of Outer Space: An Analysis of Space Power, Security and Governance*, Basingstoke: Palgrave Macmillan, 2012: p. 111; Sadeh, E., *Space Strategy in the 21st Century: Theory and Policy*, London: Routledge, 2013: p. 57; Madders, K., *A New Force at a New Frontier: Europe's Development in the Space Field in the Light of Its Main Actors, Policies, Law and Activities from Its Beginnings Up to the Present*, Cambridge: Cambridge University Press, 2006: p. 226). More importantly, different theoretical perspectives focus on the bilateral engagement of the USA with the EU, rather than presenting the EU as an additional player in bilateral relations between the USA and single European Member States. The dialogue has seen a number of concrete achievements, e.g. in the areas of satellite-based navigation and the interoperability between GPS and Galileo, earth observation via EUMETSAT's partnership with the US National Oceanic and Atmospheric Administration (NOAA), or more recently the decision allowing US public bodies to participate in EU space research projects. This achievement reflects the high level of dialogue between the EU and the USA, which has increased through the yearly EU-US Summit since 1995.

[176] Data come from the public available database European Strategic Partnerships Observatory. Last access in May 2015 at http://strategicpartnerships.eu/dialogues/

[177] EC, *Towards a coherent European Approach for Space*, SEC (1999) 789, 6 June 1999, pp. 17 – 21.

[178] EC, *The European Union and Space: fostering applications, markets and industrial competitiveness*, A4-0384/97, 3 December 1997, Report.; European Parliament (2000), *Towards a coherent European approach for Space*, *A5-0119/2000*, Minute 18 May 2000; European Council, *European Space strategy*, (2000/C 371/02), 23 December 2000.

... urges the further development of international collaboration in Space activities, in particular with the Russian Federation, the USA, China and Japan, but also with less developed countries for which the European Union could provide affordable access to Space, and asks the Commission to arrange a conference to explore the possibilities of such co-operative ventures with representatives of the above four Space powers, covering scientific, technological, industrial or economic aspects, such as the new international orbiting Space station ...

The Commission's Green Paper on Space policy[180] outlines the fundamental elements of international cooperation in order to converge on a single European vision of Space, speaking with one voice. International cooperation is envisaged with the main Space powers in order to avoid duplication of investment in research and development. In addition, international relations are supportive of clarifying matters of international trade, e.g. regulation, standardisation, non-tariff protection, etc.

There are also elements of intended cooperation with India and Ukraine[181] where a proper Space dialogue has not yet been reached.

The third Space Council of 2005 shaped the core discussion about the role of international relations[182]. Here, international cooperation was seen as a driver for European Space strategy, with benefits for Europe and the European market the key criteria for ranking the prioritization of international partnerships. The fourth Space Council in 2007[183] enhanced the role of relations with international organizations, i.e. the United Nations and particularly the Committee on the Peaceful Uses of Outer Space (COPUOS), in establishing and maintaining the rule of law in using and exploring outer Space. In 2008, the Commission[184] mentions the role of international relations in regards to improving transparency and the need for coordination of a single European voice from all stakeholders dealing with the Space dialogues. The priority is placed on coordinated actions boosting the market competitiveness of European industry by using Space systems for sustainable development, e.g. in Africa, and contributing to the practical implementation of European Space programmes. The European partnership on Space with Africa was officially established under the seventh Space Council in 2010[185] with the provision of Space-based applications, i.e. EGNOS, Copernicus and satellite communications, helping to enable Africa to achieve the Millennium Development Goals. The communication[186] from the Commission in 2011 shapes a clear comprehensive statement on the role of international relations as a substantial tool for assuring the sustainability of European investments in Space assets, e.g. Galileo and Copernicus. The Space dialogues of the EU with the ESA shall enhance cooperation for the mutual benefit of the partners in order to integrate external actions with the internal priorities of the EU, e.g. socio-economic growth and industrial competiveness. Thus the contents of international collaboration are sharing policies for the utilisation of assets, data, signals and frequencies with the Space powers, e.g. USA, Russia, China and Japan, while supporting service provision for the needs of developing areas, e.g. Africa, Brazil, etc.

