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SPACE, SOVEREIGNTY AND EUROPEAN SECURITY
BUILDING EUROPEAN CAPABILITIES IN AN ADVANCED INSTITUTIONAL FRAMEWORK

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POLICY DEPARTMENT

STUDY

SPACE, SOVEREIGNTY AND EUROPEAN SECURITY

BUILDING EUROPEAN CAPABILITIES IN AN ADVANCED INSTITUTIONAL FRAMEWORK

Abstract

The study aims to offer a comprehensive analysis of the role of space-based capabilities in supporting the security and defence policies of the European Union and of its Member States. Moving from the description of the current and future space-based systems developed at the national, intergovernmental and European level, the study tries in first place to point out the contribution of these assets to the security initiatives undertaken in Europe. Second, it describes the roles of the actors and the functioning of the institutional framework through which these capabilities are developed and exploited for Europe's security purposes. Finally, it provides options regarding the development of space capabilities for European security which could be implemented under the current treaties and within the scope of the forthcoming Multiannual Financial Framework (MFF) of the Union.

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List of acronyms

ALTBMD	Active Layer Theatre Ballistic Missile Defence
ARTA	Ariane Research and Technology Accompaniment
ASAT	Anti-Satellite
ASI	Agenzia Spaziale Italiana, Italian Space Agency
ATV	Automated Transfer Vehicle
AVUM	Altitude and Vernier Upper Module
BRIDGES	Building Relationships and Interactions to Develop Copernicus for European Security
CDG	Concurrent Design Facility
CDP	Capability Development Plan
CFSP	Common Foreign and Security Policy
CMPD	Crisis Management and Planning Directorate
CNES	Centre National d'Etudes Spatiales, National Centre for Space Studies
CS	Commercial Service
CSDP	Common Security and Defence Policy
CSG	Centre Spatial Guyanaise, Guyanese Space Centre
CSO	Composante Spatiale Optique, Optical Space Component
DG	Directorate General
DG ECHO	DG Humanitarian Aid & Civil Protection
DG ENTR	DG Enterprise and Industry
DG MARE	DG Maritime Affairs and Fisheries
DG MOVE	DG mobility and Transports
DLR	Deutsches Zentrum für Luft und Raumfahrt, German Centre for Aerospace
DoD	Department of Defense
DSP	Defense Support Program
EADS	European Aeronautic Defence and Space company
EC	European Commission
EDA	European Defence Agency
EDRS	European Data Relay Satellite
EEA	European Environment Agency
EEAS	European External Action Service
EEE	Electrical Electronic and Electromagnetic
EFC	European Framework Cooperation

EGAS	European Guaranteed Access to Space
EGNOS	European Geostationary Navigation Overlay System
EISCAT	European Incoherent Scatter Scientific Association
ELINT	Electronic Intelligence
ELISA	Electronic Intelligence Satellites
EMS	Emergency Management Service
EMSA	European Maritime Safety Agency
ENTR.G	Directorate for Aerospace Maritime Security and Defence
ENTR.H	Directorate for EU Satellite Navigation Programmes
EO	Earth Observation
EP	European Parliament
ERC	European Emergency Response Centre
ESA	European Space Agency
ESCPC	European Satellite Communication Procurement Cell
ESP	European Space Policy
ESRIN	European Space Research Institute
ESTEC	European Space and Research Technology Centre
ESTP	European Space Technology Platform
ETISC	European Tactical Interim Satellite Capacity
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorogical Satellites
EUMS	Military Staff of the European Union
EUROSUR	European external border surveillance system
EUSC	European Union Satellite Centre
FA	Framework Agreement
FLPP	Future Launcher Preparatory Program
FOC	Full Operational Capability
FP7	Seventh Framework Programme
FRONTEX	European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union
GCS	Ground Control Segment
GEO	Geostationary Orbit
GEOSS	Global Earth Observation System of Systems
GIOVE	Galileo In-Orbit Validation Element

GIP	Galileo Inter-institutional Panel
GJU	Galileo Joint Undertaking
GMES	Global Monitoring for Environment and Security
G-MOSAIC	GMES services for Management of Operations Situation Awareness and Intelligence for regional Crises
GMS	Ground Mission Segment
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRAVES	Grand Réseau Adapté à la Veille Spatiale, Wide Network Suitable for Space Surveillance
GSA	European GNSS Agency
GSMC	Galileo Security Monitoring Centre
GTO	Geostationary Transfer Orbit
H2020	Horizon 2020
HEO	High Elliptical Orbit
HQ	Head Quarter
HR/VP	High Representative of the Union for Foreign Affairs and Security Policy/ Vice President of the European Commission
ICBM	Intercontinental Ballistic Missile
ICPA	ISR Capability Package Assessment Study
IES	Institute for Environment and Sustainability
IOV	In-Orbit Validation
ISI	Integral SATCOM Initiative
ISR	Intelligence Surveillance and Reconnaissance
ISS	International Space Station
ITAR	International Traffic in Arms Regulations
IXV	Intermediate eXperimental Vehicle
JRC	Joint Research Centre
JSpOC	Joint Space Operation Centre
KhSC	Khrunichev State Space Research and Production Space Centre
LARES	Laser Relativity Experiment
LEAP	Launcher Exploitation Accompaniment Program
LEO	Low Earth Orbit
LOBOS	LOw time critical BOrder Surveillance
LRIT	Long Range Identification and Tracking system

MCO	Maintenance in Operational Condition
MEO	Medium Earth Orbit
MFF	Multiannual Financial Framework
MoD	Ministry of Defence
MS	Member States
MUSIS	Multinational Space-based Imaging System
NATO	North Atlantic Treaty Organisation
NEC	Network Enabled Capability
NELS	New European Launch Service
NEO	Near Earth Object
NGL	Next Generation Launcher
NORAD	North American Aerospace Defense Command
NSP2K	NATO SATCOM Post-2000
NSS	National Security Strategy
OCCAR	Organisation Conjointe de Coopération en Matière d'Armement, Joint Cooperation Organisation on Armament Matters
OECD	Organisation for Economic Cooperation and Development
OLAF	Office Européen de Lutte Anti-Fraude, European Office Anti-Fraud
ORFEO	Optical Radar Federated Earth Observation
OS	Open Service
PFI	Private Finance Initiative
PPP	Public Private Partnership
PRS	Public Regulated Service
PSC	Political Security Committee
R&D	Research and Development
REA	Research Executive Agency
SAB	Security Accreditation Board
SAFER	Services and Applications For Emergency Response
SAGRES	Service Activations for GRowing Eurosur Success
SAR	Synthetic Aperture Radar
S&R	Search and Rescue
SATCOM	Telecommunication Satellite
SATNAV	Navigation Satellite
SBIRS	Space-Based Infrared System

SBSS	Space-Based Space Surveillance
SEA	Support to European External Action
SECTELSAT	Secure Telecommunications by Satellite
SME	Small Medium Enterprises
SoL	Safety of Life
SPIRALE	Système Préparatoire Infra-Rouge pour l'Alerte, Infrared Preparatory System for Alert
SSA	Space Situational Awareness
SSN	Space Surveillance Network
SSO	Sun Synchronous Orbit
SSR	Security Sector Reform
SST	Space Surveillance and Tracking
STSS	Space Tracking and Surveillance System
SWE	Space Weather
TAROT	Télescope à Action Rapide pour les Objets Transitoires, Quick Action Telescope for Transients Objects
TEU	Treaty on the European Union
TFEU	Treaty on the Functioning of the European Union
TIRA	Tracking and Imaging Radar
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
UK	United Kingdom
UN	United Nations
US	United States
USAF	United States Air Force
USSTRATCOM	United States Strategic Command
VECEP	Vega Consolidation and Evolution Preparation Programme
VENUS	Vega New Upper Stage
VERTA	Vega Research and Technology Accompaniment
VESPA	Vega Secondary Payload Adapter

EXECUTIVE SUMMARY

The link between space, sovereignty and security issues seems today stronger than ever, as most of the data and information currently used in the military and security domains comes from or uses space-based systems. Space-based capabilities contribute to the enhancement of both external and internal and security of the European Union and its Member States, by ensuring superior performances compared to any ground-, sea-, air-based platform. Alongside combat activities as those carried out in Afghanistan and Libya, Member States and the European Union have been involved in various overseas security operations in the framework of the Common Security and Defence Policy, such as peace keeping/enforcement and humanitarian relief missions. These operations, and in particular those of civilian nature such as security sector reform, police and monitoring missions, are likely to characterize the European security efforts in the years ahead.

In this evolving operational context, space-based assets ensure the necessary mix of flexibility and reliability, providing a range of different applications to be integrated in fully-fledged "security from space" services. These include Earth observation satellite capabilities, navigation satellites systems, electronic intelligence satellites, early warning space-based systems. All these systems, once in orbit, are to be considered critical infrastructures requiring full protection against both intentional and unintentional threats. To protect these assets the development of a Space Situational Awareness capability has become an imperative, so as to track and counter possible threats to both space and ground infrastructures. Finally, the availability of autonomous launch capabilities is a requisite to guarantee both "security from space" and "security in space", and to develop the European and national space policies accordingly.

Having recognized the existing link between space, sovereignty and security, the European Union has politically and financially committed to space and security R&D programmes, to the development and deployment of satellite infrastructures, and to the expansion of space-based services and products as well as of the related markets. At the same time, it has repeatedly stressed the importance of an independent access to space for Europe in order to autonomously provide for all its space programmes, along with those of the Member States. In 2004 the European Commission and the European Space Agency signed the EC-ESA Framework Agreement to initiate closer collaboration in the space domain, and in 2007 they jointly adopted the European Space Policy which clearly underlines the relevance of space to the Common Security and Defence Policy. Beside the European Union, the European Space Agency and their respective Member States, other institutional and private actors contribute to the further development of space and security policies.

The governances of the space and security sectors and the roles played by all the different actors are currently evolving and, if suitably streamlined, could sensibly enhance the effectiveness of the related policies from the political, financial, legislative, and operational points of views. Indeed, the role of the EU in both the space and security domains should be aimed at guaranteeing added value where MS cannot act individually or individual action is not sufficient/efficient (i.e. large space programmes such as SSA), where more political integration and maximization of available resources are needed (i.e. security policies and related space capabilities), where more competitiveness would improve the European industry's performances on the global markets (i.e. specific industrial policies and measures for space and defence) and where technological non-dependence is an imperative (i.e. sustained R&D in critical technologies). In turn, the EU would enhance its role of global actor in both the space and security domains as well as the security and well-being of its citizens.

INTRODUCTION

The link between space, sovereignty and security issues seems today stronger than ever, as most of the data and information currently used in the military and security domains, comes from space-based systems. As recently stressed by the Commission in its *EU Space Industrial Policy*, "*these systems and services guarantee independence and security for the EU*"([1]).

Space-based capabilities, indeed, contribute to the enhancement of both external and internal and security of the European Union (EU), by ensuring superior performances compared to any ground-, sea-, air-based platform. The demand of satellite services for military and security applications has expanded in the last decades, due to the increasing participation of European forces to expeditionary military and security missions in remote and severe environments. Alongside combat activities as those carried out in Afghanistan and Libya, Member States (MS) and the EU have been involved in various overseas security operations in the framework of the Common Security and Defence Policy (CSDP), such as peace keeping/enforcement and humanitarian relief missions. These operations, and in particular those of civilian nature such as security sector reform (SSR), police and monitoring missions, are likely to characterize the European security efforts in the years ahead. Furthermore, the EU and national governments have intensified their commitment to homeland security, increasing their operational activities in domains such as border control and maritime surveillance missions (included the fight against illegal immigration, trafficking in arms, humans, and drugs) carried out by FRONTEX and European Maritime Safety Agency (EMSA), as well as civil protection and management of manmade and natural threats - coordinated by the DG ECHO's Monitoring and Information Centre (MIC).

Since emerging threats have not a purely military nature, they cannot be countered with military means only but require a set of different instruments. Space-based assets, in this context, would ensure the necessary mix of flexibility and reliability, providing a range of different applications to be integrated in fully-fledged "security from space" services. These include **Earth Observation** (EO) satellite capabilities, which provide high-detailed optical and radar images of the ground, fundamental to make intelligence, surveillance and reconnaissance (ISR) activities more accurate, and to offer timely and comprehensive information to decision-makers and personnel deployed in the theatre. **Telecommunications** satellites (SATCOM), which ensure secure communication and data relay between national headquarters (HQ) and out of area operations, playing an essential role in the transmission of the large information flows offered by a new generation of space-based, aerial and terrestrial sensors. **Navigation** satellites (Satnav) systems, which allow users to determine their position in the field with a high level of precision, and are regularly used to coordinate the activities of teams and vehicles deployed in the operations theatres. Finally, **electronic intelligence** (ELINT) satellites, used to detect active radar infrastructures or assets on the ground and in the air enabling the necessary countermeasures, as well as early warning space-based systems, useful to counter missile threats either detecting their launch, determining their trajectory, and allowing retaliation, or to simply monitor missile proliferation activities.

All these systems, once in orbit, are to be considered critical infrastructures requiring full protection against both intentional and unintentional threats. The objective to ensure "security in space" is only achievable through the development of a **Space Situational Awareness** (SSA) capability, so as to track possible threats to both space and ground assets. The availability of autonomous launch capabilities is a

[1] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions *EU Space Policy*, COM(2013) 108, 28 February 2013 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0108:FIN:EN:PDF.

requisite to guarantee both "security from space" and "security in space", and to develop the European and national space policies accordingly ([2]). Satellite systems for security and defence, indeed, are sensitive assets and relying on foreign launchers to put into orbit, replace, or upgrade them could seriously constrain the sovereignty of the EU and its MS.

Having recognized the existing link between space, sovereignty and security, the European Union has politically and financially committed to space and security R&D programmes, to the development and deployment of satellite infrastructures, and to the expansion of space-based services and products as well as of the related markets. At the same time, it has repeatedly stressed the importance of an independent access to space for Europe in order to autonomously provide for all its space programmes, along with those of the Member States. In 2004 the European Commission (EC) and the European Space Agency (ESA) signed the EC-ESA Framework Agreement to initiate closer collaboration in the space domain, clearly recognizing that given "*the nature of space technologies and infrastructures* [the implementation of the Agreement] *shall take into account their security dimension*".([3]) Three years later, in 2007, the EC and ESA jointly drafted the European Space Policy (ESP), which highlights that the space sector is a strategic asset contributing to the independence and security of Europe. The document, recognizing that space technologies are often common between civilian and defence applications, encourages deeper coordination between defence and civilian space programmes, pursuing in particular the synergies in the domain of security.

In fact, despite the effort made at the European and national level, it is not granted that space assets generally considered as European are in reality entirely designed and built in Europe. The European Space Technology Platform (ESTP) in 2006 estimated that about 60 % of on board electrical, electronic and electromagnetic (EEE) components are built in the United States([4]). Since these components are subject to International Traffic in Arms Regulations (ITAR) which can abruptly change according to US concerns, this situation could lead to a high risk of European technological dependence in this sector which could often result in procurements delays and put in the short run European industry in a further situation of dependence towards US policy fluctuations([5]). The question of sovereignty and **non-dependence** is extremely important for Europe's security, as highlighted by the joint effort of the EC, ESA and EDA who, in 2011, ran together the process to prepare a list of urgent actions for *Critical Space Technologies for European Strategic Non-Dependence*([6]). The issue of technological non-dependence of the EU space sector - along with the need to guarantee the security of supply and maintain independent access to space – has been identified has one of the five key objectives of the EU's space industrial policy, and will be specifically addressed in the EC's Horizon 2020 programme.

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[2] White Paper, *Space: a new European frontier for an expanding Union, An action plan for implementing European space policy*, COM(2003) 673, 11 November 2003.

[3] Council Decision on the signing of the Framework Agreement between the European Community and the European Space Agency, 7 October 2003 http://ec.europa.eu/enterprise/policies/space/files/policy/european_communityandeuropeanagencyframeworkagreement_en.pdf.

[4] European Space Technology Platform, *Strategic Research Agenda*, 22 June 2006 http://estp.esa.int/upload/ESTP_SRA_1.0-July2006.pdf.

[5] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions, *EU Space Industrial Policy, Releasing the potential for economic growth in the Space sector*, COM (2013) 108, 28 February 2013. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0108:FIN:EN:PDF

[6] See EC, ESA, EDA *Critical Space Technologies for European Strategic Non-Dependence Draft List for Urgent Actions for 2012/2013* http://www.euresearch.ch/fileadmin/documents/PdfDocuments/eNewsletter/European_Non-Dependence_Draft_List_2012-2013_v16_clean.pdf.

Space for security is further addressed in the Communication *Toward a Space Strategy for European Union that benefits its citizens* (2011)([7]) and the relative EP Resolution of 19 January 2012([8]). The two documents stress the importance of the GMES program for security purposes such as monitoring land borders, maritime surveillance and safety purposes such as civil protection and emergency management. The EC Communication also encourages MS and European Defence Agency (EDA) to coordinate their efforts in developing interoperable systems according to the spirit of the CSDP. Both documents, finally, emphasize the importance of a European Space Situational Awareness system to protect ground and space critical infrastructures from threats coming from space debris, space weather and near-Earth objects (NEOs).

The recent proactivity of the EC in the space domain has been encouraged by the adoption of the Lisbon Treaty, which provides the EU with a shared competences with MS on space issues([9]), laying the necessary legal framework to adopt space-related initiatives. This new legal basis allowed the Union to bring forward the two flagship programmes GMES/Copernicus and Galileo, the clearer examples of the EU attempt to strengthen its technological and industrial non-dependence in the EO and positioning segments. The European capacity to master critical space technologies independently would avoid possible interruptions of supplies due to new export regulations or to changing diplomatic relations with the supplier. In addition, mastering critical space technologies would allow Europe to maintain and improve its capabilities to respond to the continuously evolving needs of security.

This study will try to offer a detailed picture of the relationship between space, sovereignty and security in Europe. In Part One, it will analyse space assets in Europe, considering Launchers, EO, SATCOM, Navigation and positioning, SSA, ELINT and Early Warning sectors. The objective is to give a comprehensive picture of the systems at national and European level, their state of play, their possible evolutions, and their contribution to European security, including challenges and perspectives. Part Two will describe the institutional framework in which space capabilities elaborated under Part One may be made available for European security in a sustainable manner. First, the provisions introduced by the Lisbon Treaty on space and security will be presented, second the role of the different actors in the diverse phases of building such capabilities will be described. Finally, it will propose options and recommendations regarding the development of space capabilities for European security which could be implemented under the current treaties and within the scope of the forthcoming Multiannual Financial Framework (MFF) of the Union.

[7] Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions *Towards a Space Strategy for the European Union that benefits its citizens*, COM(2011) 152, 4 April 2011.
http://ec.europa.eu/enterprise/policies/space/files/policy/comm_pdf_com_2011_0152_f_communication_en.pdf

[8] European Parliament resolution of 19 January 2012 on a space strategy for the European Union that benefits its citizens.

[9] These are not ordinary shared competences, but particular ones. This argument will be addressed in detail in the Part Two of the present work.

PART ONE: EUROPEAN SPACE CAPABILITIES

Today governments – either unilaterally or bi-/multilaterally – develop their own civil, military and dual use space systems, while European institutions contribute to large civil programs for dual use purposes. SATCOM and EO are the most advanced and common applications available to MS, while GNSS and SSA could never be afforded by single European countries. For other capabilities, such as early warning and ELINT, the collaboration is presently at a low level and only France has relevant capabilities already in orbit or planned for the future. As far as launchers are concerned, so far European governments have guaranteed a solid cooperation aimed at assuring an independent access to space for Europe. Table 1 below provides a summary of all current and future space capabilities for European security & defense at the national and European level, within intergovernmental or communitarian cooperation frameworks. Such capabilities will be analysed in depth in the following paragraphs.

Table 1: European Space Programmes - Overview

	Launchers	Earth Observation	SATCOM	Navigation and positioning	SSA	ELINT-Early warning
National Programmes		**Present:** SPOT Helios 2 Pléiades COSMO-SkyMed SAR Lupe TerraSAR-X TanDEM-X **2014-2017** CSO CSG SARAH PAZ INGENIO	**Present:** Skynet 5 SatcomBw Secomsat Syracuse 3 Sicral **2015-2019** Heinrich Hertz Comsat NG SigMa		GRAVES TAROT TIRA Starbrook Fylingdales Chimbolton	**Present:** ELISA **2020+** Ceres Future Early Warning Space Based System
Cooperative Programmes	**Present:** Ariane-5 Soyuz Vega **Future:** Ariane-5 ME Ariane-6	**Present:** Helios 2 – COSMO-SkyMed Helios 2 – SAR Lupe ORFEO **2014-2017(?)** MUSIS	Sicral 2 Athena-FIDUS ESCPC ETISC SECTELSAT NSP2K EDRS		ESA SSA programme	**2020+** Ceres
EU Programmes		**Present:** GMES contributing missions **2014-2017** GMES operational system		**Present:** EGNOS Galileo IOV **2014** Galileo pre-operational **2020** Galileo operational	EU support programme to SST segment of ESA SSA	

1. AN INDEPENDENT ACCESS TO SPACE FOR EUROPE

1.1 Contribution to European security

An independent, reliable and responsive access to space represents the essential condition for any space-based military and security activity. In fact, autonomous launch capabilities are necessary to put into orbit, replace, or upgrade those satellite systems which ensure key military and security space applications - communication, navigation, earth observation, intelligence, surveillance and reconnaissance - described in the following chapters of the study. As repeatedly underlined by European institutional documents, and in particular by the ESP, the lack of such an asset in Europe would have serious security consequences. Indeed, EU independent access to space is considered as a key element for the success of the European security policies, included CSDP.

Along the fundamental role of launch systems in enabling "security from space", an independent access to space is essential also to guarantee the integrity of the critical space infrastructures mentioned above, ensure the sustainability of space activities and preserve this global common for peaceful purposes. Reliable launch capabilities, in this context, are fundamental to deploy and maintain into orbit technologies and assets for space SSA, thus ensuring "security in space".

Finally, the retention and advancement of technological competencies and industrial know-how in the launchers domain has strong strategic implications, both in civil and military terms. In this sense the reference technology, though obviously not the only one involved, is propulsion. On the one hand, the latter is at the base of any other space vehicle (i.e. ESA's Automated Transfer Vehicle – ATV and Intermediate eXperimental Vehicle– IXV) that will make Europe advance in its future exploration endeavours, in re-entry missions, and in space manned and unmanned planes. The latter could support advanced military applications in the future related to force deployment and ISR. On the other, propulsion is one of the core elements of ballistic or ICBM missiles([10]) and related defence systems, which are still central in the dissuasion policies of France and the UK, but also in the traditional defence policies of other European countries.

1.2 Current launch capabilities

Today Europe relies on launch capabilities made available within the ESA framework – Ariane-5 and Vega - and through international cooperation – Soyuz at the *Centre Spatial Guyanaise* (CSG). Developed in only six years and inaugurated in 1996, thanks to 54 consecutive successful launches Ariane-5 is currently considered the most reliable heavy-lift launcher in the space transportation global market. Inaugurated in 2012, Vega lightweight European launch vehicle contributes to fill Arianespace's operational gap in the market of small satellites. Finally, the European launchers family is completed by the Russia's medium-class launcher Soyuz, whose performances perfectly complement that of Ariane-5 and Vega. The exploitation of Soyuz is the result of the 2005 agreement signed by ESA and Russia's space agency, Roscosmos, to exploit the launch vehicle for European space transportation exigencies.

Along with the specific launcher development and accompaniment programs described in Annex I, two significant ESA initiatives contribute to ensure the continuity and improvement of the European space transportation capacity and related technologies, namely, the Future Launcher Preparatory Program

[10] Warheads are not included.

(FLPP) and the Launchers Exploitation Accompaniment Programme (LEAP)([11]). It is in the first framework that, for instance, ESA elaborated new launch concepts, including those pertaining to Europe's Next Generation Launcher (NGL), today known as Ariane-6; whereas in the second, ESA pursues a stable and comprehensive accompaniment frame for the exploitation of the ESA-developed launchers, contributing to the improvement of the competitiveness of the sector and to the sustainability of European access to space. These programmes provide once more evidence of the importance of technology and non-dependence in the space domain.

1.3 Recent developments

Given the strategic value attached to a EU independent access to space, ESA and its member states clearly recognize the necessity to keep the European family of launch vehicles up to date, capable to intercept an evolving satellite market, and competitive (in terms of costs and reliability) with new emerging international partners. For these reasons, the future of the European space transportation sector has been at the centre of tight negotiations during the ESA ministerial Council held in Naples in November 2012.

1.4 Challenges and perspectives

Despite the remarkable successes obtained by the European space transportation sector in the last thirty years, today ESA, the EU and their respective Member States may encounter some difficulties in ensuring an independent access to space. While significant efforts have been done to promote the modernisation of the available family of rockets that may responds to the evolution of satellite technologies and characteristics, the growing international competition in the sector risks to jeopardize the sustainability if the European policy on space access. In order to respond to the challenge represented by the competition of traditional space powers and emerging new actors on the global market, Europe will necessary have to find a solution to the funding and governance problems which currently affect the space transportation sector and in particular the launch company Arianespace.

1.4.1 A new governance approach

The European launchers' governance is today extremely complex. To comprehend this complexity, it's enough to think at the peculiar role of ESA – manager, developer and funder of the European launchers programs, but also the key European institutional customer. Or the role of EADS Astrium, at the same time involved as a prime contractor in the production of the launch vehicle (Ariane-5) and in the marketing of this launcher through Arianespace (holding the majority share among industrial partners). Or the interests of CNES, at the same time majority stakeholder in Arianespace, responsible over CSG, and leader in the development of the Ariane launcher.

In order to identify innovative options for the launchers' development/exploitation governance scheme, in April 2012 ESA launched an invitation to tender for a feasibility study for a New European Launch Service (NELS). The aim of the tender is to identify a solution that would ensure an independent, competitive and economically self-sufficient access to space, by achieving a self-sustained exploitation phase with no need for public support to cover its costs.

The most innovative element introduced by the NELS initiative is the focus on new industrial policy principle to manage ESA procurement. In fact, the Agency's Member States participating future

[11] LEAP financial envelop agreed on 2012 ≈ EUR 540 million. Member states contributing to LEAP: Austria, Belgium, Germany, France, Italy, Ireland, Norway, Netherlands, Sweden, Switzerland.

development programs would fund development activities on the basis of the newly-introduced "fair contribution" principle rather than adopting ESA's traditional "geographic return" rule. Thanks to this innovation, ESA expects that the industrial distribution of work would be based on best technical competence and cost effectiveness, and not strictly commensurate Member States' financial contribution to the budget of the program.

Table 2: Access to Space Programmes

	National Programmes	Cooperative Programmes	EU Programmes
Launchers		**Present:** Ariane 5 [ESA-(AT-BE-DK-FR-DE-EI-IT-NL-NO-ES-SE-CH-UK)] Soyuz (ESA-Roscosmos) Vega [ESA-(BE-FR-IT-NL-ES-SE-CH)]	
		2016-2021 Adapted Ariane 5 ME/Ariane 6 [ESA-(FR-DE-BE-IT-CH-NL-ES-SE-NO-AT-RO-EI)]	

2. EARTH OBSERVATION

2.1 Contribution to European security

EO capabilities are extensively used during the full range of European security and defence missions, included military interventions, border surveillance, response to natural and manmade disasters, and humanitarian assistance. From a military point of view, EO capabilities are fundamental both at the strategic and tactical levels and in particular are central – along with other technologies and capabilities (see further) - to make ISR more accurate, thereby providing timely and comprehensive information to decision-makers and forces in the theatre. This is obviously true for military operations carried out by single nations, but also in the framework of the EU.

As a matter of fact, in a CSDP context, satellites' data and information for monitoring, surveillance and intelligence prove essential not only for military missions, but also for civilian ones. In the first respect, for instance, in the context of the EU NAVFOR Somalia – Operation Atalanta, space imagery is used to survey with regularity and continuity both land and maritime areas in order to detect pirates' activities, monitor their bases, search for training camps([12]). Another EU military mission that benefited from space data and information is EUFOR Althea, deployed in Bosnia-Herzegovina, for which reference maps

[12] See EUSC Annual Reports 2009 and 2011,
http://www.consilium.europa.eu/uedocs/cms_data/docs/mailing/file904.PDF.
http://www.satcen.europa.eu/images/stories//eusc%20annual%20report%202011.pdf.

reporting relevant features over the area of responsibility of the EU supported the engaged forces ([13]). In EU civilian operations space data and information are equally useful. For instance, the police mission EUMM in Georgia was provided with information derived from the detection and monitoring of military activity, in particular regarding the movement of vehicles and personnel([14]). The same can be said for other police missions such EUTM Somalia deployed in Uganda, EUPM in Bosnia-Herzegovina, EUPOL-COPPS in Palestine, EUPOL DR Congo; for rule of law missions (EUJUST THEMIS in Georgia and EUJUST LEX in Iraq); and for border monitoring missions (EUBAM Rafah)([15]).

Satellites provide an important contribution also to internal security. EO information can be used to improve land and maritime border surveillance, critical infrastructures protection, fight against organised crime and counter terrorism operations. Optical remote sensors can provide users with up to date and high resolution images of land and maritime borders. Through multispectral and hyper-spectral sensors it is possible to obtain night data, while the synthetic aperture radar systems, based on high resolution radar images, can provide all time and all weather data. Satellite's data contribute to the surveillance and security of critical infrastructures such as rails, electricity networks and pipelines, especially if coupled with data coming from in-situ systems. In the fight against terrorism space data can provide important information on suspects' movements or hiding places or training camps. This is true for organized crime as well, for which different kinds of trafficking could be detected.

Satellites are also increasingly useful to support users involved in the whole cycle of crisis management – prevention, response, reconstruction. For instance, in natural or manmade disasters or humanitarian crisis space can deliver timely and accurate information to produce maps of the area of crisis for damage assessment or for planning evacuations and rescue, fire fighting and every kind of operation needed to face an emergency. With respect to disasters prevention, remote sensing allows to study the structure of land against landslides, the seasonal patterns of rivers against floods, the composition of snow against avalanches or of ice against ship accidents, and so on.

In Europe some space faring nations have developed their own EO systems for both civil and military use. In addition, the EU has funded a civilian EO programme that will be exploited also for security needs. Indeed, civil institutional and commercial systems are becoming more and more relevant also for security and military actors as the amount of data required in complex operations makes those provided by the few dedicated satellites insufficient.

2.2 National and cooperative systems

In general terms, **France** has the most comprehensive space program among European nations. Regarding EO in particular, two families of satellites for institutional and commercial purposes have been developed since the mid-1980s. The first family, called **SPOT** had its first launch in orbit in 1986. The seventh payload of the SPOT family, SPOT-7, is scheduled to be launched in 2014 and will join SPOT-6 and **Pléiades**-1A and 1B, launched in 2011 and 2012, in the same orbit, thereby creating a constellation of four high resolution optical satellites for dual use.

The second family gave birth to the first exclusively military system launched by a European nation in 1995 - that is **Helios-**1A - joined by the more advanced Helios-1B in 1999. The Helios-1 series of satellites has also the merit to have initiated the first collaboration among European nations in the field of EO for security and defence. In fact, **Italy** and **Spain** participated in the development of the satellites in

[13] See EUSC Annual Report 2011.
[14] See EUSC Annual Reports 2009 and 2011.
[15] See footnote 32.

exchange of data access rights. This collaboration is ongoing with the **Helios-2** satellites, the first launched in 2004, and the second in 2009. France separately agreed with Italy and **Germany** the exchange of data between Helios-2 and **COSMO-SkyMed** and **SAR Lupe** respectively to bring together optical and radar capabilities. Moreover, **Spain**, **Greece**, **Belgium** and **Denmark** contributed to the development of the system, thereby obtaining Helios-2 data access.

Indeed, Italy and Germany have followed France in the development of their own satellite systems for dual (Italy) and military (Germany) applications. Both nations concentrated their efforts on the development of SAR capabilities, resulted in the launch of the Italian COSMO-SkyMed constellation, four satellites between 2007 and 2010, and German SAR Lupe series, five satellites for defence purposes launched between 2006 and 2008. COSMO-SkyMed represents an innovation in Europe, being the first truly dual-use constellation conceived. Recently, Thales Alenia Space Italy signed the contract for the development and construction of two **COSMO-SkyMed Second Generation** (CSG) satellites, scheduled to be launched in 2016. In addition to the SAR Lupe military constellation, Germany launched two SAR satellites for civil use: the **TerraSAR-X** put into orbit in 2007and the TerraSAR-X Add-On for Digital Evaluation Measurement, named **TanDEM-X**, launched in 2010. The two satellites are absolutely complementary and useful, for instance, for topographic mapping, land use and cover mapping, surface movement monitoring and emergency response information. Spain is developing its **PAZ** military SAR satellite that will be later joined by **INGENIO** dual use optical satellite. Both projects are fully funded by Spanish Ministry of Defence and developed by Astrium. Their launches are scheduled for 2014.

Italy and France are also parties to the bilateral agreement **Optical and Radar Federated Earth Observation** (ORFEO), in which the French Pléiades and the Italian COSMO-SkyMed are the optic and radar components respectively. In line with these positive collaborations, France, Italy, Spain, Belgium, Germany, Greece, **Poland** and **Sweden** agreed to collaborate in an innovative intergovernmental EO programme, the **Multinational Space-based Imaging System** (MUSIS).The cooperation aims to integrate the ground segments of the future EO systems for a mutual access to data in a logic of "System of Systems", while the partners traditionally engaged in EO systems will continue to develop the relevant components.

2.3 GMES/Copernicus

The **Global Monitoring for Environment and Security** (GMES)/Copernicus is the European EO programme relying on a federation of systems. The program is co-funded by the EC and ESA, under the overall responsibility of the EU (see also Part Two 9.1 *EC* and 9.2 *ESA*). Started in 1998 with the goal of establishing a sustainable pan-European information system to specifically support environmental security, it was eventually reoriented to both environment *and* security at a time when the stiff line dividing security and defence was put into question and security was progressively appreciated as a broader concept.

The GMES/Copernicus program is divided in three components: the in-situ component, the services component and the space component.

GMES/Copernicus services are structured around six thematic areas: Land Monitoring (operational), Marine Monitoring (pre-operational), Atmosphere Monitoring (pre-operational), Emergency Management (operational), Security (pre-operational) and Climate Change (under development)([16]).

[16] See http://copernicus.eu/pages-principales/services/.

As for the security thematic area, some pre-operational products and services have been developed in Maritime surveillance, Border control and Support to the EU External Action and should become operational by 2014. GMES/Copernicus areas of support of European External Action (SEA) are: support to EU peace-keeping operations, intelligence for humanitarian-aid operations, border monitoring outside the EU, assessment of security risks related to urban resilience, food security, water management, illegal exploration of natural resources and illicit crops.

The satellites which currently contribute to GMES/Copernicus are divided in four categories:

- SAR Missions
    - COSMO-SkyMed
    - TerraSAR-X
    - TanDEM-X
    - Radarsat-2
- Optical Missions
    - SPOT
    - Pléiades
    - Rapid Eye
    - UK-DMC-2
    - Proba V
- Altimetry Missions
    - CryoSat
    - Saral/Altika
- Atmospheric Missions
    - Calipso
    - Meteosat Second Generation
    - MetOp.

GMES/Copernicus will be fully operational when its own space component will be launched in Earth orbit. This component is composed of five Sentinels missions and one named Jason CS. As said, these satellites and payloads are under development by ESA specifically for the operational needs of the GMES/Copernicus program. The Sentinel missions are based on three constellations of two satellites each and two payloads to be embarked upon other satellite platforms. ESA has planned the first launch of a Sentinel satellite, which should be Sentinel-1A, no earlier than 2014.

2.4 Recent developments

In the field of national EO systems France, Italy and Germany dominated the scene in the last decade and such trend will be certainly confirmed through 2020. France recently launched its first dual use system, Pléiades, allowing the full application of the ORFEO agreement with Italy. Spain will soon join the group with its two EO satellites, while France will launch its third system for military purposes, CSO. On their part, Italy and Germany will complete their second SAR systems for dual and military uses respectively, namely, CSG and **SARAH**(2017?). Moreover Italy - which intends to strengthen its position

in the EO segment with the realization of the OPSIS (Optical System for Imaging and Surveillance) satellite dual-use system – is also involved in extra-EU initiatives, such as the development of the hyper-spectral satellite Shalom in cooperation with Israel. The establishment of these new European capabilities will potentially contribute to the success of MUSIS, although at the time of writing no relevant development can be highlighted in that respect.

At the same time, it has to be noticed the increasing role of private actors in the geospatial information market. This is, for instance, the case of Astrium Services, which has exclusive access to data from the SPOT and Pléiades optical satellites as well as the TerraSAR-X and TanDEM-X radar satellites, and can therefore offer a complete set of EO products and services to the end-users.

Concerning GMES/Copernicus, 2012-2014 represent crucial years for the success of the programme in general and of its Security dimension in particular. Indeed, decisions on funding and on the governance of the programme are the main variables. Negotiations all along 2012 on the EU budget have allowed to reintegrate the flagship programme in the MFF, as decided by the European Council in February 2013. According to its conclusions, the programme will fall under the Sub-Heading 1a (Competitiveness for growth and jobs)([17]) for an amount of EUR 3.786 billion. Considered the financial needs of GMES/Copernicus for the transition from the pre-operational to the operational stage, the EP evaluated that the amount agreed cannot be sufficient. In fact, it should be recalled that in the original EC's proposal for a special fund the amount reached EUR 5.8 billion. Unsatisfied with the overall cuts to the EU budget as a whole operated by the Council, in March 2013 the EP rejected the Council's conclusions judging it too restrictive and not sufficiently focused on investments in research and development, innovation and infrastructures for stimulating the growth of Europe and overcome the economic and financial crisis ([18]).

Regarding the governance of the programme as a whole, the EC is about to issue a proposal for a Regulation. In this respect, the organizational setting of the Security dimension and related services is still unclear. Of course, great attention is paid to this point by MS, which are concerned about the proper handling of security aspects in general and of data security policy in particular. In this sense, the EC is also preparing a proposal for a Delegated Regulation on the access to GMES dedicated data and GMES service information (see also Part Two 9.8 *MS*).

2.5 Challenges and perspectives

Since EO systems generate data/images with very high information content and are therefore considered one of the most sensitive space applications, the establishment of a future European EO capability for defence and security is challenged by a series of factors.

First, both SAR and optical technologies are currently mastered by a handful of European countries which are desirous to maintain sovereignty over their technological advances in satellites, sensors and data processing, thus preventing significant transfer and sharing of know-how at the European level. Such approach, for instance, has contributed to block the development of MUSIS, producing intense debates over the ownership question. In fact, countries which have already done relevant investment in EO satellite systems - such as France and Italy - in order to defend their privileged towards newcomers, are today extremely sceptical about the evolution of the programme.

[17] Conclusions of the European Council, EUCO 37/13, 8 February 2013.

[18] European Parliament resolution of 13 March 2013 on the European Council conclusions of 7/8 February concerning the Multiannual Financial Framework.

In addition, cooperation on EO issues is discouraged by different legal, data policy and security approaches adopted at the national level. Each country, as France with the *Loi Relative aux Operationes Spatiales*, Germany with *Satellitendatensicherheitsgesetz* (SatDSig), and Italy with COSMO-SkyMed Data Policy, defines internally the measures and the procedures for distributing data and security-related information. The establishment of a European integrated EO capability, therefore, will necessarily require convergence of the different legal frameworks adopted by each MS. Reaching these kinds of agreement, however, is far from being easy. In the case of the current multilateral cooperation between Helios, COSMO-SkyMed and SAR Lupe, each country individually and confidentially plans its daily image captures to be received by their own ground stations according to its political priorities and security interests.

While technical obstacles represent a minor issue for further assets integration, the sensitivity of the data and information acquired, processed and generated by EO systems still produces significant political resistance. Without a strong push from Europe's top three space nations – France, Germany and Italy - towards deeper cooperation, the current impasse is hard to overcome.

In the meanwhile, it will be extremely important for the EU to bring GMES to completion, and possibly to extend – when needed - the provision of its services also in NATO framework. This would contribute to generate confidence among strategic partners, contributing to increase civil-military synergies and the reliability of dual-use systems both from the political and the technical points of view.

Table 3: Earth Observation Programmes

	National Programmes	Cooperative Programmes	EU Programmes
Earth Observation	**Present:** SPOT (Civil-FR) Helios 2 (Military-FR) Pléiades (Dual-FR) COSMO-SkyMed (Dual-IT) SAR Lupe (Military-DE) TerraSAR-X (Civil-DE) TanDEM-X (Civil-DE)	**Present:** Helios 2 – COSMO-SkyMed Helios 2 – SAR Lupe ORFEO (FR-IT)	**Present:** GMES contributing missions

	2014-2017 CSO (Military-FR) CSG (Dual-IT) SARAH (Military-DE) PAZ (Military-ES) INGENIO (Dual-ES)	**2014-2017(?)** MUSIS (BE-DE-ES-FR-GR-IT-PL-SE)	**2014-2017** GMES operational system (present contributing missions + future contributing missions + Sentinel + Jason CS)

3. SATELLITE TELECOMMUNICATIONS

3.1 Contribution to European security

SATCOM capabilities constitute the backbone of any operation and activity in the domain of defence and security. Security missions increasingly rely on advanced SATCOM connectivity and information technology solutions to manage vast amounts of data with timely dissemination. Adequate SATCOM services are necessary to ensure both strategic decision-making and tactical operational autonomy. Moreover, satellite communications play a fundamental role in the management of growing information flows guaranteed by a new generation of space-based, aerial and terrestrial sensors.

SATCOM ensure a fundamental early-entry tool in new remote theatres characterized by lacking or unreliable terrestrial communication infrastructure. SATCOM are necessary to develop and implement sophisticated command, control, communications, and computers (C4) capabilities, to meet troops' war fighting information requirements and guarantee reliable combat support information. As well, they ensure the operational coordination of first responders, rescue teams and survivors in public safety missions.