In conclusion, there is no doubt that the European Space policy is industry oriented; Space is a catalyst of industrial competitiveness. It feeds the ambition for European technological leadership. When negotiating over Space affairs with established Space powers, the industrial content is partially overtaken by geopolitical priorities. The wording of European policy statements often refers to the aim to strengthen the

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179 European Parliament, *Europe and Space: Turning to a new chapter*, P5 – TA (2002) 0015, 2002

180 EC, *Green Paper: European Space Policy*, COM (2003) 17, 21 January 2003.

181 EC, *Europe and Space turning a new Chapter*, COM (2000) 597, 27 September 2000; European Commission, *Towards a European Space policy*, COM (2001) 718, 7 December 2001.

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industrial sector through the promotion of socio-economic growth, sustainable development, and the sustainability of Space activities.

In a broader context, the EU is shaping its international relations and international cooperation in Space by focusing on both industrial interests and geopolitical values. International Space cooperation serves European interests regarding its Space policy and its more general foreign policy objectives. On the one hand, Space cooperation is a pragmatic tool to implement ambitious programmes such as Space exploration and the International Space Station; on the other hand, international Space activities foster a climate of political cooperation and help in responding to Europe's political priorities like climate change, sustainable development, humanitarian aid, and security in the broad sense. At the same time, Europe's Space activities illustrate its role and position in the international system. Europe is still an international actor under construction, and is in search of its specific international identity as neither a state, nor a classical intergovernmental organization, but an actor of its own kind. On the international stage, it needs to find an adequate balance between cooperation and autonomy, making itself a credible cooperation partner for the established Space-faring nations. The ambiguity of EU identity remains even in these negotiations, where the EU puts across the sum of the interests of its Member States. Another feature of the international relations of the EU in the Space sector is that the shape of international cooperation has been mainly inherited from the European Space Agency, where international relations activities are more closely tied to its programmes and less to broader policy considerations. Because of this, there exists no clear roadmap for the international relations of the EU regarding Space, with most relationships established on an opportunistic, pragmatic basis in order to support existing programmes. Past evidence shows that Space cooperation usually starts with science where costs are high, and collaboration is known to reduce costs. The purpose is to enhance the scientific value of missions, share risks, combine competencies, and promote open data policies for scientific purposes. When the EU has its own space facilities and when it can express its normative political values then its international relations will be shaped by a strategy that is then implemented through appropriate programmes. The history of EU international relations in the field of Space presents itself rather more as a proliferation of programmes in need of a strategy.

6. Conclusions and Recommendations

The economic dimension of the Europe-Japan relations in the Space sector is quite significant, reaching a volume of around €4.1 billion in the last 5 years, taking into account mainly the bilateral relations between Japan and the EU Member States taking a variety of forms, from government-to-government, to inter-agency, inter-university, industry-to-industry and other hybrid relations. On science and technology there is a solid potential both at the bilateral and EU level within the Horizon2020 Programme.

Furthermore, the new interpretation of Art. 9 of the Japanese Constitution opens the door for potential Japanese autonomy in security matters, including in Space-related fields. This is a very promising context in which the Japanese industry can export abroad and expect to flourish in its advanced technological know-how from commercial ventures, at least in the Asia Pacific. In order to achieve this, the binds of the US ITAR regulation shall be released through the development, at least, of non-dependent Space technology. This target is common also to the EU, in its quests to increase competitiveness and global leadership. Aside from this dichotomous vision with the two groups US-Japan or EU-Japan, even trilateral relations can be implemented to facilitate industrial trade and jointly pursue the advanced technological challenges of Space exploration, manned Space transportation systems and innovative capacities.

Moreover, Space is a key enabler and catalyst for various technologies that serve a diverse set of policies, e. g. in transport, ICTs, energy, climate change, economic growth, in the advancement of knowledge, safety and security. The utilisation of Space assets, *e.g.* SatCom, Sat EO and SatNav, for terrestrial usage increases the efficiency of resources and effort, because satellites feature trans-nationality covering wide areas, 24-hour time ubiquity for telecommunications, and non-invasive technology for monitoring purposes. These requirements make satellites also very valuable to serve the needs of users located in unreachable conditions and/or remote locations. The synergetic Space utilization emerging from APRSAF-21 and the integrated applications element of the ESA hold great promise for market fertilization, which Japan is willing to promote and the EU to enhance. There is also a common interest in spin-offs in terms of marketable ideas multiplying benefits from initial public expenditures and supporting synergies with other industrial sectors, *e.g.* automotive, health, oil & gas, media, industrial procedures, innovative materials, buildings, etc. In conclusion, boosting industrial cooperation in Space has a spill over effect beneficial to other sectors. As such, industrial cooperation is the most promising way to bridge the European and Japanese Space communities and enhance their competitiveness.