Quickly deployable and highly efficient, SATCOM are largely used to establish secure and independent strategic communications with national HQs and tactical connection among the forces or rescue teams deployed in theatre. Due to increasingly demanding operational requirements, satellites are not only used to ensure voice communications, but play a growing role in real-time transmission of data, images and videos. At the strategic level, commanders rely upon SATCOM to communicate directly with domestic decision makers to keep them continuously briefed on the progress of operations and planning for future missions, either over conference calls or by using video teleconferences, which require high bandwidth connections. At the tactical level SATCOM ensure intra-theatre dissemination of information and data (i.e. for situational awareness or damage assessment) among personnel belonging to different commands and areas of responsibility. Moreover, space-based communications are largely used for second line services, administrative and support functions (i.e. telemedicine, distance learning) and for personnel's communications with their families.

In recent years, the military and security domain has experienced a tremendous evolution in technology which has contributed to drive SATCOM capacity and capability needs forward. Such evolution characterizes, in particular, three domains: ISR applications, which guarantee indispensable strategic and tactical information advantage across all sectors of EU military and homeland security activities (from CSDP missions to border surveillance operations and civil protection interventions); the unmanned aerial vehicles (UAVs) sector, which dramatically improved the timeliness and accuracy of situational awareness in the theatre of operations while reducing risks for human life; the Network-enabled capability (NEC) domain, which exploits the potential of information technology for military equipment in order to improve the "shared situational awareness" at all levels, from the infantry unit to the HQs. In this respect, SATCOM represent the necessary communication link to ensure an effective and efficient integration of these new capabilities into the existing C4 architecture (See, for instance NATO's *NEC over SATCOM* Task Group).

The increasing reliance on aerial ISR platforms encourages a rapid transition from narrowband communications using L-band satellites to wideband SATCOM exigencies, thus creating even greater demand for high-capacity bandwidth. In addition, satellite communications play a critical role in ensuring efficient use of semi-autonomous and fully autonomous UAV platforms. Indeed, reliable and secure satellite communications are a critical enabler for medium- and high-altitude UAVs, whose increasingly sophisticated sensors - high-definition cameras, multiple video feeds, wide-area airborne surveillance radar, and modular, multi-intelligence payloads - would allow to send immense quantities of imagery and data from their remote locations to geographically dispersed sites both at home and in the theatre. These platforms rely on airborne applications that require four to eight times the space segment to deliver equivalent data rates compared to land-based VSAT links, and clearly drive the demand for secure and larger quantities of satellite services.

Additional satellite bandwidth capacity will be finally required to integrate SATCOM systems with terrestrial communication networks. The NEC evolution, will indeed lead towards further digitalization of the operational field, requiring the creation of local wireless bubbles connecting deployed personnel's handheld, nomadic and vehicle mounted devices, in order to provide them access to strategic, tactical and administrative information and data. Satellite communication services are best suited to provide easily scalable, adaptable, secure and interoperable capabilities to sustain wireless technology integration and ensure efficient and cost-effective communication interchanges among forces in all kinds of operational environments.

At present, technical constraints and limited satellite availability do not allow European military and security personnel to deploy and fully exploit these new assets and capabilities. The necessity to enhance the European capacity of data and information transmission has been clearly recognized by the national governments, by ESA and by the EDA, which have developed and continue investing in satellite communication capabilities (see below).

3.2 National systems

European countries have adopted different approaches towards the establishment of SATCOM for defence and security purposes. On the one hand, the main space faring nations in Europe - **France**, **Germany**, **Italy**, **Spain**, and the **UK** - have developed, and are currently updating, their own national satellite systems for military communications. New approaches also envisage the establishment of government-owned dual-use systems for military and public safety requirements (See Athena-FIDUS, below).

On the other hand, other European countries completely rely on commercial operators for their military SATCOM since these are providing increasingly secure services. In addition, there emerges a clear trend

towards the PPP form of procurement based on service provision rather on asset purchase. In addition, the French-Italian cooperation in the field of military SATCOM could pave the way for other pooling and sharing initiatives in Europe, as those launched in the framework of EDA.

At present Europe relies upon five almost dedicated SATCOM systems, composed by twelve different communication satellites and 10 ground control stations. The UK MoD is procuring satellite communications services through **Skynet-5**. The Skynet-5 system is developed within a Private-Finance-Initiative (PFI), whereby the military procures SATCOM services - including maintenance and operation of the complete ground infrastructure - from Paradigm (subsidiary of Astrium, purposely created). In 2022, when the contract with Astrium will expire, the UK government will take ownership of the four satellites and will launch another competition to assign service operations.

Also in Germany the provision of secure satellite communication services is contracted to a commercial entity. In fact, while the **SatcomBw**'s satellites are owned by the MoD, the 10-year programme is managed by MilSat Services, a joint-venture company between Astrium Services and ND SATCOM. Additional C- and Ku-band capacity is acquired through long-term leases from commercial operators such as Intelsat.

Spain has adopted a hybrid approach. In fact, the Spanish MoD procures a relevant part of its secure military communication services from a partly-commercial system, **Secomsat**. Secomsat is composed by two satellites: SpainSat, which services are provided by HisdeSAT - a government satellite services operator - for the MoD, and XTAR-EUR, a spacecraft operated by XTAR LLC, a US-based joint venture between HisdeSAT (44 %) and Loral (56 %).

France's military forces, on the contrary, rely upon **Syracuse-3**, the third generation of the French dedicated military SATCOM system, owned and operated by Direction Générale de l'Armement (DGA-General Directorate for the Armament), the MoD's procurement agency. Under Sarkozy's Presidency - France has explored the possibility to privatize the system by selling and leaseback the Syracuse 3 constellation to a commercial operator (Thales Alenia Space, indeed, had expressed interest in the sale-and-leaseback scheme adopted by Astrium Services in the UK), but such possibility was finally rejected for strategic reasons. In 2007 France was expected to order a third Syracuse spacecraft, but this option was eventually ruled out in favour of including the Syracuse-3C payload on the Italian X-band/EHF satellite system, Sicral-2.

Sicral is Italy's family of military SATCOM system. The first generation of Sicral – operated by the Italian MoD - is composed of two satellites (Sicral-1A and 1B) for military telecommunications. The system can operate simultaneously on several frequency bands (SHF, EHF and UHF). In 2010 the Italian MoD announced, in collaboration with its French counterpart, the development of the second generation of the military communications satellite (Sicral-2) together with its ground segment. Sicral-2 – which will separately host the French SHF Syracuse-3C payload - represents the first cross-border cooperation in military SATCOM in Europe.

3.3 Cooperation (bilateral and multilateral)

The Franco-Italian cooperation is expected to produce further innovation in the security satellite communications domain. In fact, Italy's MoD and ASI together with France's DGA and CNES have launched the **Athena-FIDUS** initiative, aimed at realizing the first dual-use Ka-band broadband SATCOM system that will complement Syracuse 3 and Sicral 2 (2014). Once operational the system will be used by both the French, Belgian and Italian armed forces as well as the civil protection services of France and Italy.

Italy and France, together with the UK, also contribute to NATO's satellite communication capacity. Under the framework of the **NATO Satcom Post-2000** (NSP2K) programme, the three countries provide the Alliance with their SATCOM capabilities (the French Syracuse-3, the Italian Sicral-1, and the British Skynet-4 and 5) for a 15-year period, from January 2005 until the end of 2019. At the end of 2012, Germany announced the possibility to offer part of its SatcomBw's capacity to the NATO community.

At the European level, important cooperative initiatives have been undertaken both at the ESA and EDA level. ESA is currently developing a **European Data Relay Satellite** (EDRS) system, expected to contribute to overcome the delays in the delivery of time-critical data to users. The satellites will be able to rely on data from/to other satellites and space-crafts, as well as ground stations and antennas.

In the light of the emerging need of secure and reliable satellite telecommunication for military purposes, EDA has undertaken an ambitious programme to strengthen the European capabilities. The first, short-term, step in this context is the establishment of the European Satellite Communication Procurement Cell (ESCPC), in charge of coordinating the EU Member States' orders (currently France, Italy, Poland, Romania, and the United Kingdom) of commercial satellite communications services. Astrium Services has been awarded the ESCPC framework contract by the EDA, and is the first provider of commercial satellite communications for European military needs. EDA's initiative, however, has even more ambitious goals. In fact, the Agency is also involved in two projects, the mid-term European Tactical Interim Satellite Capacity (ETISC) and the long-term Secure Telecommunication by Satellite (SECTELSAT), which aim at responding to the increasing needs of space-based secure and reliable telecommunications taking into due account current and future cuts in public – and particularly defence – budgets.

3.4 Recent developments

While EDA's attempts to establish a shared SATCOM capability are still in their embryonic phases, national governments started discussing and planning future strategies to ensure their military and military forces with adequate, secure and autonomous satellite communication capacity. As already mentioned, the UK decided to undertake the private path with Skynet-5, and by 2022 the MoD will launch a new competition to assign service operations, which could be won by the incumbent operator Astrium Services.

On the contrary, the German MoD plans to strengthen its sovereignty on SATCOM by adding a dedicated Ku-band payload to the **Heinrich Hertz** telecommunications satellite planned by Germany's space agency, DLR. As in the case of the second EDRS satellite, DLR will use the OHB's SmallGEO bus to host the military payload. Such solution- to be approved in October 2013 -is clearly driven cost-efficiency calculations, and would ensure the MoD an additional dedicated capacity to be added to the services currently leased from the commercial operator. As expected, the bulk of the future demand for SATCOM capacity will be determined by the intensive use of UAVs in defence and security missions, to accommodate which the bandwidth guaranteed by SatcomBw would probably be not sufficient.

Despite its commitment in joint initiatives with Italy (Sicral-2 and Athena-FIDUS), France is currently planning the establishment of next-generation military satellite communications system to succeed Syracuse 3 in 2019, and to complement the capacity offered by the two Franco-Italian programmes. Last year the DGA has in fact contracted both Thales Alenia Space and Astrium Satellites to conduct two separate one-year technical and industrial studies for the realization of the future SATCOM system, dubbed Comsat NG. The DGA expects to include X-band, Ka-band and EHF payloads on the satellite, and does not rule out the possibility to involve other countries – namely Italy and the UK - in the initiative. The three-party SATCOM alliance would replicate somehow the cooperative initiative NSP2K

undertaken by the three countries in the NATO framework, providing continuity of their commitment also after the expiration of the first contract in 2019.

Also Italy, despite the bilateral cooperation with France, is evaluating the ASI proposal – backed by the MoD - to launch its own SATCOM system for civil institutional users (i.e. Government, Civil Protection), therefore with a possibility of military use. The system proposed, **Sigma**, will be composed by two Ka-band communications satellites and will funded an operated in partnership with the industry, as already done in the case of Sicral-1B and Sicral-2. Such an approach would represent a cost-efficient approach for both ASI and the MoD, who would ensure autonomous control over a secure SATCOM capacity despite Italy's current public finance crisis. In the meanwhile, at the end of 2012 Italy's tentatively agreed to assume control of the UHF-band military payload carried on the Intelsat 27 (IS-27) satellite. The destiny of the payload, however, it not yet clear, and it could eventually remain in Intelsat's hands which could directly lease – possibly on short-term agreements - its capacity to US or European defence forces. The IS-27 solution, as clearly stressed by the Italian MoD, would represent a second-best option for Italy, while the country's priority would remain the establishment of its own autonomous UHF capacity.

3.5 Challenges and perspectives

A series of strategic, technological and financial factors are likely to influence the evolution of the military and security SATCOM sector in Europe in the years ahead. In particular, the growing demand of satellite high-bandwidth capacity will be driven both by increasingly complex and demanding operational requirements, and by evolving technological capabilities in the fields of ISR, UAVs and NEC system.

In order to cope with these changes, the European military SATCOM domain - which for a long period has been under the exclusive control of national governments through their MoDs - is likely to move rapidly towards a significant structural and functional reorganization.

Greater emphasis on international cooperation, both at the intergovernmental, European and transatlantic level, represents the first potential trend. Italy and France, through their joint-initiatives Sicral-2 and Athena-FIDUS, have paved the way for further collaboration in this domain. The future participation of Italy and/or the UK to France's Comsat NG will show whether European governments are ready to deepen strategic integration to overcome evident European capacity shortcomings. EDA, in this context, could play a pivotal role, acting as a catalyser of the MS's exigencies. Top EDA's officials clearly recognize and promote the development of a European SATCOM capacity as one of the most important targets for the EU's defence and security policy. The success of the IDT Command of the Capability Directorate of the Agency in successfully launching the ESCPC's activities in 2012 is the best example of EDA's commitment to this subject. The experience of NATO's NSP2K, reinforced by Germany's potential inclusion in the programme, certainly represents a potential pooling & sharing model for the establishment of a European capacity.

At the same time, efforts could be expected in the establishment of dual-use capabilities, in order to provide secure SATCOM communications to both military and public safety forces. In this context, investments in dual-use would contribute to rationalize and reduce public spending; enhance interoperability between military and non-military actors; exploit technological and industrial synergies.

The need to invest in dual-use capabilities is recognized both at the national and European level. Among EU Member States, France and Italy are certainly in the forefront in this domain, as demonstrated by their commitment in the Athena-FIDUS and Sigma programmes. The necessity to embrace a dual approach has been sponsored– possibly surprisingly – by EDA, who expects to offer the access to its SECTELSAT programme also to EU civilian communities, thus moving from five national military SATCOM capabilities towards an integral single European-wide intergovernmental (thus not exclusively military) satellite communication system.

Table 4: Satellite Telecommunication Programmes

	National Programmes	Cooperative Programmes	EU Programmes
SATCOM	**Present:** Skynet 5 (Military-UK) SatcomBw (Military-DE) Secomsat (Military-ES) Syracuse 3 (Military-FR) Sicral (Military-IT)	Sicral 2 (Military - FR-IT) Athena-FIDUS (Dual - FR-IT) ESCPC [EDA-(FR-IT-PL-RO-UK)] ETISC (EDA)([19]) SECTELSAT (EDA)([20]) NSP2K (NATO)	

[19] ETISC is a medium-term EDA's project for pooling and sharing on SATCOMs. At the moment there is no list of participating States.

[20] SECTELSAT is a long-term EDA's project for pooling and sharing on SATCOMs. At the moment there is no list of participating States.

	2015-2019 Heinrich Hertz (Military-DE) Comsat NG (Military-FR) SigMa[21] (Civil-IT)	EDRS (ESA)	

4. NAVIGATION AND POSITIONING

4.1 Contribution to European security

The range of navigation satellites' (Satnav) users has increased since the mid-1990s, when GPS was made available to the world public on a free basis. In fact, space-based navigation can be useful to guide air, ground and maritime transportation, both for passengers and cargoes, while supporting citizens' orientation in the city's traffic or agriculture for precision farming or financial transactions worldwide. GPS has become so common that today even cell-phones have their built-in receivers. Al these applications have created an international civil market of space-based navigation systems, which has become a very remunerative business.

As a matter of fact, navigation satellites were originally designed for strictly military purposes, such as coordination of ground troops on the operations theatre and the guidance of vehicles, air sorties and strikes. Back in the Cold War, for instance, the US' pioneering satellites for positioning, the Transit series, supported the Navy's nuclear powered submarines to determine their position. Notwithstanding, today, Satnavs are also fundamental for safety and security purposes with a wide range of applications. Indeed, navigation services can provide important information to police and security forces to coordinate their efforts for counter terrorism or organized crime operations. For instance, Global Navigation Satellite Systems (GNSS) help users to remotely guide UAVs, or manned aerial assets, for border or target surveillance, giving to ground security forces a better situational awareness. GNSS can also be useful to coordinate rescue operations in case of natural or man-made disasters, guiding forces were they are needed. For instance, navigation satellites can provide aerial components of fire brigades with guidance in case large fires cause walls of smoke, making visual navigation impossible.

The importance of disposing of an independent GNSS is given by the possibility of a GPS' voluntary or involuntary failure. Indeed, if the American system faces a problem or threat that causes service's interruption, all the missions and tasks mentioned above could be seriously hampered or even made impossible to perform.

This consideration was therefore at the base of the launch of the EU GNSS programme in the mid-1990s. Given the width and complexity of the endeavour, it was envisaged to rely on a two-phase strategy to this purpose: one (GNSS-1) establishing the **European Global Navigation Overlay System** (EGNOS)

[21] SigMa is an Italian SATCOM project announced in 2009 for civil institutional use and possibly dual use. In 2011 ASI created the subsidiary ASITEL to manage the PPP which would finance SigMa. At the moment there is no scheduled time for developing and launching the system.

aimed at providing a satellite-based augmentation system that improves the accuracy signals of the GPS constellation, guaranteeing the detection and corrections of errors; the second (GNSS-2) including the development of a new constellation of satellites for civil navigation purposes, named **Galileo**. After initial difficulties due to combined and different factors and marked by the failure of the PPP model of financing, costs overruns, and delays, the project is back on track again since 2008 following its re-profiling, with some operational services provided by EGNOS and the first Galileo ones to be inaugurated starting from 2014.

4.2 EGNOS

EGNOS infrastructure comprises a ground network of 34 ranging and integrity monitoring stations (RIMS), six navigation land earth stations (NLES), four mission control centres and signal transponders on three GEO satellites: ARTEMIS, Inmarsat AOR-E and Inmarsat IOR-W.The signal coverage area comprises the European countries. The services are provided by the European Satellite Service Provider (ESSP).

EGNOS is already operational sharpening and correcting the accuracy of GPS' signal on European countries. Moreover, the system informs users about the current reliability level of the GPS' signal. If the accuracy falls below a given threshold, users are warned within six seconds. EGNOS today provides two services: the Open Service (OS), available since 2009 for general applications without safety and security implications, and the Safety of Life (SoL), available since 2011 for applications where human lives depend on the accuracy and integrity of the signals such as air navigation. In fact, the GPS' signal can suffer of delays and lack of accuracy due to the interference of the ionosphere or timing errors. This can result in a position error that could be fatal for an airplane forced to make an instrumental landing due to bad atmospheric conditions. EGNOS can thus execute a couple of actions: correct the signal's error or indicate it to the pilot so he/she can decide to take manual controls and switch on different navigation instruments.

4.3 Galileo

The first steps of the Galileo program were the launches of the **Galileo In-Orbit Validation Element** (GIOVE), a constellation of two satellites, launched in 2005 and 2008, as technology demonstrators.

The GNSS Galileo will be a constellation of 30 satellites, 27 operative and three in-orbit spares, that will provide users with 4 different kinds of services: the OS, the SoL, the Search and Rescue (S&R), the Commercial Service (CS) and the Public Regulated Service (PRS).

The most relevant service for security and defence, the **PRS**, will be a highly encrypted signal. Its utilisation will be reserved to the Council, the EC, the EEAS, MS and, under specific arrangements and agreements, to EU agencies as well as third Countries and International Organisations. It shall be for each individual MS, the Council, the EC and the EEAS to decide whether to use the PRS within their respective competences. In this sense, each MS shall decide independently which categories of national natural and legal persons are authorised to be PRS users, as well as the uses they should make of it,

including security-related uses. This is true for the Council, the EC and the EEAS too, which shall decide which categories of their agents are authorised to be PRS users([22]).

PRS applications may be very sensitive from a political and strategic viewpoint and its use will be closely monitored and controlled for safety and security reasons. In this sense, the Galileo Security Monitoring Centre (GSMC) – entity directed by the European GNSS Agency (GSA, see Part Two 9.4 *GSA*) - will play a major role. In fact, GSMC will be responsible for the operation of the PRS and will be the single interface between the system and users (i.e. organization of users community, access to the service, etc.). At the same time, the GSMC will be also in charge of operational security issues related to the whole system, such as monitoring performances and threats. The GSMC is composed of two centres located in France – in a military complex - and in the UK and will turn operational together with the PRS, while expected to be ready by the end of 2013.PRS applications will be used for emergency services, critical transportation, energy, internal security and defence: even if Galileo is the first civilian GNSS in the world, nothing prevents MS from the use of it for military purposes([23]).

4.4 Challenges and perspectives

Initially the European project to realize an independent navigation system faced the opposition of the US. The US Department of Defence (DoD) contrasted Galileo considering it a useless duplication of GPS which was available on a free basis to European governmental and non-governmental users. In addition, the European Galileo was to be a civil program under civil control, which was at odds with the US' conception of having strategic assets under the direct control of the military for security reasons. Consequently, in 2001, the US advanced concerns about Galileo. The arguments raised related to the possible unfriendly use of Galileo's signal by US' enemies and the potential interference of the PRS and OS signals with the American M-Code, the military code, in the high frequency band. As a matter of fact, the possibility of a degradation of the accuracy of GPS' civil signal for US' defence and security purposes was being ruled out by the European system. In an attempt to reassure the US on the validity of the EU programme and on its harmless purposes, the EC proposed for the first time a joint exploitation of the two systems([24]).

The reluctance of the US was overcome after a series of intense negotiations lasted four years, which led to official cooperation through the agreement reached in 2004([25]). The EU concurred to change the modulation of the PRS to not interfere with the military signals of GPS which is at the service of US and NATO armed forces. The agreement also allowed the parties to jam their own signals without affecting the other's and made GPS and Galileo compatible and interoperable([26]). The final signals modulation was established in 2006 by a dedicated EU-US Working Group.

The EU-US collaboration on navigation systems nevertheless bears a technology competition. As mentioned above, the Galileo system is at the first stage of its operations and will not be fully

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[22] Decision 1104/2011/EU of the European Parliament and of the Council of 25 October 2011 on the rules for access to the public regulated service provided by the global navigation satellite system established under the Galileo programme http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:287:0001:0008:EN:PDF.

[23] European Commission, Enterprise and Industry, Satellite navigation, Galileo: Public Regulated Services http://ec.europa.eu/enterprise/policies/satnav/galileo/applications/public-regulated-services/index_en.htm.

[24] European Commission, Directorate-General Energy and Transport, Information Note, 'Galileo', 26 March 2002 http://ec.europa.eu/dgs/energy_transport/galileo/doc/galileo_info_note_2002_03_26_it.pdf .

[25] Agreement on the Promotion, Provision and Use of Galileo and GPS satellite-based navigation systems and related applications http://ec.europa.eu/enterprise/policies/satnav/galileo/files/2004_06_21_eu_us_agreement_en.pdf .

[26] For further information about compatibility and interoperability see http://www.unoosa.org/pdf/icg/2008/icg3/ICG_WGA_DEC2008.pdf.

operational before the end of the decade. In the meantime, the US is developing a new kind of military signal, also highly encrypted, which has been tested on the GPS Block II-F satellites currently in orbit([27]). This new generation M-Code will be fully operational with the third new series of GPS satellites, called GPS-III, along with improved civil signals which will be able to correct automatically errors due to timing or ionosphere's interfering.

The collaboration between GPS and Galileo programs paves the way for a wide range of potential opportunities for the security sector. The interoperability between the systems will provide an improved accuracy of the signals to benefit military and security users. In addition, GPS and Galileo will be able to work as each other's backup in case of a failure of one of the two, ensuring continuity of space-based navigation services to users. Interestingly, in the framework of EU-US cooperation, the American partner is considering the possibility to use the PRS for its security missions (i.e. police)([28]).This would be a major recognition of the utility and importance of the EU and its GNSS system, as well as a great advantage for the US, which could continue to provide military operations with the advanced M-code, while increasing the effectiveness and reliability of security missions carried out using the European PRS.

If this cooperation was successful, then other opportunities could arise, for instance the use of PRS by NATO in the framework of low-intensity military operations.

During the development phase of Galileo, the EU involved international partners such as India, Israel, Morocco, Brazil, Japan, Canada, Republic of Korea, Ukraine and, above all, China.

After the failure in 2006 of the collaboration with China and the other countries ([29]), the EU has negotiated agreements on radiofrequencies allocation and compatibility with those countries advancing in the deployment of navigation systems (i.e. Russia, Japan), except for Beijing. The Chinese Beidou system is scheduled to be fully operational by 2020 and its registered frequencies are close to Galileo's with a high risk of overlapping. In September 2012 the EC and China signed an agreement earmarking the commitment of the two parties to propose options improving the compatibility and interoperability of the two systems([30]), thereby making evident that the solution, or compromise, still need to be given time.

Concerning the different uses of the PRS in Europe, to be discretionally decided by MS, governments still maintain mixed positions, just like they did at the beginning of the Galileo programme, though the military use is not put into question anymore. On the one hand, virtually all MS have been relying for more than 20 years on the GPS signal for their armaments systems as well as land, air, and sea vehicles. Thus, switching to the PRS could prove costly, while representing only in part an opportunity for European manufacturers of receivers. Indeed, these need to be duly authorized by the competent authorities, which in turn create barriers for entering the PRS market. The technically challenging alternative on which both MS and industry's interest is converging is the development of receivers that can use both the planned GPS military M-code and Galileo's based on compatibility, which however has still to be operationally proved ([31]). On the other hand, even putting aside the military use of PRS, the

[27] The Block II-F is a constellation of 12 satellites launched since May 2010.

[28] As confirmed by EU officials at the Workshop on the Future Galileo PRS at European Space Solutions conference, London, 3-5 December 2012 http://www.space-solutions.eu/index.php?anzeige=galileo_prs.php.

[29] See Anna Veclani, 'The Galileo Programme: management and financial lessons learned for future space systems paid out of the EU Budget', Directorate-General for External Policies, Policy Department, 2011.
http://www.europarl.europa.eu/committees/en/studiesdownload.html?languageDocument=EN&file=67675

[30] http://ec.europa.eu/commission_2010-2014/tajani/headlines/news/2012/09/20120920_en.htm.

[31] As confirmed by EU officials at the Workshop on the Future Galileo PRS at European Space Solutions conference, London, 3-5 December 2012.

perimeter of the security purposes is being conceptually forced by some MS to include civil activities with potential security implications, such as critical infrastructure and financial transactions management([32]). Although the dual use nature of technologies is a clear case in point, the use of PRS for civil, albeit strategic, activities would make the Galileo Commercial Service - also encrypted – almost meaningless and would nevertheless oblige to differentiate the PRS in "tiers": one for security and military uses and the other for strategic civil activities.

Table 5: Navigation and Positioning Programmes

	National Programmes	Cooperative Programmes	EU Programmes
Navigation and Positioning			**Present:** EGNOS Galileo IOV
			2014 Galileo pre-operational
			2020 Galileo operational

5. ELINT

5.1 Contribution to European security

Detecting non-communication signals could be vital for the success of an out of area operation or for security purposes. Electronic Intelligence (ELINT) instruments are designed to analyse the collected parameters of a specific signal, either matching it to known criteria, or recording it as a possible new emitter. ELINT sensors can be based on the ground, on airborne platforms or on satellites and can detect electromagnetic radiation, such as those produced by radar. This implies that any platform which is using a radar, such as ships, airplanes, ground stations and guided missiles can be detected and tracked. In out of area operations the ELINT, combined with EO data, can provide decision makers and commanders on the ground with an improved situational awareness of potential threats. Detecting radars can be also useful to security purposes, such as maritime border and airspace surveillance. Space-based ELINT has the advantage of providing users with up to date data without risking an airborne platform and with a better range of action than ground based sensors.

5.2 National capabilities

France is the only European country owning space-based ELINT capabilities. The first experimental satellite, named **Cerise**, was launched in 1995 for a short-lived mission, ended in 1996 when it collided with space debris coming from an Ariane rocket. The satellite suffered heavy damages and was thus unable to continue the mission.

[32] As confirmed by EU officials at the Workshop on the Future Galileo PRS at European Space Solutions conference, London, 3-5 December 2012.

In 1999 France launched its second experimental satellite called **Clémentine**, built by Alcatel Space and commissioned by the French DGA. This mission was a success and was followed by the **Essaim** constellation of five small satellites([33]), four operational and one spare, launched by an Ariane-5 G+ rocket in 2004. The satellites were put in LEO and orbited the planet hundreds of kilometres apart from each other. The experimental mission was scheduled to last about three years, but an agreement among DGA, Astrium and Thales in 2008 extended it for 18 months and the constellation operational life ended in 2010.

In December 2011 a Soyuz rocket launched from CSG carried in polar sun-synchronous orbit the four small 125 kilograms **Electronic Intelligence Satellites** (ELISA). The system has been developed and built for DGA and CNES by Astrium and Thales([34]). ELISA is scheduled to be operational for three years and is another system demonstrator, paving the way for the first operational ELINT constellation, named Ceres, able to identify not only ground-based radars but also other telecommunication sources in higher frequencies

5.3 Cooperation

The French White Paper on Defence and National Security, released at the end of April 2013, puts space-based communication and intelligence surveillance and reconnaissance on top of the defence's priorities, alongside drones, in flight aircraft re-fuelling and cyber-security. The **Ceres** program, a constellation of ELINT satellites, is considered a French defence priority since the 2008 White Paper. The project has been open to other countries participation but for now only **Greece** and **Sweden** have joined in the development phase. In any case, French authorities made clear that Ceres will move forward with or without European partners([35]). Astrium and Thales Alenia Space are developing payloads and platforms. The latter would be based on Thales Alenia Space's EliteBus platform which is being used for Iridium-Next satellites([36]). The Ceres constellation is scheduled to be launched no earlier than 2020.

5.4 Challenges and perspectives

The United States possess an advanced ELINT space-based system, which is the only operative among NATO countries. By putting in orbit Ceres also some European countries, namely France Greece and Sweden([37]), will acquire space-based ELINT data. This could provide EU with an initial capacity in this field. In addition, Ceres could lead to a collaboration based on data exchange between space ELINT systems within the NATO's framework, improving quantity, quality and updating of information. In addition, given the promising applications of future ELINT capabilities, such as identification of telecommunications sources virtually anywhere in the world, cooperation frameworks would certainly provide stronger legitimacy for the acquisition of sensitive information.

[33] Each satellite weighed 120 kilograms.
[34] Astrium built the platforms, Thales built the payloads and the ground segment: http://www.astrium.eads.net/en/programme/elisa.html.
[35] Peter B. de Selding, 'Operational French Elint System Slated for End of Decade Start', in *SpaceNews*, 16.12.2011http://www.spacenews.com/article/operational-french-elint-system-slated-end-decade-start.
[36] P. B. de Selding, 'Thales Alenia Space Seeks Wider Market for Iridium Bus', in *SpaceNews*, 20.3.2013 http://www.spacenews.com/thales-alenia-space-seeks-wider-market-for-iridium-bus.
[37] This only if Greece and Sweden move forward in the collaboration. Otherwise, Ceres will be a French only program.

Table 6: Electronic Intelligence Programmes

	National Programmes	Cooperative Programmes	EU Programmes
ELINT	**Present:** ELISA (Military-FR)		
	2020+ Ceres([38]) (Military-FR)	**2020+** Ceres([39]) (Military - FR-GR-SE)	

6. SPACE SITUATIONAL AWARENESS

6.1 Contribution to European security

Space-based systems are critical infrastructures on which Europe relies for its well-being and security. These systems are indispensable to provide services to European economies, and institutional functions, included those related to the security sector. Services' interruption would affect a large number of activities, including commercial land, air and sea navigation, telecommunications, information technology and networks, broadcasting, climate monitoring and weather forecasting([40]). In addition, the safety and security of citizens would be affected too: space-based services, or related ground segments, shutdown would put at risk European, national and regional emergency management and security operations.

There are three cases of space-borne threats to services' providing and people safety and security: space-debris collision with a satellite in orbit or an inactive spacecraft uncontrolled re-entry into the atmosphere([41]); space weather events; NEOs space or ground impact.

It has been demonstrated that a collision in space between a small-size object and a satellite could cause heavy damages to the latter. If the object is sufficiently large, the collision could even cause the complete destruction of the satellite. This could happen because in space, collisions occur at the speed of more than 7 kilometres per second with high kinetic energy. Every impact causes a number of thousands other debris which remains in Earth orbit for years threatening other satellites and spacecrafts. The US DoD in 2011 tracked approximately 22 000 man-made objects in EO larger than 10

[38]Greece and Sweden are participating in the initial development phase of Ceres. If they not go on with the cooperation, Ceres will be a French-only system.

[39]See footnote 98.

[40] ESA SSA web-page http://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness/About_SSA.

[41] Most of the unmanned spacecraft are not designed to survive an atmosphere's re-entry. During the descent phase, the spacecraft literally disintegrates. When this kind of re-entry is a planned one, the spacecraft's course will ensure an ocean's final impact of debris. In case the re-entry is not planned or controlled there is a risk of a land impact of debris which could arm citizens' life and proprieties, critical infrastructures, etc.

centimetres of which about 1150 are active satellites([42]). Through statistical calculations it has been hypothesized the presence of about 300 000 to 600 000 objects larger than 1 centimetre.

Space-based system could also be severely damaged by space weather events. For example, a high intensity geomagnetic storm, caused by the Sun, can shut down the electronic components of satellites make them inoperable. For instance in 1859 the Carrington super flare set fire to telegraph stations in North America and Europe and a geomagnetic storm caused the 1989 Quebec blackout, cutting power to millions of people in Canada and causing more than 200 electrical anomalies in the USA. The Halloween storms in 2003 temporally disabled instruments of a large number of satellites in orbit([43]). Also the ground segments of in-orbit mission can suffer the same damages.

The threat posed by NEO, most of them asteroids, has been acknowledged by the public on February 15th 2013 when one 30 metres diameter asteroid called 2012-DA14 passed Earth at 27 000 kilometres (lower than GEO and not so higher than MEO) and another, measuring 17 metres, exploded on the sky over Chelyabinsk in Russia, causing damages to infrastructures and buildings and hurting hundreds of people.

Space situational awareness (SSA) systems are vital to monitor this kind of space threats, tracking satellites or debris in Earth orbit to avoid collisions or predict re-entry trajectories, studying the Sun activity to forecast potential damaging geomagnetic storms and finally surveying NEO to predict any possible risk of impact with the planet.

SSA cannot deal with all space hazards alone. It is important to have redundant systems, such as in-orbit spare satellites, interoperable systems which could serve as each other backup or the availability of flexible launch capabilities to replace damaged satellites. In addition, it is necessary to have a good resilience plan for the "worst case scenario", that is, in case SSA fails to achieve its objective.

To date European SSA has been largely dependent external sources. Recently, essential data to avoid collisions between European satellites and space debris have come through other countries such as the United States.

6.2 National capabilities

Some European countries have developed Space Surveillance and Tracking (SST) ground systems, both optical and radar.

France operates two radar systems, the **Grand Réseau Adapté à la Veille Spatiale** (GRAVES-Wide Network Suitable for Space Surveillance) and the Missile Range Instrumentation Ship, named Monge, equipped with the Armor radar. In addition, it operates the **Télescope à Action Rapide pour les Objets Transitoires** (TAROT-Quick Action Telescope for Transients Objects).

GRAVES is owned by the French Ministry of Defence and operated by the Air Force. The system produces a self-starting catalogue which can be autonomously built-up and maintained. Its resolution is limited to objects of 1 metre size and larger in LEO. The system started its operation in 2005. The Armor radar on board the Monge ship is a powerful system designed to track incoming missiles. It is operated by the System Evaluator and Test Directorate of the French Ministry of Defence and used also to monitor objects in LEO. Armor has been used to track Ariane's launches. TAROT is an optical telescope

[42] Jana Robinson, 'Space Security through the Transatlantic Partnership: Conference Report and Analysis', *ESPI Report 38*, November 2011, p. 18.
[43] For further information visit http://www.nasa.gov/mission_pages/sunearth/news/swef-2013.html.

operated by CNES. Its primary mission is to detect the optical afterglow of gamma-ray's burst, but is also useful to track objects in GEO. A second telescope has been installed in Chile.

Germany developed its space surveillance radar called **Tracking and Imaging Radar** (TIRA). The system is operated by the Research Establishment for Applied Science. In its tracking mode, TIRA can determine orbits from direction angles, range and Doppler for single targets. The detection size limit is about 2 centimetres at 1,000 kilometres range, with the collaboration of the Effelsberg radar telescope, the system's accuracy can detect objects of 1 centimetre.

United Kingdom has three space surveillance systems, two radar and one optical. The latter is a telescope managed by the British National Space Centre (BNSC) and named **Starbrook**. It is located in Cyprus and has an added experimental survey sensor since 2006. The two radar systems are the **Fylingdales** complex and the **Chilbolton**. The first is part of the US Space Surveillance Network (SSN) and is operated by British armed forces. The second is managed by the Rutherford Appleton Laboratory and is mainly used for atmospheric and ionospheric research. The radar has been upgraded to track down to 10 centimetres objects at an altitude of 600 kilometres.

6.3 Cooperation (bilateral and multilateral)

ESA began its SSA program in 2009 as an optional program with 14 member States' financial participation. The 2012 ESA Ministerial Council extended the program mandate to 2019. The Phase II is currently funded for the period 2013-16.

To achieve the objective of acquiring new SSA capabilities, the program is focusing in three main areas: Space Surveillance and Tracking (SST); Space Weather (SWE); NEO. Each of these activities is being developed as a segment in parallel with setting of capabilities and services, supported by data centres and a Taking Centre with contributions by existing European structures([44]).

The Phase II activities are focusing in developing SWE and NEO technologies while for the SST segment testing and validation activities are on-going.

Since the Council Resolution *Taking forward the European Space Policy*([45]), the EU confirmed its intention to develop a European SSA system through a coordination of efforts in Europe and among the MS. However, in the White Paper on European Space Policy of 2003, the EC had already recognized SSA as strategic for European security. The EP Resolution of 19 January 2012 on a *Space strategy for the European Union that benefits its citizens* stated that the creation of a European SSA system will be an essential asset to improve the protection of space and ground infrastructures from impacts with space-borne objects. The GMES/Copernicus and Galileo programs are essential for the European space strategy and they will have a great economic and safety-security impact. For this reason not acting in the SSA field could affect their long-term security and sustainable exploitation([46]).

The new European program should be based on existing capabilities and infrastructures, with new MS' investments to close the existing gaps. The SSA development will benefit the EU External Action Service (EEAS), improving the EU position in international space negotiations. The EEAS is supposed to be an essential entry point for discussions on space policies with foreign and security policy implications. EEAS

[44] ESA SSA website
http://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness/SSA_Programme_overview.
[45] Council Resolution 13569/08 'Taking forward the European Space Policy', 26 September 2008.
[46] SWD (2013) 54, Commission Staff Working Document, Executive Summary of the Impact Assessment accompanying the document Proposal for a Decision of the European Parliament and of the Council establishing a space surveillance and tracking support programme.

is a user of space services and the principal actor involved in EU external action under the direction of the High Representative for Common Foreign and Security Policy. For these reasons, the involvement of the EEAS in the development and definition of a European SSA program should be strongly encouraged (see also Part Two 9.4 *GSA*).

The EC Proposal *Establishing a space surveillance and tracking support programme*([47]) just recently released, stresses the intention of the EU to not develop new systems and infrastructures but to establish a SST joint service to prevent collisions between spacecrafts and between spacecraft and debris. The objective is to create a partnership where MS will contribute with their existing and future assets to the SST capability at European level and the Union will provide a legal framework and a financial contribution to the implementation of the actions defined. The legal framework will define the governance scheme and the data policy in accordance with the relevant Council conclusions. The Proposal stated that there is a consensus among EU and ESA Member States that the EU shall lead the constitution of the SST support service because it has a security dimension([48]) of which the Union has the competence, given by the TFEU, to deal with, unlike the ESA. The MS are in favour of ESA's development of technologies and infrastructures and EU managing of SST services through the contribution of the EUSC. In this collaboration, EDA had taken the responsibility to integrate the military requirements for the systems and services, due to the intrinsic dual nature of SST, and to coordinate the military expertise if necessary. The financing of the program will be kept into the margins of the MFF 2014-20, drawing resources, if necessary, from existing space programs.

6.4 Challenges and perspectives

In the aftermath of the 2007 Chinese Anti-Satellite (ASAT) technology test, which caused thousands of space debris, the Council of the European Union proposed a Draft Code of Conduct for Outer Space Activities (the 'Code')([49]) that, however, has not yet been adopted. In 2012 a new version of the Code was presented([50]). The document concerns the whole community, adopts an approach that does not require the definition of space weapon and is politically but not legally binding([51]). The Code objective is to help space faring nations to minimize the creation of new space debris in Earth Orbit and eventually to elaborate new methods to even reduce the amount of existing debris.

After an initial US opposition under Presidency of George W. Bush, the Obama Administration is considering to join the EU efforts and to collaborate to the drafting of the Code. The National Security Space Strategy([52]), released in January 2011, defines space as "congested, contested and competitive". In particular, it is congested because of the large and increasing amount of space debris and inactive satellites in orbit. The Strategy aims to secure the space access and utilization for the US, through improving space capabilities and promoting partnership with other responsible Nations and

[47] Proposal for a Decision of the European Parliament and of the 'Council Establishing a space surveillance and tracking support programme', COM(2013) 107, 28 February 2013.
[48] Data from SST could be information about third States' civil and military space operations.
[49]Draft Code of Conduct for Outer Space Activities as approved by the Council on 8-9 December 2008 http://register.consilium.europa.eu/pdf/en/08/st17/st17175.en08.pdf.
[50] Working Document Revised Draft 'International Code of Conduct for Outer Space Activities', 5 June 2012: http://www.consilium.europa.eu/media/1696642/12_06_05_coc_space_eu_revised_draft_working__document.pdf.
[51] Lucia Marta, 'The Hague Code of Conduct Against Ballistic Missile Proliferation: "Lessons Learned" for the European Union Draft Code of Conduct for Outer Space Activities', *ESPI Perspectives* 34, June 2010.
[52] National Security Space Strategy, Unclassified Summary, January 2011: http://www.defense.gov/home/features/2011/0111_nsss/docs/NationalSecuritySpaceStrategyUnclassifiedSummary_Jan2011.pdf.