In order to reach this target, aside from the actions described above for each industrial segment, three key recommendations are presented in the table bellow:

Recommendations	Actions
1. Make EU-Japan Space industrial cooperation the best tool for growing existing and new Space businesses	• Secure practicable measures to facilitate the exchange of expertise for downstream applications introducing unambiguous, flexible and achievable criteria for companies (mainly SMEs and start-ups) interested in entering the two areas • Harmonize the export control regimes between the two areas • Establish a Space session under the EU-Japan Business Round Table with the joint participation of the EU, supported by ESA, and the Japanese METI, supported by JAXA • Promote the trans-disciplinary dimension of Space under the scope of the EU-Japan Centre for Industrial Cooperation
2. Increase economic returns from Space-related public expenditures by continuing to pursue new technological challenges	• Facilitate Industry-to-Industry relations in the field of Space launching systems, as a joint task of ESA and JAXA • Create an EU – Japan Engagement Plan for the technological assets and facilities on board the ISS for the fertilisation of spin-off opportunities • Develop a cost-effective Space value chain jointly funding innovative production procedures (e.g. a 3-D printer)
3. Stimulate a vibrant Space sector by promoting internationally-oriented professional skills	• Propose the Space sector to students, researchers and young professionals under the existing mobility programs (e.g. Vulcanus, Japan Society for the Promotion of Science, EURAXESS, etc.) • Motivate people to enhance the 3Is dimension of their professional profile with experiences at, for example, the ISU or the forthcoming Okinawa School in Japan

Table 32: Policy recommendations for pursuing EU – Japan industrial cooperation in Space

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Appendix

I. EDA – ESA

The following table depicts the main similarities and differences between the EDA and ESA in terms of legal reference and status, mission, membership, governance model, approval policy of programs and related budget, immunity and other benefits, and relation with the EC. The two inter-governmental agencies differ in their budget contribution, where the national dimension is relevant for defence purposes but not for the case of Space. In addition, the immunity regime is less invasive for the EDA than it is for the ESA where the benefits are juridical and tax related.

	EDA	ESA
Lisbon Treaty	Common Security and Defence Policy (CSDP): Art. 42 (3) and Art. 45	Space Policy: Art. 189 TL
Legal References	Council of the European Union, Joint Action 2004/551/CFSP on the establishment of the European Defence Agency, 12 July 2004 and Council Decision 2011/411/CFSP (12.07.2011)	ESA Convention and Council Rules of Procedures
Legal Status	*The Agency shall have the legal personality and the capacity to conclude contracts with private or public entities or organisations*	*The Agency shall have legal personality*
Mission	The mission is *to support the Council and the Member States in their effort to improve the EU's defence capabilities in the field of crisis management and to sustain the ESDP as it stands now and develops in the future. The Agency's mission shall be without prejudice to the competences of Member States in defence matters*	*The purpose of the Agency shall be to provide for and to promote, for exclusively peaceful purposes, cooperation among European States in Space research and technology and their Space applications*
Membership	- Participating Member States: EU Member States choose to be part of EDA - Contributing Member States: EU or overseas Member States choose to contribute to only some programmatic lines of EDA	- Member States: committed to fund mandatory and optional programs - Associate States: committed by their choice to contribute to ESA programs - Cooperating States: admitted by consensus of ESA Ministerial Council and committed to participate in mandatory programs
Governance	• The EDA falls under the authority of the Council of the EU, to which it reports and from which it receives guidelines • The EDA Steering Board meets at ministerial level. Defence Ministers decide on the annual budget, the 3-year work programme and the annual work plan as well as on projects, programmes and new initiatives • The Head of Agency, who is the High Representative of the Union for Foreign Affairs and Security Policy, is also Vice-President of the European Commission • The Chief Executive is appointed by decision of the Steering Board and assisted by staff	• ESA is managed by a decision-making organ and an executive organ • Decision-making is the responsibility of the Council, which is composed of the representatives of all Member States. It elects a Chairperson and a vice-chairperson and the Chairperson shall be assisted by a Bureau • Executive power is vested in the Director General, who is assisted by a structured staff of personnel
Approval policy	• The Steering Board adopts decisions by a 2/3 majority rule • For EDA purposes, the EU Council adopts decisions by consensus	The ESA Council adopts decisions by majority rule and in some specific cases a 2/3 majority is required
Budget	• The Member States contribute according to their GNP • There can be ad hoc contributions for specific programs • The Financial Framework is adopted every three years	• The Member States contribute according to their GDP • No Member State can contribute over 25% of all mandatory programs • The Financial Framework is adopted every four years