International Organisations. On January 2012 the US Secretary of State, Hillary Clinton, stated that US should partner with EU to elaborate an International Code of Conduct for Outer Space Activities based on the EU Code, specifying that these works should not limit or constraint US National Security and defence capabilities([53]).

Today Europe does not have a comprehensive SSA system yet. Notwithstanding the good progress of the ESA's program, most of EU MS are still largely dependent on US SSA data. As mentioned above, only few States, such as France, Germany and UK, possess operational SSA infrastructures. A European SSA system, supposing that the EU, ESA and MS cooperation is successful, cannot substitute the long established expertise and capabilities of the US([54]). For this reason, a transatlantic cooperation continues to be essential and a common EU-US draft of an International Code of Conduct for Outer Space Activities could represent an important contribution to the space's security.

Table 7: Space Situational Awareness Programmes

	National Programmes	Cooperative Programmes	EU Programmes
Space Situational Awareness	GRAVES (Military-FR) TAROT (Civil-FR) TIRA (Civil-DE) Starbrook (Civil-UK) Fylingdales (Military-UK) Chimbolton (Civil-UK)	ESA SSA program [ESA-(AT-BE-CH-DE-ES-FI-FR-GR-IT-LU-NO-PT-UK)]	EU support program to SST segment of ESA SSA

7. EARLY WARNING

7.1 Contribution to European security

Space-based Early Warning systems are equipped with infrared sensors capable to detect the heat caused by a missile engine's ignition.

Early Warning satellites can be useful to alert national authorities and forces of the incoming threat and to estimate its trajectory, its point of impact and its time of arrival, giving the possibility to activate the

[53] 'US joins EU effort to develop space 'code of conduct'' in *The Telegraph*, 17.1.2012 http://www.telegraph.co.uk/science/space/9021800/US-joins-EU-effort-to-develop-space-code-of-conduct.html.
[54] J. Robinson, 'Space Security through the Transatlantic Partnership: Conference Report and Analysis', p. 21.

necessary countermeasures both active and passive. Once a missile launch is detected, it is possible to identify the launch facility and, consequently, the identity of the aggressor([55]).

Infrared sensors on board satellites can monitor the activity of possible nuclear proliferating States, such as development and testing of missiles, analysing the characteristic of the engines and measuring their heat trace for subsequent identification. In addition, Early Warning satellites can also contribute to safety, monitoring and detecting wildfires giving to fire brigades and civil protection units, essential information to manage such emergency.

7.2 National Capabilities

France is the only European country which has developed space-based early warning technologies. On February 12th 2009 an Ariane-5 rocket carried in orbit the **Système Préparatoire Infra-Rouge pour l'Alerte** (SPIRALE-Infrared Preparatory System for Alert). The two satellites constellation was put in a High Elliptical Orbit (HEO) and the technology demonstration mission ended between February and March 2011([56]).

The success of SPIRALE's mission leads the way to a fully operational French early warning satellites system which is scheduled to be launched to GEO no earlier than 2020. The new program has been repeatedly opened to bilateral and European collaboration but no State has joined the effort yet, so for now it remains a French-only project.

7.3 Challenges and perspectives

The US early warning system relies on ground, naval, aerial and space assets. The latter include the Defense Support Program (DSP), the Space Based Infrared System (SBIRS) and the Space Tracking and Surveillance System (STSS).

The DSP is a constellation of five satellites in GEO([57]) developed by Northrop Grumman and managed by 460th Wing of the USAF, data are sent to the North American Aerospace Defense Command (NORAD) and to the USSTRATCOM. The program started in the 1970s.

The SBIRS is a composite system which includes dedicated satellites and hosted payloads. There are two satellites in GEO and two payloads hosted in two more space platforms in HEO. Satellites and payloads are designed and developed by Lockheed Martin and managed by the USAF. Two more satellites for GEO are being developed and are scheduled to be launched in the mid-decade.

The STSS will be a constellation of satellites in LEO to be complementary with the SBIRS and DSP systems. There are now two technology demonstrator missions in orbit paving the way for the fully operational constellation. These satellites are developed by the Missile Defense Agency (MDA) and managed by the USAF.

The constellations mentioned above are the unique space-based systems which contribute to the US and NATO early warning. After the success of the SPIRALE mission, France is ready to make available its future early warning satellites for the under development **Active Layer Theatre Ballistic Missile Defence** (ALTBMD) of the Alliance([58]). It has to be remembered that an Early Warning system is a

[55] This is possible with States actors, in case of a non-state actor the identification is very hard to be done only with infrared sensors.
[56] For more information about SPIRALE visit http://www.astrium.eads.net/en/programme/spirale.html.
[57] Three operational satellites and two spares.
[58] P. B. de Selding 'French Senate Panel Calls for $2.2 Billion Missile Defense Investment', in *SpaceNews*, 12.7.2011

strategic asset for States with a retaliation capacity. In Europe only UK and France have this capacity, so it is understandable the reason why there is no collaboration among EU MS in this field.

Table 8: Early Warning Programmes

	National Programmes	Cooperative Programmes	EU Programmes
Early Warning	Future Early Warning Space Based System (Military-FR)		

PART TWO: THE EUROPEAN INSTITUTIONAL FRAMEWORK

8. LISBON TREATY: RELEVANT ELEMENTS ON SPACE AND SECURITY

When contextualizing the development and management of space capabilities for security and defence at the European level, it must be borne mind that the two domains rely on two different institutional frameworks which surely share some actors, but are based on different rules.

On the one hand, the institutional context in which European space activities developed is unique in its kind. The reference space institutions in Europe today are the EU, ESA and their respective MS, which interplay is commonly referred to as the "institutional triangle". Such triangle is rather an irregular one, given that these coexisting players are all different in nature - a supranational body, an intergovernmental entity, and sovereign nations – and sided by other private and public actors intervening in the relationship. In addition, their action in the space domain, at times overlapping, is based on different legal instruments, namely, the Lisbon Treaty, the ESA Convention, the Framework Agreement between ESA and the EU, and national legislations. This complex institutional framework brings to the coexistence of governmental, intergovernmental, and communitarian space programmes and systems, which future generations could and should be better integrated to contribute to European security in a sustainable manner.

On the other hand, the institutional framework in which security and defence policies, from EU external action and CFSP/CSDP to home affairs, are developed and implemented by the EU and its MS based on the Lisbon Treaty as well as on national legislations.

In other words, putting in perspective how space capabilities elaborated under the first part of this study may be made available for European security implies the understanding and correlation of:

1. two European institutional frameworks in which space and security are addressed, the related differences and the multiplicity of actors involved;
2. the governmental and intergovernmental frameworks in which space, security and defence initiatives are carried out and the related sovereignty issues.

Before going into the details of single roles and related actors it is important to provide a brief overview of the legal bases on which both space and security policies are developed and implemented. In particular, it should be looked at the Lisbon Treaty - which has brought innovations still to be fully

http://www.spacenews.com/article/french-senate-panel-calls-22-billion-missile-defense-investment.

implemented both in the space and security and defence domains - and at the main elements of the Framework Agreement (FA) between the EU and ESA – which could sensibly evolve beyond 2014 in light of the current debate and of the potential "rapprochement" of ESA towards the EU envisaged by the EC Communication *Establishing appropriate relations between the EU and the European Space Agency* ([59]).

Concerning ESA Convention, it is sufficient to recall that based on the Convention the agency's purposes shall be of shaping and promoting cooperation among European States in space research and technology and related applications for exclusively peaceful purposes. The Convention and its Annex V also provide for an industrial policy which is based on the geographical return principle. These two fundamental elements of the Convention – space cooperation for peaceful purposes and geographical return – have been subject to debates among EU and ESA stakeholders regarding cooperation between the two institutions. In the first respect, the absence of a definition of the reference terms – the same used in UN Treaties and Resolutions on outer space - allows to broaden the interpretation as to include the security dimension of space activities, which as a matter of fact and beyond any ambiguity, stems from the intrinsic dual-use nature of space technologies. In the ESA Director General's vision, the agency's gradual opening to security and defence components - starting from Galileo and GMES through the SSA programme – is part of the evolution of the European space policy, in turn tied to the developments and requirements of CSDP and its stakeholders([60]). Concerning the second element, the rule of fair return is overtly in contrast with that of the EC which is instead based on open competition. This is a longstanding open question. Not without difficulties, the two institutions have found *ad hoc* working arrangements based on the FA (see further), however this remains a critical aspect when implementing programmes funded by mixed ESA and EU appropriations, like GMES and Galileo.

The EU legislation on space and security on the one hand and the ESA-EU FA on the other, are not irreconcilable for many aspects, but they surely impose some constraints, especially when it comes to the coordination of roles and responsibilities as well as to the exercise of relative authority.

8.1 The Lisbon Treaty and the different fields of application

8.1.1 The Lisbon Treaty and Space

In the consolidated version of the TFEU space is mentioned twice, first in Title I defining the Categories and Areas of Union Competence and, second, in Title XIX regarding Research and Technological Development and Space.

Within Title I, Art. 3 TFEU establishes the exclusive competences of the EU, while Art.4 outlines fields in which the Union shall share power with the MS. In general, shared competence does prevent EU MS from legislative action where the EU has already acted. However, art. 4 (3) TFEU defines a sort of shared competence sub-category in the areas of **research**, **technological development** and **space policies** whereby the exercise of the Union competence shall not result in MS being prevented from exercising theirs. Thus, the EU may act in parallel to MS, without overcoming them (and ESA), but fostering stronger cooperation in areas where national industrial policy considerations might prevail today. In

[59] Communication from the Commission to the Council and the European Parliament *Establishing appropriate relations between the EU and the European Space Agency*, COM(2012)671, 14 November 2012 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0671:FIN:EN:PDF.

[60] See interview with ESA Director General Dordain, in *European Defence Matters, A magazine of the European Defence Agency*, 1:2012, pp. 18-19
http://www.eda.europa.eu/docs/eda-magazine/edm_issue1.

other words, the EU can still provide remarkable contribution, thereby promoting and achieving mutually consistent results possibly geared at progressive integration. Such "special" shared competence clearly unveils the strict connection between not only space and sovereignty, but also research and technology and state control.

Concerning Art. 189 TFEU, it is interesting to look at the main three commas so as to highlight the relevant elements. According to Art. 189(1) TFEU the European space policy should promote, among other things, the implementation of EU policies. To this end, the comma specifies, the EU may promote joint initiatives, support research and technological development and coordinate the efforts needed for the exploration and exploitation of space. Just to provide a concrete example, it might be considered how R&D projects realized within the EC FP7 Space Theme (i.e. G-MOSAIC, G-NEXT, G-SEXTANT, etc.) have contributed to develop GMES/Copernicus services for Security applications in support to EU External action (see Annex I, Earth Observation - *Recent developments*) as well as for border control and maritime surveillance (i.e. DOLPHIN, NEREIDS, SAGRES and LOBOS([61])).

In Art. 189(2) the roles of the EP and of the Council are clearly defined: in the pursuit of the European space policy goals they shall jointly act by ordinary legislative procedure to establish specific measures, which may take the form of a European space programme, excluding any harmonisation of the laws and regulations of the MS. Hence, the new competence of the EU in space matters also makes that the EP and the Council have the same weight in adopting related legislation, duly proposed by the EC. Based on this article, the first legal acts in the space domain and regarding both GMES/Copernicus and Galileo were adopted in 2010 on the same day: Regulation (EU) No 911/2010 of 22 September 2010 on the European Earth monitoring programme (GMES) and its initial operations (2011 to 2013) and Regulation (EU) No 912/2010 of 22 September 2010 setting up the European GNSS Agency. Concerning GMES Regulation, the EP successfully brought forward a number of amendments which adoption was the result of a compromise reached with the Council([62]). Of particular interest here are those that allowed to add a recital in the preamble regarding the importance of security services for the challenges which Europe is facing in the security field([63]); to envisage a specific configuration of the GMES Committee so as to deal with concrete security issues (data security policy, security of the programmes, etc.), namely, the Security Board([64]); to foresee the possibility to increase the funding within the 2007-2013 MFF([65]); to add in the Annex among objectives the specificities of services, including of those for security([66]). It should be specified that this role of the EP adds on to that played in the adoption of multiannual framework programmes on research and technological development activities (Arts. 179-188 TFEU) where both space and security are addressed and of the general budget of the EU through which space programmes such as Galileo and GMES/Copernicus are funded.

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[61]See Copernicus On-going Projects web page http://copernicus.eu/pages-principales/projects/other-gmes-projects/security/.

[62]European Parliament - Legislative Observatory, 2009/0070(COD) - 16/06/2010 Text adopted by Parliament, 1st reading/single reading http://www.europarl.europa.eu/oeil/popups/summary.do?id=1114755&t=d&l=en.

[63] See recital No. 23, "Security services are an important part of the GMES initiative. Europe will benefit from the use of space and in-situ assets in support of the implementation of services responding to the challenges which Europe is facing in the security field, notably border control, maritime surveillance and support to Union external actions".

[64] See Art. 16(2), "ES Committee may meet in specific configurations to deal with concrete issues, notably those relating to security (the 'Security Board').

[65] See recital No. 33, "To that end, the Commission should, in the context of the mid-term review of the current MFF, and before the end of 2010, examine the possibility of additional funding for GMES, within the overall Union budget during the MFF 2007-2013".

[66] See Annex, Point No 5, "Security Services shall provide useful information in support of the challenges which Europe is facing in the security field, notably border control, maritime surveillance and support for EU external actions".

Concerning interaction with other space institutional actors at the European level, Art. 189(3) states that the EU shall establish any appropriate relations with ESA. As said, currently, such relations are regulated by the FA and subject of open debates.

8.1.2 The Lisbon Treaty and Security & Defence

As already stressed in the introduction to this study, the EU is progressively shaping and implementing a comprehensive approach to security, one that takes into account synergies among different EU policies and instruments, and tries to make the best of existing and diverse resources and capabilities (i.e. civil and military assets). Such an approach does not only emerge in strategy and policy documents already highlighted, but is also legally reflected in the Lisbon Treaty under both Title V of TEU and Part V of the TFEU. In this sense, the main innovation regards the establishment of 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). Indeed, the HR, 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). He/she is then in charge of the Commission's external relations responsibilities, while conducting CFSP/CSDP and coordinating with other communitarian policies and EC services. Thus, the HR/VP is responsible for the overall consistency in EU external action. 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, included those related to crisis management([67]). As a result, even though CFSP/CSDP still relies 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 be still guaranteed.

As far as security and defence are concerned, the Treaty specifies that the CSDP is a Union policy as well as an integral part of the CFSP (Art. 42(1) TEU). Within such policy, the definition and scope of CSDP missions have been widened (Art. 43(1) TEU)([68]) compared to the past([69]), while envisaging the development of an operational capacity drawing on civilian and military assets and synergies (Art. 42(1) TEU). The Treaty does not exclude that CSDP might evolve into a common Union defence policy. Eventually, the decision on a common defence should be adopted by the European Council acting unanimously (Art. 42(2) TEU).

Finally, even in the field of CSFP/CSDP the EP is empowered to play a role despite the intergovernmental approach. Indeed, by Art. 36 TEU the HR/VP shall consult the EP 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. On 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 CSFP/CSDP. The last debate was held in September 2012 but was not followed by the

[67] Crisis Management and Planning Directorate (CMPD), European Union Military Staff (EUMS), Civilian Planning and Conduct Capability (CPCC).

[68] Joint disarmament operations, humanitarian and rescue tasks, military advice and assistance tasks, conflict prevention and peace-keeping tasks, tasks of combat forces in crisis management, including peace-making and post-conflict stabilisation. All these tasks may contribute to the fight against terrorism, including by supporting third countries in combating terrorism in their territories.

[69] Petersberg Tasks included in the Amsterdam Treaty (art. 17(4)) which included: humanitarian and rescue tasks, peace-keeping tasks and tasks of combat forces in crisis management, including peace-making.

adoption of a resolution. The EP nevertheless adopted one on the implementation of CSDP in November 2012, and included a short paragraph on "A space policy to underpin the CSDP"([70]).

8.1.3 The Lisbon Treaty and Home Affairs

As already mentioned, internal security is an important dimension of the EU security policies, while being strictly connected to external action, including CFSP/CSDP. Compared to the latter, the Area of Freedom, Security and Justice (FSJ) – which also used to be based on the intergovernmental method under the second pillar of the EU -, has made significant progress towards "communitarization". Among other things, Title V of 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. It is the responsibility of the Council to define the strategic guidelines for legislative and operational planning within FSJ (Art. 68 TFEU), while MS maintain their competence concerning law and order and the safeguarding of internal security (Art. 72 TFEU). Nevertheless, to counter 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 necessary. As a result, certain measures shall be taken by the EP and the Council according to the ordinary legislative procedure, especially where deemed necessary for the gradual establishment of an integrated management system for external borders (Art. 77(2)(d)). For instance, the EUROSUR initiative([71]) (see also par. 9.5 *FRONTEX and EMSA*) was launched with a view to improving such management and to enhancing information exchange and cooperation among MS for the surveillance of land and sea external borders. Space assets, among instruments, are to be exploited for the purposes of EUROSUR.

8.1.4 The interplay of Space and Security in light of the Lisbon Treaty

As said, the provisions set by the Treaty concerning space and security are not to be considered incompatible in at least four respects. In fact, the broadening of the concept of security and the concurrent expansion of the European Space Policy to cover security are mutually reinforcing.

First, considered that European space policy should promote the implementation of EU policies, the EU external action and CFSP/CSDP as well as FSJ can be certainly included, based on the appropriate rules.

Second, EU (civilian) assets with dual-use application like Galileo and GMES, as already argued, can certainly serve CSDP operations' needs. In this sense, Art. 42(4) 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 coherent with their civil nature; should incompatibility arise, then any decision should be taken in the framework of Title V TFEU([72]). It is

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[70] European Parliament Resolution 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), 22 November 2012.
http://www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=P7-TA-2012-0455&language=EN&ring=A7-2012-0357.

[71] EUROSUR is a pan-European border surveillance system composed of measures and mechanisms aimed at enhancing information exchange and cooperation among MS. The system is under development and first operations were supposed to start by 2013. See Proposal for a Regulation of the European Parliament and of the Council Establishing the European Border Surveillance System (EUROSUR), 12 December 2011, COM(2011)873. http://ec.europa.eu/home-affairs/doc_centre/borders/docs/eurosur%20final.pdf.
As of March 2013 the related negotiations between the EP and the Council had made good progress, meaning that the Regulation could be adopted soon.

[72] Council Resolution on the European Space Policy, 22 May 2007.

up to MS in the Council to decide which measures should be taken, similarly to what is envisaged in Council Joint Action 2004/552/CFSP. In addition, those same assets can also support the surveillance of sea and land external borders and the safeguarding of lives in the wider framework of a common policy on asylum, immigration and external border control.

Third, space capabilities could be at the centre of work conducted by the European Defence Agency (EDA) as provided by Arts. 42(3) and 45(1) TEU. Based on these recitals, capabilities for military purposes 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 programmes, support defence technology research and launch joint research activities.

Fourth, the Treaty provides for two frameworks of cooperation that can be applied to both CSDP and space, namely, the permanent structured cooperation and the enhanced cooperation.

In the first case, Art. 42(6) TEU establishes that those MS committed to one another in the area of military capabilities, fulfilling higher criteria in that respect, willing and ready to engage in the most demanding missions, shall establish permanent structured cooperation within the EU context. Except for these conditions, the Treaty provides for a certain flexibility of the framework. In fact, the cooperation should be approved by qualified majority of the Council, while remaining open to other MS wishing to participate (Art. 46(3)) and guaranteeing the possibility to withdraw. In addition, there are no minimum requirements in terms of number of participating MS or of financial commitments. The objective of the cooperation should be in particular that of proceeding more intensively in the development of defence capacities (Protocol No 10, Art. 1(a)). As a result, space assets for military uses could be developed by those MS that are most advanced in this field, such as France, Germany, Italy, Spain and the UK as it clearly emerged from the first part of this study, with the support of other MS which might have an interest in both space policy and CSDP. In general terms, the cooperation on military capabilities would constitute an element of functional integration with a view to progressively framing a common defence.

As far as enhanced cooperation is concerned (Art. 20 TEU and Arts. 326-334 TFEU), the framework applies to fields where the EU does not have exclusive competence, thus including both CFSP/CSDP and space. Since an enhanced cooperation exclusively on space does not appear reasonable in light of the current overall European space policy context, it would be more appropriate to include specific activities on 'space for security' within the purpose of furthering political integration in the field of CFSP/CSDP.

8.2 The EU-ESA Framework Agreement

The Framework Agreement was signed in 2003 and entered into force in 2004, while its duration was extended twice (2007 and 2012) to cover 2016. The overarching objective of the cooperation is the coherent and progressive development of an overall European Space Policy (Art. 1(1)). This includes, first among other aims, securing Europe's independent and cost-effective access to space and the advancement in other fields of strategic interest necessary for the independent use and application of space technologies in Europe (Art. 1(2)(a)). Such goal encloses in a nutshell the acknowledgement of the strategic value of space for security. Indeed, as already highlighted, without an autonomous access to space, European space activities – regardless of the civil or military nature – would depend on third party's capabilities, which availability should never be taken for granted. In addition, Europe needs to reach a certain degree of technological independence (or non-dependence) in domains of strategic interest, among which are certainly space applications for European security. The other stated aims encompass the coherence of the European space policy with, and support to, the EU policies, the

optimization of resources and of synergies for R&D, the consistency between demand and supply (Art. 1(2)(b, c, d ,e))

In principle cooperation shall rely on the respective tasks and responsibilities as well as institutional settings and operational frameworks (Art. 2(1)), while the implementation of the agreement shall be undertaken in accordance with the relevant prerogative, legal instruments, and procedures (Art. 4(1)). This notwithstanding in no circumstances shall the EU be bound to apply the rule of "geographical distribution" (Art. 5(3)).

The agreement envisages a number of areas of cooperation, which encompass the most important space applications addressed in this study (Art. 3) by allowing the management by ESA of EU space-related activities based on EU rules, and/or the participation of the EC in ESA optional programmes, and/or the joint financing, coordination and management of programmes (Art. 5(1)(a, b, c)).

The Council of the EU (Competitiveness Configuration in charge of space issues) and the Council of ESA at ministerial level should pursue the coordination of initiatives through regular joint meetings, referred to as "Space Council" (Art. 8(1)). The joint meetings shall provide orientations supporting the objectives of the Agreement, recommendations, advice to the parties, revision of the effectiveness of the Agreement (Art. 8(2)). The Space Council should be supported by a Joint Secretariat composed of personnel from the EC and ESA and, in turn, the Secretariat should regularly consult a high level group of experts constituted by representative of ESA and EU's MS (Art. 8(4,5)). As already highlighted, the resolutions adopted by the Council since 2004, and in particular in 2007, represent the basis of the continuous evolution of the European Space Policy, included in terms of its security dimension.

Indeed, for a decade, the FA has allowed ESA and the EU to cooperate on important programmes such as Galileo and GMES. This is how the EU became ESA's first contributor, channelling in 2013 21,3% of the whole budget([73]). At the same time, Art. 189(3) TFEU reopened the question and the debate on the governance of space in Europe among the EU, ESA and the respective MS. In 2011 the EC, with its Communication on a Space Strategy for the EU, already provided some indications, calling for an evolution of ESA based on a "flexible model" in terms of:

1. nature, that is, coexistence of the intergovernmental and EU dimensions;
2. mission, management of both civil and military programmes;
3. structure dedicated to the management of EU programmes based on EU rules;
4. funding from diverse sources;
5. membership, as Switzerland and Norway are not EU MS, but could be involved in some EU-led programmes([74]).

A stronger stance was taken by the EC right before the ESA Ministerial Council in November 2012. The EC issued a Communication stressing the inconsistencies of the ESA-EU relations, seemingly overcoming the "flexibility model" privileged in the previous occasion, albeit recalling it. Hence, mismatch of financial rules and membership represents structural obstacles to cooperation causing

[73] Precisely EUR 911.1 million. ESA Budget 2013, http://spaceinimages.esa.int/Images/2013/01/ESA_budget_2013.

[74] Communication from the Commission to the Council, the European Parliament, the European Social and Economic Committee and the Committee of the Regions *Toward a Space Strategy for the European Union that benefits its citizens*, COM (2011) 152, 4 April 2011.
http://ec.europa.eu/enterprise/policies/space/files/policy/comm_pdf_com_2011_0152_f_communication_en.pdf

organizational difficulties and security concerns respectively([75]). In addition, the *ad hoc* arrangements based on the FA do not allow for ESA activities to be coherent with EU policies. Finally, the EC considers that ESA lacks political accountability given that it is in no way connected to the EP and, therefore, to the European citizens. Thus, the EC suggests that these obstacles can be overthrown with a rapprochement of ESA to the EU foreseeable between 2020 and 2025. Two options in this sense are put forward: relying on the status quo while improving it by bringing the intergovernmental agency under EU authority (similarly to EDA and EUSC) or transforming ESA in an EU decentralized agency (similarly to GSA, FRONTEX, etc.). Regardless of the option, the EC calls for ESA to undertake structural adaptations (financial and internal decision-making) and for the possibility to be involved in ESA-relevant statutory bodies.

In the occasion of the ESA Ministerial Council few days later, a political declaration on the matter, which took into account the EC's positions, was adopted. The document officially launches a reflection process on the governance question through a consultative approach that involves MS and the EU. The declaration doesn't fail to recall the nature of the agency and the longstanding success of its activities, as well as the equal rights and responsibilities of its all MS – growing in number - in the decisions regarding the agency's evolution.

The Communication was not uniformly welcomed among ESA MS and, in particular, its main contributors. While France would approve a partial or total integration of ESA into the EU with the acceptance of the Union's rules and its prominent role, Germany supports the *status quo*, especially opposing the abandonment of those features and mechanisms that made of ESA an outstanding successful space actor, albeit without downplaying the role of the EU and of cooperation between the two. On its part, Italy took an intermediate position, recognizing the need for an evolution and improvement of the FA, along with the value of the two different roles played by ESA and EU on which the governance should be based([76]). Such position is similar to that expressed by the Council of the EU in February 2013([77]).

9. ACTORS AND ROLES IN SPACE TODAY AS RELATED TO SECURITY

The legal bases described already provide a clear idea of the complexity of the European space governance from a legal point of view, but do not shed light on the multiplicity and diversity of actors intervening in such context along with ESA, the EU and MS and their specific roles.

In an effort of schematization and simplification, it can be useful to provide two main sets of roles - "upstream" and "downstream" - identified in the wide European space value chain underlying space policy and related programmes. Hence, these roles are generalized so that they can be applicable to all actors – public and private, national, intergovernmental, communitarian - at the European level. It should be borne in mind that the edge between the sets of roles is very thin, that some actors can be involved at both levels, and that a specific hierarchy among the latter cannot be established. In other words, it would not be possible to draw a detailed scale of roles, given that these vary from actor to

[75] COM(2012) 671.

[76] These positions were given by representatives of national space agencies at the 5th Conference on EU Space Policy, "Building up a global tool for global challenges", during the dedicated debate "What relationship between the European Commission, ESA, national and specialised agencies for ensuring the best space governance possible?", Brussels, 29-30 January 2013. For a deeper analysis of national positions see also L. Marta, 'National visions of European space governance: Elements for a new institutional architecture', in *Space Policy*, Vol. 29, 1:2013, pp. 20-27.

[77] Council Conclusions *Establishing appropriate relations between the EU and the European Space Agency (ESA)*, 19 February 2013 http://register.consilium.europa.eu/pdf/en/13/st06/st06571.en13.pdf.

actor, from one space application to another, in the different phases leading to the completion of a satellite or launch system and their exploitation.

The **upstream** level can include macro roles such as:

- **Role #1**: political guidance, priorities setting, budget approval;
- **Role #2**: space policy -making, launch and supervision of programmes;
- **Role #3**: implementation of funding:
  - 3.a R&D,
  - 3.b System (development, deployment, exploitation),
  - 3.c Part of the system (development or development and deployment);
- Role #4: definition of industrial policy (including procurement policy and regulatory framework).

The **downstream** level can comprise the following general roles:

- **Role #1**: management/coordination/implementation of programmes;
- **Role #2**: R&D;
- **Role #3**: development and production;
- **Role #4**: operations;
- **Role #5**: data/services provision.

The so called "institutional triangle" especially acts at the upstream level, although ESA and the EC also play a role at the second. Adding to them, other EU agencies and bodies are involved in the downstream sphere, along with private actors. The latter, in turn, are also increasingly involved in funding, therefore in an upstream role, usually in the form of PPPs and in relation to national military systems.

Provided the two broad sets of roles, it is now necessary to turn to the European space actors to discover what exactly they currently do – encompassing decisional, financial, managerial, and technical-industrial tasks – in relation to space and security. Eventually, these players and their specific roles will be placed within the upstream and downstream categories to obtain a comprehensive picture. This should make it easier to identify options - to be implemented under the current treaties and institutional frameworks, and within the scope of the forthcoming multiannual financial framework (MFF) -, for the sustainable provision of space capabilities for security until the end of the decade, while highlighting where Union level engagement would offer added value.

The actors selected are all involved, to different extents and based on diverse legal instruments, in the European space policy and programmes with a security dimension as described in Part One. The SSA Support programme is however excluded, given the proposal put forward by the EC might change according to the EP and Council's opinions. Actors include both public and private entities playing a role at different levels, such as: the EC, ESA, EDA, EUSC, FRONTEX, EMSA, GSA, EEAS, MS and the industry. The European Council/Council of the EU([78]) and the EP are not further deepened, as their roles are clearly outlined in the overview of the Lisbon Treaty. Nevertheless, due reference to them is made in terms of interactions with other players within single programmes and initiatives.

[78] Please note, the Council deals with space issues in its Competitiveness Configuration, however it deals with Galileo aspects in its Transport, Telecommunications and Energy Configuration.

At the same time, the **generalization of their role** can be appreciated as:

- ✓ **Upstream role:**
  - **Role #1: political guidance, priorities setting, budget approval**

9.1 The EC

As already highlighted, the EC has the power of initiative in the field of European space policy (and in the designation of the general budget of the EU supporting it). The EC' s initiative may regard:

- **policy** in general;
- **legal acts**;
- **specific programmes**.

For instance, in terms of space policy a milestone initiative of the EC can be considered the Communication "Towards a space strategy for the European Union that benefits its citizens"([79]), which laid down the main priorities of the EU, including the success of Galileo and GMES, the protection of space infrastructures, and space exploration, while calling for the development of an industrial space policy. Concerning legal acts, the Regulation No 910/2011 on the initial operations of GMES is a perfect example. Finally, one of the latest initiatives of the EC with regard to specific programmes also supporting security goals – beyond Galileo and GMES – is the Proposal for a Decision of the EP and of the Council on the establishment of a space surveillance and tracking (SST) support programme([80]).

The Directorate General (DG) in charge of space policy and related matters is DG Enterprise and Industry (DG ENTR) through two different directorates and a variety of units based on thematic areas. Interestingly, space policy issues and GMES/Copernicus have been included under the Directorate for Aerospace, Maritime, Security and Defence Industries (ENTR.G)([81]), signalling the full awareness of the EU on the line binding space, security and defence not only in conceptual and policy terms, but also in industrial ones.

As far as Galileo is concerned, given the advanced status of the programme and the upcoming operational phase, the Directorate for EU Satellite Navigation Programmes (ENTR.H)([82]) is specifically in charge of all the different and related aspects.

DG ENTR may be supported and/or advised by other DGs and services based on specific expertise needs and concerning cross-sectoral aspects, for instance by the Joint Research Centre (JRC) with its Institute for Environment and Sustainability (IES), DG Maritime Affairs and Fisheries (DG MARE) and DG Humanitarian Aid & Civil Protection (DG ECHO) for GMES/Copernicus. The same can be said for Galileo, with its obvious link, for example, to DG Mobility and Transports (DG MOVE). This interplay also guarantees that space policy really contributes to the achievement of goals in other policy areas of the Union.

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[79] COM (2011) 152 http://ec.europa.eu/enterprise/policies/space/files/policy/comm_pdf_com_2011_0152_f_communication_en.pdf.

[80] Proposal for a Decision of the European Parliament and of the Council *Establishing a space surveillance and tracking support programme*, COM(2013) 107, 28 February 2013 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0107:FIN:EN:PDF.

[81] Unit G.1 Space Policy, Unit G.2 Space Research, Unit G.3 Security Research and Industry, Unit G.4 GMES/Copernicus, Unit G.5 Defence, Aeronautic, Maritime Industries.

[82] Unit H.1 EU Satellite Navigation Programme Management, Unit H.2 EU Satellite Navigation Financial Management, Unit H.3 EU Satellite Navigation Applications and International Affairs.

Before the EC issues proposals, it assesses the potential economic, social and environmental impacts that they may generate. Impact assessment is carried out through an integrated approach and specific guidelines with a view to preparing evidence for political decision-makers on the benefits and shortcomings of possible policy options. In doing so the EC takes advantage of the relevant expertise within its services as well as inputs from stakeholders, which allows, here too, to increase the coherence of initiatives across policy areas.

Once the EC's proposals have been adopted and the relative budgeted has been allocated, policy, legal acts and programmes - as well as the related funds – need to be managed.

Here, it is worth providing a brief overview of the implementation of the main space programmes already in place, therefore Galileo and GMES/Copernicus, and of the multiannual framework programmes on research and technological development activities, namely, the FP7 and H2020. In addition, concerning policy proposals, it is considered important to provide an account of the recent EC's Communication on a space industrial policy, titled *EU Space Industrial Policy: Releasing the Potential for Growth in the Space Sector* ([83]).

9.1.1 Galileo

Before considering the role of the EC, it is important to recall that the EU is the owner of all tangible and intangible assets created or developed under the satellite navigation programmes Galileo/EGNOS. This absolute innovation and the current public governance of the programmes([84]) are established by Regulation (EC) No 683/2008 on the further implementation of the European satellite navigation programmes (EGNOS and Galileo)([85]) which will be soon repealed by a new regulation, taking into account the concurrent deployment and exploitation phases of Galileo for which a further modification of the governance is needed.

It should also be borne in mind that at the highest level, the EP and the Council exercise the overall political oversight, with the EC keeping them duly informed on the progresses of the programmes implementation. In addition, the Galileo Inter-institutional Panel (GIP), composed by representatives of the EC, the EP and the Council, guarantees tight cooperation among the three institutions, while closely following the progress, management and governance of the programmes among other things.

The implementation of the programmes and related budget implies both **direct and indirect management** by the EC, based on the strict division of tasks and responsibilities, under the overall responsibility of the EC. The EC has the overall responsibility for the programmes (direct management), in particular management of funds and supervision of the implementation of all programmes activities (i.e. cost, schedule, performance). In doing so, the EC shall be assisted by the European GNSS

[83] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - EU space industrial policy releasing the potential for economic growth in the space sector, COM(2013) 108, 28 February 2013
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0108:FIN:EN:PDF.

[84] As opposed to the first governance model proposed for Galileo, that is, a PPP form. See A. Veclani; with research support from Jean-Pierre Darnis, Valérie Miranda, The Galileo programme: management and financial lessons learned for future space systems paid out of the EU budget, Brussels, European Parliament, October 2011 (Policy Department External Policies Study)
http://www.europarl.europa.eu/committees/en/studiesdownload.html?languageDocument=EN&file=67675.

[85] Regulation (EC) No 683/2008 of the European Parliament and of the Council of 9 July 2008 on the further implementation of the European satellite navigation programmes (EGNOS and Galileo)
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:196:0001:0011:en:PDF.

Programmes Committee, composed of representatives of MS and chaired by the EC([86]). As well, the EC allocates tasks through delegation agreements to other entities, namely the European GNSS Agency (GSA, see further) and ESA (see below).

Since 2008 when the programmes have been funded by the EU budget and the governance has been reorganized, Galileo has achieved major successes and proceeded on a sustained path. Nevertheless the real challenge with which the EC is confronted is the timely entrance into operations of the first services and exploitations itself.

9.1.2 GMS/Copernicus

The GMES/Copernicus governance is certainly more complex than Galileo's, given it is a federation of systems and that it includes a Space component (Sentinels and Contributing Missions); a Service component which is characterized by six reference areas of services (atmosphere, land, marine, emergency, security, climate change) and related "sub-services" (i.e. Services for Security applications include border control, maritime surveillance, support to EU external actions); and an In-situ component. In addition, the governance is evolving from that of initial operations (2011-2013) to that of full operations (2014 onwards). GMES/Copernicus Initial operations (GIO) and related governance are governed by Regulation (EU) No 911/2010, while for operations a regulation is still under preparation. Similarly to Galileo, the implementation of the programmes and related budget implies both **direct and indirect management**. Notwithstanding, the EC in GMES/Copernicus has more responsibilities in terms of direct management and many more tasks to entrust to numerous and diverse entities.

In GMES/Copernicus the EC is involved in the direct management of certain technical tasks, in particular within the Service component, where it is in charge of the implementation and technical coordination of the Emergency Management Service (EMS).

The decision to manage the EMS service is a serious test case for the EC. The service has been operational for a year and was activated almost 40 times([87]), mainly for emergencies in Europe and Africa, but also in the Middle East and Asia. These numbers are beyond expectations([88]), and - supposedly - also the associated work. An independent interim evaluation carried out between April and December 2012 has found that management and implementation of initial operations as a whole under the overall coordination of DG ENTR (GMES Unit) was efficient and effective([89]).

9.1.3 FP7 and H2020

As already mentioned, the FP7 complements the activities carried out by MS in the research area as well as other EU initiatives, such as those run under the structural funds and those relating to various policy areas (i.e. agriculture, competitiveness and innovation, industry, employment, environment, etc.). The

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[86] Based on the general rules established by the Regulation (EU) No 182/2011 of the European Parliament and of the Council of 16 February 2011 laying down the rules and general principles concerning mechanisms for control by Member States of the Commission's exercise of implementing powers.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:055:0013:0018:EN:PDF

[87] List of activations, EMS Portal, http://portal.ems-gmes.eu/ActivationPage/gioActivations.html.

[88] As it emerged from interviews with service providers.

[89] Centre for Strategy and Evaluation Services (CSES), Interim evaluation of the European Earth Monitoring Programme (GMES) and its Initial Operations (2011-2013), Final Report, January 2013
http://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCwQFjAA&url=http%3A%2F%2Fcopernicus.eu%2Fpages-principales%2Flibrary%2Fstudy-reports%2F%3Fno_cache%3D1%26cHash%3D87e9a8c6fbd6f67d63ec978f5bda6de9&ei=GbOQUZvZCMnXObq3gDA&usg=AFQjCNHz3ldpoToXvN5SC_2s_u_FPjHTCQ&bvm=bv.46340616,d.ZWU .

Space and Security Themes of the FP7 constitute an industrial policy tool, as they aim to strengthen the EU scientific and technological base, while fostering innovation and competitiveness and guaranteeing that SMEs are fully involved through concrete measures and specific actions.

DG ENTR contributes to bring space and security into FP7, along with the related objectives and prioritization of actions. Following an intense consultative process between the EC and institutional and research stakeholders as well as end users, in 2004 the EC firstly identified space and security as new thematic priorities([90]). A similar process is currently on-going for the new programme Horizon 2020 (H2020), so as to gather inputs from the European space research community to feed the proposal for space and security Research under the programme and the corresponding implementation strategy([91]).

The FP7 is implemented under direct management of the EC, namely through the Research Executive Agency (REA), purposely created. Indeed, REA was founded on the basis of the statute set by Council Regulation (EC) No 58/2003 ([92]) to be entrusted, under the direct control and responsibility of the EC, with the management of a large part of the FP7 all along its life time. Nevertheless, the REA is expected to remain operational beyond 2013 and until 2017 to cover the management of all the projects funded under the programme. Meanwhile, H2020 will have taken off and the agency's mandate might be extended to continue to cover the management of research activities.

It should be recalled that the FP7 provided for more than EUR 1.4 billion for space and 1.35 for security. The largest part of the funds available under the FP7 Space Theme (85%) were used for GMES components, while the remaining for space foundations to develop cutting-edge technologies enabling the potential of space sciences([93]).

In June 2013 the Council and the EP reached an informal agreement on the overall H2020 budget (the MFF 2014-20), setting H2020's budget at about EUR 70 billion([94]). The EP plenary assembly will discuss about the new agreement ad it is expecting to vote on the final document no earlier than September 2013([95]).

9.1.4 Space industrial policy

Space has been repeatedly recognized since 2010 as an important component of an integrated European industrial policy by the EC Communication on an integrated industrial policy for the globalization era, supporting the Europe 2020 strategy([96]). The Communication acknowledged space as

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[90] See for instance the Group of Personalities' report "Research for a Secure Europe" (2003), the European Security Research Advisory Board's activities, the ASTRO+ project as part of the EC's Preparatory Action for Security Research (PASR), etc.

[91] Hearing on Space Research in FP8, Preparation for the future of space research in Europe begins, DG ENTR. http://ec.europa.eu/enterprise/policies/space/research/hearing_fp8_en.htm

[92] Council Regulation (EC) No 58/2003 of 19 December 2002 laying down the statute for executive agencies to be entrusted with certain tasks in the management of Community programmes.

[93] See Space – Framework Programme 7, DG ENTR, http://ec.europa.eu/enterprise/policies/space/research/fp7/index_en.htm

[94] J. O'Dea 'Horizon 2020 in line to start on time after €70B package agreed' in *ScienceBusiness*, 26 June 2013 http://www.sciencebusiness.net/news/76181/Horizon-2020-in-line-to-start-on-time-after-%e2%82%ac70B-package-agreed

[95] http://horizon2020projects.com/policy-research/societal-challenges-pillar-to-receive-largest-budget-share/

[96] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – *An Integrated Industrial Policy for the Globalisation Era, Putting Competitiveness and Sustainability at Centre Stage*, COM (2010) 614, 28 November 2010, pp. 24-25 http://ec.europa.eu/enterprise/policies/industrial-competitiveness/industrial-policy/files/communication_on_industrial_policy_en.pdf .

a "driver for innovation and competitiveness at citizens' service", emphasizing societal, economic and strategic imperatives that must drive space policy([97]).