Types of programs	• Companies based in the contributing Member States can participate in the EDA programs independently of the return • Category A (opt-out): every member state automatically participates unless they express dissent • Category B (opt-in): every member state participates only if they explicitly declare a desire to take part	• Optional programs: Space programs for applications (SatCom, Sat EO, etc.); to opt out member states shall express their dissent within three months. The just return shall be guaranteed within an adjustment factor between 0.84 and 1.05 • Mandatory programs: general expenditures and scientific programmes require contribution from all States. The just return shall be guaranteed with an adjustment factor of 0.85 within 5 years
Relation With the EC	• The EC has a representative without voting rights in the Steering Committee • The EC can participate in programme categories A and B and its contribution is approved on a case by case basis	• The EC interacts with the ESA for the development of Space programmes
Benefits and immunity of personnel	• The Chief Executive and staff-members can have diplomatic immunity upon approval from the EU Council on a case by case basis	• Diplomatic immunity of the Director general and of the ESA Experts during their institutional tasks • Judicial immunity • Tax exemption

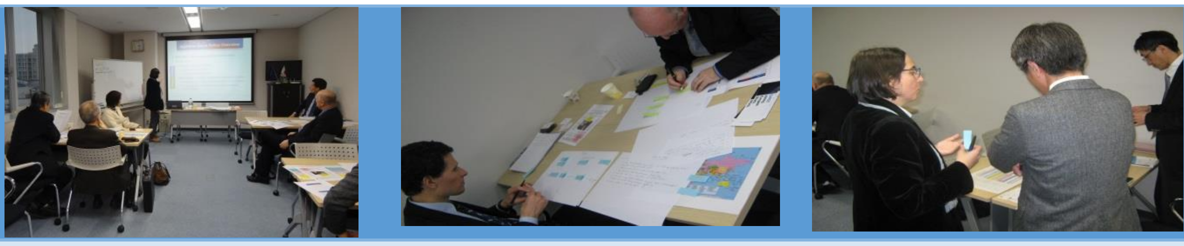
Table 34: Comparison between ESA and the EDA

II. Business-to-Business Facilitation

The author performed almost 65 individual interviews with the main Japanese stakeholders in Space sectors. This made the author aware of the current technological gaps in Japan and she was disposed to share her insights into European capabilities. In three cases, follow-up from these interviews reached sufficient maturity for bridging actions to take place between a Japanese firm and a European one, binding their agreements initially with Non-Disclosure Agreements (NDAs). These three cases (launching technologies, Space-based components and SatCom downstream) are under NDA and details cannot be disclosed.

III. Cosmo Café: European and Japanese sessions

Time constraints and the cultural differences prevented the author from gaining a comprehensive overview of the issues and intentions for EU – Japan industrial cooperation in Space. To get around these problems, the author organized two sessions, one each for European and Japanese industrial players, in *World Cafè* format, labelled for this purposes *Cosmo Cafè*. In this way, participants were facilitated to easily interact and to draft a SWOT analysis concerning the three main segments - launching systems and services, Space-based systems and downstream applications. The outcomes from these *Cosmo Cafès* have been valuable in putting together this report.



Cosmo Cafès – European Session, Tokyo 16 December 2014

Cosmo Cafès – Japanese Session, Tokyo 18 December 2014

IV. Business-to-Business Mission

The EU-Japan Centre for Industrial Cooperation leads, *inter alia*, the GNSS.Japan project under the framework of EU COSME[187] – the Programme for the Competitiveness of Enterprises and Small and Medium-sized Enterprises (SMEs). For this purpose the Centre organised a 3-day B-2-B event selecting 13 European SMEs willing to partner with Japanese companies. The author gauged the real interests of cooperation opportunities and supported the matching of partners from the two areas. The event was the EU-Japan Partnering Support Mission in the Space Sector - Tokyo, 9-11 March 2015 (http://www.eu-japan.eu/eu-japan-partnering-support-mission-space-sector)

EU-Japan Partnering Support Mission in the Space Sector
Tokyo, 9 – 11 March 2015

The Application Form for the European Companies is available at:
http://www.eu-japan.eu/sites/eu-japan.eu/files/ApplicationForm_20150113.docx

The **EU – Japan Centre for the Industrial Cooperation** is pleased to launch its first **Partnering Support Mission in the Space Sector, which is planned as a Business-to-Business event** with the objective of boost industrial relations for EU and Japanese space and downstream industries.

European and Japanese companies targeted for this mission are involved in developing technologies/know-how in at least one of the 4 following market segments: Space-based components and systems (launch, ground and space segments); Satellite Communications (SatCom) value-added services; Earth Observation (SatEO) raw data, processing techniques and applications; and Satellite Navigation (SatNav) downstream applications.

The mission is a unique opportunity to engage in B2B partnership discussions between European and Japanese stakeholders involved in this challenging market sector. The mission will also offer insights into the Japanese space industry, a networking seminar with direct contact to the Japanese industry, B2B sessions, round tables with space market experts, stakeholders and Japanese space governmental officers. The event, which is expected to be a launch-pad for partnership discussions, will be driven by a mix of approaches to sharing information, coupled with a strong commitment to developing interactive sessions.

The 3-day event is planned around the following schedule:

9 March 2015	***Day 1***
Morning	Orientation session for selected European companies + experts' briefings on the Japanese space industry and market dynamics
Afternoon	Networking seminar with Japanese firms + top-level keynote speakers from European and Japanese stakeholders Introduction of participating European companies + ignite talks: interests in Japan and presentations about related products/services portfolio
10 March 2015	***Day 2***
Morning	Briefing with insights on the potential mutual benefits of industry-to-industry collaboration B2B Meeting Sessions
Afternoon	B2B Meeting Sessions Wrap-up with mission participants
11 March 2015	***Day 3***
Morning	Round table with European stakeholders in charge of Space affairs in Japan
Afternoon	Visit to a Space facility around Tokyo Back-up B2B Meeting Sessions

All networking slots are duly planned in the final schedule.

Interested companies are required to apply to this mission by filling in the online application at:
http://www.eu-japan.eu/sites/eu-japan.eu/files/ApplicationForm_20150113.docx
The EU-Japan Centre for Industrial Cooperation will proceed to a final selection based on the profile and quality of each application form as well as on the applicant's business potential for cooperation with Japan. Selection results will be announced in February 2015 by email to all applicants. Selected European SMEs are eligible for a flat rate subsidy which shall cover part of their travel costs to Japan for the mission. Japanese companies will be invited to express their interest in B2B meetings based on information provided by selected European Companies in their application forms. The EU-Japan Centre for Industrial Cooperation will organize B2B meetings for all selected mission participants, the number of meetings arranged may vary by participant depending on the interest of Japanese companies to meet, and final B2B meeting schedules will be communicated shortly before the start of the mission. Contact the EU-Japan Centre for Industrial Cooperation at SpaceJapan@eu-japan.gr.jp for any questions or inquiries about this mission.

EU – Japan Centre for Industrial Cooperation
Head office in Japan
Shirokane-Takanawa Station bldg 4F
1-27-6 Shirokane, Minato-ku Tokyo 108-0072 Japan
Tel: +81 (0)3 6408 0281 Fax: +81 (0)3 6408 0283

[187] COSME is the EU's programme established by Regulation (EU) No 1287/2013 (the "COSME Regulation") to strengthen the competitiveness and sustainability of the Union's enterprises and to encourage an entrepreneurial culture and promote the creation and growth of SMEs.