Since then the EC has been working on a specific space industrial policy, aware that the sector bears certain specificities. In early 2013 the EC issued the Communication *EU space industrial policy releasing the potential for economic growth in the space sector*([98]), which identifies current challenges, sets the related objectives and concrete measures to achieve them. The objectives include a stable regulatory framework, a solid industrial base, efficiency of the value chain to foster global competitiveness, development of for space applications and services, technological non-dependence.

Generalization of roles:

- ✓ **Upstream role:**
  - **#2 space policy -making, launch and supervision of programmes**
  - **#3 implementation of funding:**
    - **3.a R&D**
    - **3.b System (development, deployment, exploitation)**
  - **#4 definition of industrial policy (including procurement policy and regulatory framework)**
- ✓ **Downstream role:**
  - **#1 management/coordination/implementation of programmes**
  - **#5 data/service provision**

9.2 ESA

ESA is the European intergovernmental agency for R&D defining and implementing scientific, technological and space applications development programmes based on the specific interests put forward by MS as a whole (ESA Council at the ministerial and delegations levels). Here it should be looked at the role of ESA in those programmes that have a security dimension, namely the Launcher programme, the SSA programme, Galileo and GMES/Copernicus. The first two programmes fall within ESA's activities and therefore the agency is the sole responsible entity, while for the other two ESA is entrusted by the EC with certain management tasks.

9.2.1 SSA programme

Similarly to the Launcher programme, SSA is fully managed by ESA. The overall responsibility is held by the Directorate of Human Spaceflight & Operations, while a dedicated SSA Programme Office was also established (Spain). Nevertheless, considered the three different SSA segments (SST, SWE, NEO, see Part One *Space Situational Awareness*) and the multiplicity of technologies needed for such a complex endeavour, other teams spread within the agency and its sites, as well as partner agencies and organizations, are also involved.

Management functions performed by the SSA Programme Office and its Manager are similar to those under the Launcher programme, however SSA also aims to federate and network existing assets.

[97] See Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *An integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*, COM(2010)614, 28 October 2010.

[98]See Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *EU Space Industrial Policy*, COM(2013) 108, 28 February 2013 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0108:FIN:EN:PDF .

Therefore, the SSA Programme Manager, supported by a team, is also in charge of identifying potential assets that may be pooled into the European SSA and provided by MS or other governments, scientific and research institutions and future customers([99]).

9.2.2 Galileo

During the development and validation phase, before Galileo came under a public governance and was funded by the EU budget in 2008, the EU channelled its funds through the ESA GalileoSat optional programme, leaving to ESA the management, while a PPP was supposed to take the lead of the deployment and operations phases([100]). At the same time the Galileo Joint Undertaking (GJU) was established – the founding members being the EC and ESA - so as to ensure the unity of the administration and the financial control of the project, in particular the implementation of the development and validation phase([101]).

Regulation (EC) No 683/2008 established that development and validation were still to be funded by both the EU and ESA, while the deployment phase by the EU only. Hence, in the latter phase the EC delegated ESA to be the procurement agency for the ground and space infrastructures (indirect management).

In the upcoming regulation ESA will continue to be delegated by the EC for the completion of the deployment phase, however it will need to enter into working arrangements directly with the GSA for any further activity during the exploitation phase.

9.2.3 GMES/Copernicus

ESA is not only involved in the management of the programme, but also in co-funding it with the EU. Indeed, the agency has funded both services and the space component starting from 2001 and 2005 respectively, based on the FA and *ad hoc* arrangements with the EC. Services were included under the GMES Service Element optional programme within the overall ESA Earthwatch programme, which duration and projects were extended up to 2013. Concerning the space component, ESA has also a dedicated optional programme. The Directorate of Earth Observation Programmes has the overall responsibility, but the GMES Space Office (Italy) is in charge of laying down programmatic aspects.

The delegation to ESA of the technical implementation of the GMES/Copernicus space component was formalized by the GIO Regulation. Tasks includes the procurement and development of the Sentinel satellites and related infrastructures as well as the coordination of data access coming from Contributing Missions (GMES space component data access system, GSCDA) . Moreover, ESA is responsible for the definition of the overall GMES Space Component architecture and for the planning of future GMES elements.

Generalization of roles:

- ✓ **Upstream role:**
  - – **#3 implementation of funding:**
    - **3.a R&D**

[99] The description of ESA's role in the SSA programme is based on information available on the programme's website, http://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness/SSA_team.

[100] For further details see The Galileo programme: management and financial lessons learned for future space systems paid out of the EU budget.

[101] Council Regulation (EC) No 876/2002 of 21 May 2002 setting up the Galileo Joint Undertaking, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:138:0001:0008:EN:PDF.

- **3.b System (development, deployment, exploitation)**
- **3.c Part of the system (development or development and deployment)**

✓ **Downstream role:**

- **#1 management/coordination/implementation of programmes**
- **#2 R&D**
- **#3 development and production**
- **#4 operations**
- **#5 data/service provision**

9.3 EUSC

Today, EUSC doesn't have a role established by a regulation in any of the above mentioned programmes, however it is highly relevant to consider it both in terms of its traditional role in the field of CSDP and of the potential one in GMES/Copernicus services for Security applications.

EUSC, as stated in the founding Council Joint Action (2001/555/CFSP)([102]), has the specific mission to "support the decision-making of the Union in the context of the CFSP, in particular of the ESDP, by providing material resulting from the analysis of satellite imagery and collateral data […]". Thus, in the last years, the centre's work has been integrated into the operational work of a wide range of CSDP military and civilian operations such as EUNAVFOR Somalia, EUPM in Bosnia-Herzegovina, EUJUST THEMIS in Georgia, EUBAM Rafah, among others([103]).

In performing its mission, EUSC today is strictly connected by praxis to the EEAS (though not being part of it): on the one side, it supports it with its products upon request of its structures and crisis management bodies (i.e. INTECEN, EUMS, CMPD, etc.); on the other, its tasking for requests coming from the EU is coordinated and centralized by the EEAS itself. In addition, it is the HR/VP who gives the centre operational direction based on the Political and Security Committee's (PSC) guidance.

Regarding sources of satellite information and data, EUSC prominently relies on commercial systems (i.e. QuickBird, WorldView, Rapid-Eye, GeoEye, Spot and Radarsat). Notwithstanding, it is constantly increasing dialogue with governments disposing of national systems (IT, FR, DE) in order to improve, and increase, the use of European governmental imagery for EU decision making and to strengthen the ties among/with such governments (Governmental Imagery Forum)([104]). Arrangements between EUSC and MS are already in place for what concerns the delivery of governmental imagery data from Helios, COSMO-SkyMed and SAR Lupe. Negotiations between the centre and the French government are currently ongoing to define an agreement on data from Pleaidés.

9.3.1 GMES/Copernicus

A potential role of the EUSC in the security dimension of GMES/Copernicus cannot be excluded given the current and past engagement of the EUSC in FP7 projects dealing with security, as well as emergency (i.e. SAFER), and its expertise.

[102] The founding Joint Action was amended by three other Joint Actions. Here it is considered the consolidated version, merging all the elements, as prepared by the EUSC.
http://www.satcen.europa.eu/images/stories//consolidated%20council%20joint%20action%2025-08-11.pdf.
[103] See EUSC Annual Report 2011,
http://www.satcen.europa.eu/images/stories//eusc%20annual%20report%202011.pdf.
[104] See footnote 150.

EUSC was/is involved in projects especially addressing support to EU external actions, namely, G-MOSAIC, G-NEXT and G-SEXTANT. In these projects EUSC is often the interface with users (service coordinator and/or users engagement), but also service provider. In addition, given its security expertise and available infrastructure to handle confidential data and information, in G-NEXT EUSC directly deals with sensitivity issues regarding both the activation of the services and the content of products (Which is the area of interest? Which sensitive information could be drawn from the final product? Which is the time of the activation? etc.). Beside this domain, the centre is also active in the other two areas of the security dimension, that is, border control and maritime surveillance. In particular, it takes part in projects such as DOLPHIN, NEREIDS, SAGRES, LOBOS. EUSC is therefore fully aware of the mechanisms established by these projects, having also contributed to shape them, concerning in particular production and delivery of services as well as users engagement.

As already mentioned, the FP7 BRIDGES project is exploring suitable models of governance for the Security dimension which will also take in consideration the potential role of EUSC therein. Based on the projects' results and on the parallel work performed by the EC, along with institutional stakeholders, the EC might propose in the new regulation on GMES/Copernicus operations to delegate specific tasks of the security dimension to the EUSC. Indeed, if the EC is to exploit existing resources, the centre is certainly a relevant one given not only its experience, but also its Union dimension. As a matter of fact, EUSC was mentioned in the Communication of the EC on GMES/Copernicus and its operations among the possible entities for the implementation of the security-related services([105]). It should be noted however that in order to perform new tasks, the founding Council Joint Action should be amended.

Generalization of roles:

✓ **Downstream role:** – **#2 R&D** – **#5 data/service provision**	✓ **Potential downstream role in GMES/Copernicus:** – **#1management/coordination/ implementation of programmes** – **#5 data/service provision**

9.4 GSA

The evolution of the GSA in its current form goes hand in hand with the advancement of Galileo programme from its development phase to exploitation. Established in 2004 as the authority in charge of covering the deployment and operational phases([106]), it subsequently took over the GJU's tasks related to the management of the development phase([107]). It became a decentralized agency in 2010, in charge of security and commercial aspects of the programme([108]) and based on the upcoming

[105] Others are: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the European earth monitoring programme (GMES) and its operations (from 2014 onwards), 30 November 2011, COM(2011) 831, p. 6 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0831:FIN:EN:PDF.

[106] Council Regulation (EC) 1321/2004 of 12 July 2004 on the establishment of structures for the management of the European satellite radio-navigation programmes http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:246:0001:0009:EN:PDF.

[107] Council Regulation (EC) No 1942/2006 of 12 December 2006 amending Regulation (EC) No 1321/2004 on the establishment of structures for the management of the European satellite radio-navigation programmes http://ec.europa.eu/dgs/energy_transport/galileo/documents/doc/texte_final_1942_en.pdf.

[108] Regulation (EU) No 912/2010 of the European Parliament and of the Council of 22 September 2010 setting up the European GNSS Agency, repealing Council Regulation (EC) No 1321/2004 on the

regulation on Galileo implementation and exploitation should be in charge of the overall programme management([109]). As a decentralized agency, GSA is a body of the Union funded by its budget and by voluntary contributions from MS and possibly third countries, endowed with legal personality, which independently exercises the assigned mission and tasks and adopts its own budget([110]). Its administrative board is composed by representatives of the MS, of the EC and of associated or participating third countries with voting rights, while representatives of the EP, of the HR/VP, and of the Security Accreditation Board (SAB, see below) as well as experts from ESA are involved as observers. Regarding budget, expenditures, and work programmes, the agency annually reports to the EC, the Council, the EP, the Court of Auditors and the *Office Européen de Lutte Anti-Fraude* (OLAF).

9.4.1 Galileo

The effective management of the programme is entrusted to the GSA (indirect management), an already existing decentralized agency of the EU, which legal basis were duly modified to take over this role([111]). The selection of GSA for this role was the result of a substantial reflection within the EC, which evaluated different options in this sense. The other possibilities included the EC itself, a Joint Undertaking (JU), and a new EU public company. The reasons for discarding these options are worth consideration here as they might be relevant for other current or future space programmes. The EC did not believe to be endowed with the suitable organizational and procedural features to manage a complex programme like GNSS. In addition, the responsibility for the political supervision would have been incompatible with programme management, thereby raising a conflict of interest. Finally, the EC also took note of the European Court of Auditors' opinion, according to which the EC had little experience in programme management. On its part, the JU did not fit the purpose of management, rather, of R&D([112]). Lastly, the European public company was considered incoherent with the political, legal and financing framework for managing the exploitation of Galileo/EGNOS([113]).

establishment of structures for the management of the European satellite radio navigation programmes and amending Regulation (EC) No 683/2008 of the European Parliament and of the Council
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:276:0011:0021:EN:PDF.

[109] Proposal for a Regulation of the European Parliament and of the Council on the implementation and exploitation of European satellite navigation systems – Partial general approach, Council of the EU, 11105/12, 12 June 2012
http://register.consilium.europa.eu/pdf/en/12/st11/st11105.en12.pdf.

[110] Following the adoption of the general budget of the EU.

[111] Regulation (EU) No 912/2010 of the European Parliament and the European Council of 22 September 2010 to be repealed based on Proposal for a regulation of the European Parliament and of the Council amending Regulation (EU) No 912/2010 setting up the European GNSS Agency, COM(2013) 40, 6 February 2013.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:276:0011:0021:EN:PDF
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0040:FIN:EN:PDF.

[112] See Commission Staff Working Paper, Impact Assessment Accompanying the document Proposal for a Regulation of the European Parliament and of the Council on further implementation of the European satellite navigation programmes (2014 – 2020), 30 November 2011.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2011:1446:FIN:EN:PDF

[113] "While an EU public company could have the advantages of a private sector company in terms of effectiveness and efficiency in the commercialisation of services, it raises questions as to the feasibility of putting in place the legal prerequisites (rules would have to be established in EU law with respect to issues such as governance, the opening of share capital and privatization) in a timeframe that is useful for the GNSS programmes". See Commission Staff Working Paper Impact Assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council on further implementation of the European satellites navigation programmes (2014-2020), SEC(2011) 1446, 30 November 2011, p. 48.

Turning to GSA, the agency may consider the use of other public or private sector entities, whenever necessary to fulfil the tasks assigned. To provide an idea of the complexity if these tasks, here some are mentioned, however it is out of the scope of this study to deepen them:

- Security accreditation, through the Security Accreditation Board (SAB), which is part of GSA but is made independent in light of the sensitivity of security accreditation of the whole system (infrastructures, services, receivers, operations, etc.) which is also the reason why it is supported by a panel of MS experts.
- Operation of the Galileo Security Monitoring Centre (GSCM), which is the "hub" of Galileo security.
- Tasks relating to the PRS functioning.
- Contributing to marketing of the services.
- Operational activities of the Galileo and EGNOS programmes including system infrastructure management, maintenance, ongoing improvement, certification and standardisation, as well as service provision.

9.4.2 GMES/Copernicus

In the Communication of the EC on GMES/Copernicus and its operations, GSA was mentioned as one of the potential entities to which the EC could delegate certain tasks related to programme management, but at the time of writing it is uncertain whether this is still an option. The document makes reference to tasks such as management of funds allocated to the programme and the supervision of the implementation of tasks.

Generalization of roles:

✓ **Downstream role:** – **#1 management/coordination/implementation of programmes**	✓ **Potential downstream role in GMES/Copernicus:** – **#1 management/coordination/implementation of programmes**

9.5 FRONTEX and EMSA

FRONTEX and EMSA are decentralized agencies having very similar legal features to those of the GSA. FRONTEX was founded in 2004([114]) and EMSA in 2002([115]) with the missions, respectively, of management of the external borders of the EU and of maritime safety and security, including prevention of and response to pollution. In these domains of action GMES/Copernicus and Galileo could certainly serve the agencies' objectives. Thus, FRONTEX and EMSA can be appreciated as users of the two systems in order to complement their work, services and instruments. On the one hand, FRONTEX

[114] Council Regulation (EC) No 2007/2004 of 26 October 2004 establishing a European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union and following integrations and amendments: Regulation (EC) No 863/2007 and Regulation (EU) No 1168/2011
http://www.frontex.europa.eu/assets/About_Frontex/frontex_regulation_en.pdf
http://frontex.europa.eu/assets/Legal_basis/rabit_regulation-863-2007.pdf
http://frontex.europa.eu/assets/About_Frontex/frontex_amended_regulation_2011.pdf.

[115] Regulation (EU) No 100/2013 of 15 January 2013 amending Regulation (EC) No 1406/2002 establishing a European Maritime Safety Agency
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:039:0030:0040:EN:PDF.

will be responsible for the coordination of the EUROSUR initiative and for the related service provision, which, among other things, will exploit existing surveillance systems (ground-, air-, sea-, and space-based) to gather surveillance information on the external borders and on the pre-frontier area. Hence, GMES/Copernicus will be a major resource in this sense and its use has been already envisaged. Indeed, a number of FP7 GMES/Copernicus projects are dedicated to the definition of services which could support EURUSUR. Within these projects FRONTEX is regularly consulted and involved as a stakeholder and user.

On the other hand, EMSA CleanSeaNet service([116]) exploits satellite imagery and data, including a quota made available within GMES/Copernicus initial operations. This is the reason why EMSA has contributed to the definition of Sentinel 1 requirements. EMSA is also active in vessel traffic monitoring and information both at the European and global levels. In particular, SafeSeaNet is a centralised European platform exploiting the Automatic Identification System (AIS) for maritime data exchange, linking together maritime authorities from across Europe, while the Long Range Identification and Tracking system (LRIT) provides contracting European governments (EU and non-EU) to obtain ship identity and location information. This kind of services is particularly relevant to safety at sea and prevention of maritime pollution.

9.5.1 GMES/Copernicus

Besides being users of future services for Security applications, FRONTEX and EMSA might be delegated by the EC for their technical implementation, especially concerning the domains of border control and maritime surveillance respectively. Similarly to EUSC, the two agencies were mentioned in the 2011 Communication of the EC on GMES/Copernicus and its operations.

Generalization of roles:

✓ **Downstream role:** – **#1 management/coordination/implementation of programmes** (FRONTEX) – **#5 data/services provision** (EMSA, FRONTEX)	✓ **Potential downstream role in GMES/Copernicus:** – **#1 management/coordination/implementation of programmes** (FORNTEX and EMSA) – **#5 data/services provision** (EMSA, FRONTEX)

9.6 EDA

The agency was founded by a Council Joint Action in 2004 (2004/551/CFSP)([117]) and its role in CSDP was subsequently recognized in the Lisbon Treaty (see 1.2 *The Lisbon Treaty and security and defence*). In recent years EDA's action in the space domain notably increased, within the overall scope of supporting the Council and MS in their effort to improve defence capabilities for CSDP.

The activity of EDA in the space field mainly interests intelligence, surveillance, reconnaissance (ISR) and EO, SSA, SATCOM as well as critical space technologies for European non-dependence. These topics are treated at different levels and within all principal directorates (Capabilities, Research and Technology,

[116] CleanSeaNet is the Near Real Time European satellite based oil spill monitoring and vessel detection service, set up and operated by the EMSA since April 2007. See CleanSeaNet website, https://csndc.emsa.europa.eu/web/csn?l=n&n=0.

[117] Council Joint Action 2004/551/CFSP of 12 July 2004 on the establishment of the European Defence Agency http://www.eda.europa.eu/docs/documents/COUNCIL_JOINT_ACTION_2004_551_CFSP.pdf.

Armaments, Industry and Market) in an integrated manner, starting from the priorities identified in the Capability Development Plan (CDP). The plan, currently under review, covers future capability needs from the short to the long term (beyond 2025). ISR is among the "Top 10 Priorities" and it includes SSA. Additional specific support actions cover the other applications mentioned. These include for instance:

- R&T projects (i.e. studies such as ETISC, Enhanced Radar Imaging Techniques, and Micro-satellite Cluster Technology);
- coordination of programmes (i.e. MUSIS);
- definition of requirements and/or identification of civil-military synergies (i.e. SSA, MUSIS-GMES);
- pooling and sharing initiatives (i.e. ISR, ESPC, SECTELSAT).

Generalization of roles:

- ✓ **Upstream role**
  - **#3 implementation of funding:**
    - **3.a R&D**
- ✓ **Downstream role:**
  - **Role #1: management/coordination/implementation of programmes,**
  - **Role #2: R&D**

Besides, EDA's role can also be appreciated as **"support"**.

9.7 EEAS

Given the international dimension of space policy and related programmes, the EEAS naturally comes to play an important role therein. Besides supporting international cooperation goals through dialogue and negotiations with the space faring nations worldwide, the EEAS can significantly contribute to the well-functioning of space programmes such as GMES/Copernicus, Galileo and SSA, especially when it comes to external and security issues. In these frameworks, it is not only an important stakeholder, but also a user, thereby in place to provide feedback to improve the services.

From a legal point of view, based on the Council Decision defining the organisation and functioning of the EEAS, the service shall assist, support and cooperate with the Commission, while ensuring the consistency between the different areas of the Union's external action and between those areas and its other policies (Arts. 2(2) and 3)([118]).

9.7.1 Galileo

In the upcoming regulation on the implementation and exploitation of Galileo, the EEAS is expected to have a specific support function, in particular:

- assisting the EC in relation to the implementation of security-related tasks (i.e. security of the systems) in the field of external relations;
- supporting the EC in the preparation or implementation of international agreements.

9.7.2 GMES/Copernicus

[118] Council Decision 2010/427/EU of 26 July 2010 determining the organisation and functioning of the European External Action Service
http://www.eeas.europa.eu/background/docs/eeas_decision_en.pdf.

The EEAS is mentioned neither in the GIO regulation nor in the Communication of the EC on GMES/Copernicus and its operations. Notwithstanding, it is already involved in the programme to different extents. Regarding services for Security applications, the relevant EEAS services have been participating in the *ad hoc* GMES-Security working group in Support to External Actions (SEA), both as a stakeholder and a user, in order to identify requirements and define a service/product portfolio for this service area([119]). The portfolio will constitute the basis on which the services/products will further evolve, thereby providing guidance over 2013-2014 to the dedicated FP7 projects. Concerning the EMS, the EEAS is kept informed on activations of the service and provides recommendations on sensitivity upon request by DG ECHO([120]).

Generalization of roles: the EEAS cannot be suitably placed within the two categories of roles. Its role can be better appreciated as "**support"**.

9.8 Member States

Notwithstanding cooperation within ESA and the EU (including EDA and EUSC), MS are still fundamental actors for space activities in Europe and especially in the field of security and defence, as it clearly emerged from the first part of this study. Given the importance of these domains, where sovereignty is perceived as the dominant paradigm, governments often issue policy documents in order to define space, security and defence strategies and objectives on which their action in the medium to the long term relies([121]). Hence, these documents provide overall policy guidance and priorities on which policy-making and launch of programmes are based.

Regardless of the civil or military nature of space systems, until twenty to twenty-five years ago these were originally exclusively publicly funded as they were – and still are - regarded as strategic, high-tech, high-risk and investment intensive instruments. In addition, governments usually had to take on their operation and maintenance. Therefore, they intervened all along the life cycle of such systems, while procuring the infrastructure from national high technology industries. Although space investments remain elevated even today, thanks to significant technological advancements some applications and services have progressively become marketable and are offered by private firms, including to governments for military purposes. This is the case in particular of SATCOM, while EO and navigation are still in need, albeit to different extents, of public support for both development and exploitation. As their maturity and utility constantly increase, these applications might eventually become profitable, opening market possibilities for new private entrants.

Today, when it comes to space systems for security and defence, European governments are increasingly confronted with the delicate choice between public investment and diverse forms of funding that involve the private sector (i.e. Skynet-5). Indeed, sophisticated commercial technologies on the one hand and shrinking defence budgets on the other encourage such methods of financing. Between the two options, other opportunities for reducing costs while maintaining state control of such strategic assets can be found in institutional cooperation, either at the intergovernmental level (i.e. Athena-Fidus, launchers) or within the framework of the EU (i.e. Galileo and GMES/Copernicus). At the same time, even in these cooperative endeavours private actors can play an important role (i.e. ESPC).

[119] FP7 Work Programme 2012, Cooperation, Theme 9, Space, p. 22 ftp://ftp.cordis.europa.eu/pub/fp7/docs/wp/cooperation/space/j-wp-201201_en.pdf.

[120] GIO EMS – mapping. Manual of operational procedures, March 2012.

[121] Two recent examples are the French White Paper on Defence and National Security and the UK Civil Space Strategy 2012-2016

Once policy guidance and funding are established, the appropriate administrations and ministries, including space agencies or offices, mainly contribute to policy making and are in charge of supervision and implementation. In addition, in some MS space agencies and ministries of defence also have more operational roles, such as operation of the systems, and data/service provision. Finally, universities and research centres also provide their contribution in terms of R&D. In other words, every MS has its own organization and governance, which can be summarized and simplified for some European space faring nations as shown in Table 9 below. Here, the four main ESA contributors are considered, along with Norway which is an ESA MS, but non-EU. This is just to provide an idea of how each country approaches space policy and the complexity this creates in the overall European space governance, where also ESA and the EU stand.

Table 9: Member States - Space governance & Space strategies

	FR	DE	IT	UK	NO
Agency - creation	CNES - 1961	DLR - 1969	ASI - 1988	UKSA - 2010	NSC - 1987
Ministry/Department reporting to	Higher Education & Research + Defence	Economics and Technology	Education, Research and University	Business, Innovation & Skills	Trade and Industry
Defence involvement	Fully involved	Increasingly involved	Fully involved	Involved	Low but increasing
Intra-governmental committees or bodies	Steering Committee	Inter-ministerial Commission	Inter-ministerial Group	Space Innovation & Growth Team	-
Space strategy - issuing authority	Space Strategy (2012) – Min. of Higher Education & Research	Space Strategy (2010) – Min. of Economics & Technology	Strategy Vision 2010-2020 (2010) - ASI	National Civil Space Strategy 2012-2016 (2012) – Dept. for Business, Innovation & Skills	Long-Term Plan 2010-2013 (2010) - NSC
Leading applications	Launchers, SATCOM, EO	EO, SATCOM, Robotics	EO, launchers, SATCOM, science	Space science	SATCOM (AIS)

Source: Euroconsult, 'International overview of space governance and policies for the Canadian Aerospace Review' June 2012. Elaboration and updates of the authors.

Concerning EU initiatives, MS not only play a predominant role in the decision taking through the voice of the Council, but also intervene and contribute at the programmes level. Here Galileo and GMES/Copernicus are both relevant and can be treated together as the involvement of MS therein is very similar. Indeed, the existing Regulations in place for both programmes confer implementing

powers on the EC to adopt specific measures. In doing so the EC is subject to the assistance and control a committee composed of representatives of the MS. In GMES/Copernicus, such the Committee shall have a specific configuration to deal with security issues only, that is, the Security Board. As a matter of fact, the measures to be adopted by the EC regard security issues and other delicate questions (i.e. programming, additional funding provided on voluntarily bases, definition of priorities for the implementation of Galileo, reduction and management of risks, etc.). Regarding security in particular, for instance, by the GIO Regulation the EC shall adopt specific measures:

- for restricting access to the information produced by GMES services and data collected through the GMES dedicated infrastructure (Art. 13(1));
- laying down technical requirements in order to ensure the control and integrity of the system within the GMES space component dedicated programme, and to control the access to, and handling of, technologies that provide security to the GMES space component dedicated programme. (Art. 13(2)).

By the upcoming regulation on the implementation and exploitation of Galileo the EC shall for instance:

- lay down the requirements and standards necessary to ensure the security of the systems and their operation.

The fact of having a Committee and related mechanisms in place in both GMES and Galileo to assist the EC is mainly about having control over the EC' s action. In both programmes, the EC is delegated the power to adopt delegated and implementing acts([122]), nevertheless these are subject to the potential opposition of MS, the Council and the EP. The EC's responsibility over a variety of security aspects of the programmes, be them data policy or integrity of the systems, suggests that the more sensitive the measures are the more control will be exercised. Once again it is a question of sovereignty and of state control over strategic programmes bearing important security aspects.

Generalization of MS roles:

- ✓ **Upstream role:**
  - **Role #1: political guidance, priorities setting, budget approval**
  - **Role #4: definition of industrial policy (including procurement policy and regulatory framework)**

Generalization of MS ministries/departments, administrations and space agencies/offices' roles:

- ✓ **Upstream role:**
  - **Role #2 policy making and launch of programmes**
  - **Role #3: implementation of funding:**
    - **3.a R&D**
    - **3.b System (development, deployment, exploitation)**

[122] The TFEU has introduced two new articles, 290 and 291, that regulate delegated and implementing acts respectively, which are two different methods of delegating powers to the EC. Delegated acts are adopted by the EC and directly proposed to the EP and the Council, which can oppose it on any basis. The EC is assisted by an expert group in drafting these acts, not by a committee. Nevertheless, the GIO Regulation still envisages the presence of a regulatory committee to adopt delegated acts. This is probably because the alignment to the new provisions is gradual and indeed the GIO Regulation was proposed before the entry into force of the Lisbon Treaty and adopted less than a year later. Implementing acts require the assistance of the committee based on either the advisory procedure or the examination procedure. If the latter provides a negative opinion on a proposal of the EC, the EC shall not proceed on that act as it is.
http://ec.europa.eu/transparency/regcomitology/index.cfm?do=implementing.home.

- **3.c Part of the system (development or development and deployment)**

✓ **Downstream role:**

- **Role #1: management/coordination/implementation of programmes,**
- **Role #2: R&D,**
- **Role #4: operations,**
- **Role #5: data/services provision.**

9.9 Industry

As already mentioned, the dual-use nature of space technologies allows aerospace industries to produce and provide systems and services for both civil and military use. The space industrial sector is normally associated with the wider security and defence industry, in which governments still play a role, both as customers and at times as shareholders. Yet, these industries strongly need commercial and export sales, as the governments' demand alone cannot sustain them.

The space sector in Europe is a narrow niche featuring unique peculiarities compared to other traditional industrial segments. Its complexity is given by the different kinds of private businesses and enterprises. The structure of the space supply chain is articulated around two main segments: upstream and downstream (not to be confused with the overall approach applied to the whole space value chain used for the purposes of this study). The former mainly consists of R&D, consultancy, manufacturing of space and ground hardware and the provision of launch services, while the second mostly comprises satellite operators and service providers. As in the overall space value chain described above, the distinction between the two segments is not always entirely clear, as companies increasingly undertake activities that could be included in both the upstream and downstream segments of the space supply chain.

In the upstream segment, the European space industry is significantly concentrated, with a high degree of vertical integration in the manufacturing supply chain. Vertical integration is driven by the highly specialised nature of the space business, its high capital requirements, and a need for costly testing facilities with low volume production. There is also strong pressure to retain control over the supply of critical components, as to ensure security of supply and quality as well as reputation with institutional customers and space insurers. Further, interest in accessing a greater share of the supply value chain stimulates the creation of subsidiaries that do not only satisfy in house demand, but also sell to other systems integrators.

At the top of the supply chain, the European space manufacturing industry is dominated by four large companies, EADS, Finmeccanica, Safran and Thales, which currently account for more than 70% of the total space employment([123]). OHB-System, being awarded as the prime contractor for the first 14 satellites for the European GNSS system, can be considered a new entry in the space industry's upper tier. The current industrial concentration reflects the wider privatization and consolidation efforts began in the late 1990s, when the European space manufacturing sector was restructured through a series of major mergers and acquisitions. The four "aerospace giants" mainly operate in the upstream market as prime contractors and system integrators, although their effort towards vertical integration led them to be active (through subsidiaries and joint-ventures) also in the subsystems tier. These moves were fundamental for these European firms to keep the "critical mass" and to ensure continuity to their role as global suppliers vis-à-vis old and new international competitors. Today, thanks also to these choices 14 European companies are in the world space industry top 50([124]).

[123] European Space Directory 2012, 27th Edition, ESD Partners Publication, Paris 2012, p. 132.

[124] See charts in Space News 'Top 50 | 2011 Brought Winds of Change for U.S. Industry'

The second industrial tier in the upstream segment is composed of specialised sub-systems producers: alongside the primes' subsidiaries such as Astrium and Thales Alenia Space, other companies such as Avio, Cobham, GMV, Indra, Ruag and Selex Galileo supply the prime contractors with structures, systems, mechanisms and equipment.

SMEs and small space businesses occupy a lower level in the upstream segment, providing components to the upper tiers of the industrial pyramid (integrators, prime, sub-systems producers). According to the EC, SMEs are those enterprises which employ fewer than 250 persons, have an annual turnover not exceeding EUR 50 million or an annual balance sheet total not exceeding € 43 million. These criteria are in force also at the ESA level, witnessing an important convergence of methods at the base of the two institutions' work. Despite this definition provides clear parameters to distinguish SMEs among other small space businesses, the heterogeneity of the group does not allow to easily establish well defined borders for these categories. They often provide key innovative goods and services to the major space companies, and are often specifically valued for their flexibility and adaptability allowing faster introduction of new technologies that better respond to emerging security requirements.

A key part of the upstream segment comprises academia and R&D centres (public and private). They contribute to the space industry's technology innovation processes by dealing with both prime contractors and sub-systems producers. Their activity ranges from basic research associated with the design and development of space hardware, to detailed work on scientific payloads and key software tools. Although private laboratories and innovation agencies are important actors, R&D activities are generally sustained and supported at public level, by both national and European institutions.

The structure of the downstream segment is much less easy to define, as there is no a clear hierarchical or pyramidal division of the market. The satellite services sector is even more dependent on the commercial market, but is particularly significant to the whole space supply chain as it turns public or private investments directed to the manufactory industry into value added applications and services.

In the domain of security and defence this segment includes satellite operators for SATCOM from which governments lease or buy capacity (i.e. Intelsat and Inmarsat) and meteorology (i.e. EUMETSAT), service providers for EO (i.e. Astrium Services and e-Geos) as well as user equipment (i.e. Galileo receivers currently under development). The increasing use of satellite services for security and military purposes is sustaining a growing stream of applications in such areas as air traffic control, transport safety, emergency and crisis management, etc. In addition, the progressive creation of new downstream opportunities within the institutional market, along with spin-offs in the commercial one, led big upstream actors (also prime contractors and sub-systems providers) to expand their business, providing niche satellite services and applications. This is the case, for instance, of Astrium Services and e-Geos. Also universities, academia and R&D laboratories contribute to the development of the downstream activities.

Finally, it should be underlined the increasing role of the private sector within PPPs, only recently implemented in Europe in the space sector, mainly in relation to SATCOM and EO.

Given the lack of a universal definition of PPP and the variety of options available, this study adopts the general OECD definition: "an agreement between the government and one or more private partners (which may include the operators and the financers) according to which the private partners deliver the service in such a manner that the service delivery objectives of the government are aligned with the profit objectives of the private partners and where the effectiveness of the alignment depends on a

http://www.spacenewsinc.com/pdf/Top502012Page1.pdf.

sufficient transfer of risk to the private partners. In the PPP, the government specifies the quality and quantity of the service it requires from the private partner"([125]). In this framework, the private sector may be entrusted not only with the provision of the service to the government and possibly to third party users, but also with the design, construction, funding, operation and management of the infrastructure. In turn, the private partner receives compensations from the government and, if envisaged by the agreement, charges from third party users (third party revenues).

As space is a peculiar sector and quite new to PPPs, there exists to date no leading form of partnership in the security and defence sphere. Compared to traditional sectors in which PPPs are usually implemented, the domain of space for security and defence is characterized by the rooted governments' strategic interests; political and economic issues; elevated risks connected to funding, launch and operations; national and international laws; and profitability. Nevertheless, the PPP model is very attractive and promising thanks to a number of advantages for both private and public actors: the sharing of risks and costs, which are most suitably allocated between partners; expansion of both institutional and commercial markets; investments in innovative technologies; transfer of know-how across Europe in the different industrial segments (R&D, manufacturing, services); efficient development and implementation cycles; transparency and control of budgets; guaranteed revenues for private actors either generated by the public purchases alone or even by private ones. Notwithstanding, some conditions are necessary for the success of a PPP: on the public side, governments' long-lasting commitment to the partnership and clear definition of requirements in a long-term perspective; on the private one, contractors' expertise not only in the space sector, but also in dealing with security and military aspects([126]).

Among the different forms of PPPs, great potential is attached to "hosted payloads", currently explored by both governments and industry in Europe and in the US. This form would allow governments to exploit extra capacity on commercial satellites, thereby placing military instruments (sensors, transponders, etc.) on space-crafts already scheduled for launch. For the time being, military SATCOM seems the most suitable application for hosted payloads. Such opportunity is considered cost-effective and operationally efficient, since it could sensibly reduce the investments and time normally needed by public authorities to plan, build, launch and operate constellations. The governments' interest in hosted payloads stems from the ever growing need for satellite bandwidth required for complex military platforms such as Unmanned Aerial Systems (UAS) or simply for the transmission of vast flows of data (voice, videos, images, etc.). In addition, hosted payloads could guarantee a certain degree of redundancy when satellite networks are overstretched, delivering responsive services for urgent operational needs.

Although some contracts have been signed in Europe in the civilian domain, governments and industry still need to work on shared requirements as far as military hosted payloads are concerned. Indeed, some of the key challenges identified by Euroconsult in a recent report on the matter are the alignment of government and industry programme schedules and the operational constraints (i.e. interfaces, interoperability, etc.). This notwithstanding, common grounds are found regarding some other

[125] OECD, Public Governance and Territorial Development, Public Management Committee, *From Lessons to Principles for the use of Public-Private Partnerships*, 32nd Annual meeting of Working Party of Senior Budget Officials, Luxembourg, 6-7 June http://www.oecd.org/gov/budgetingandpublicexpenditures/48144872.pdf.

[126] Presentations given at the ESPI conference on Partnership models for the benefit of sustainable space-based services, 15 June 2012 http://www.espi.or.at/past-events-conferences-events-18/9-misc/misc/819-public-private-partnerships-workshop-15-june-2012.

conditions, such as political commitment, a firm-fixed price contract for cost control, launch option flexibility and effective failure management procedures([127]).

Generalization of roles:

- ✓ **Upstream role:**
  - **Role #3: implementation of funding:**
    - **3.a R&D**
    - **3.b System (development, deployment, exploitation)**
    - **3.c Part of the system (development or development and deployment)**
- ✓ **Downstream role:**
  - **Role #1: management/coordination/implementation of programmes,**
  - **Role #2: R&D,**
  - **Role #3: development and production,**
  - **Role #4: operations,**
  - **Role #5: data/services provision.**

10. INTER-INSTITUTIONAL DIALOGUE AND INITIATIVES

Along the main space actors in Europe and their specific roles, a number of institutional initiatives guarantees that dialogue among them favours both coordination and cooperation in terms of R&D, civil-military synergies, capability development and so on., while providing support to the overall European space policy.

10.1 ESA-EDA Administrative Arrangement

The Administrative Arrangement (2011) between ESA and EDA allows the two agencies to work synergistically on:

- civil-military synergies in the field of EO (i.e. parallel studies on Earth Observation ground segment system of systems for security and defence (EDA) and for civil security (ESA));
- Intelligence, Surveillance, Reconnaissance (i.e. ISR Capability Package Assessment Study (ICPA), with ESA making available its Concurrent Design Facility (CDF(128)) at ESTEC);
- Satellite Services (C2) for UAS Missions (i.e. Demonstration of Satellites enabling the Insertion of Remotely Piloted Aircraft Systems in Europe);

[127] Hosted Payloads Report Sheds Light on Government & Industry Requirements
http://www.euroconsult-ec.com/news/press-release-33-3/57.html

[128] The CDF provided the intergovernmental modelling and simulation environment for the study. The CDF has been developed and is being used for implementing and assessing systems of systems designs at optimum balance of cost, benefit and risk.
http://www.esa.int/SPECIALS/CDF/SEM4N1YEM4E_0.html.

– tactical/mobile satellite communications (i.e. activities started in the framework of ETISC led by EDA, coordination with ESA subsequent feasibility studies);

– SSA (i.e. EDA military requirements, ESA Preparatory programme and civil requirements).

10.2 Structured dialogue on Space and Security

The Structured Dialogue on space and security was set up in response to a Council request, bringing together the relevant EC services, the Secretariat-General of the Council including the EUSC, EDA, and ESA. It is an instrument to exploit inter-institutional synergies and policy dialogue. This is also the framework within which a programme on Critical Space Technologies for European Non-dependence was set([129]).

10.3 European Framework Cooperation

The EDA Steering Board launched the European Framework Cooperation (EFC) with the EC and ESA for defence, civilian security and space-related research to improve the coherence and comprehensiveness of European research and technology programmes in the field of civilian security, space and defence. Thus, the EFC is aimed at maximizing synergies between the EC's civil security research programme, the EDA co-ordinated defence-related research, and ESA's space research([130]). This implies frequent consultation, exchange of information on both activities and goals, alignment of research agendas, and coordination of time schedules.

Table 10: Summary of actors and roles - Upstream and downstream

	Upstream actors/roles	Downstream actors/roles
National programmes (military and/or dual use)	○ Governments (1, 4); ○ Relevant ministries and departments (defence, research, economy, etc.) (2, 3); ○ Space agencies/ space offices (2,3,4); ○ Industry (3).	○ Relevant ministries and departments (1,2,4,5); ○ Space agencies /space offices (1, 2, 4,5); ○ Public and private research centres/university (2); ○ Industry (2,3,4,5).
Collaborative programmes (intergov't - military and/or dual use)	○ Governments, relevant ministries and departments (defence, research, homeland, etc.), space agencies/space department (1,2,3,4); ○ ESA (**launcher programme and SSA** 2,3, 4); ○ EDA (2, 3a).	○ Space agencies/space departments, relevant ministries and departments, public and private research centres/university (1,2,3,4, 5); ○ ESA (**launcher programme and SSA** 1,2,3, 4,5); ○ EDA (1,2); ○ OCCAR (**MUSIS**, 2); ○ Industry (2,3 4, 5).

[129] *European Framework Cooperation for Security and Defence Research*, EDA Factsheet http://www.europarl.europa.eu/meetdocs/2009_2014/documents/sede/dv/sede301109factsheetefcsecuritydefence_/sede301109factsheetefcsecuritydefence_en.pdf.

[130] EDA Factsheet, European Framework Cooperation for Security and Defence Research http://www.europarl.europa.eu/meetdocs/2009_2014/documents/sede/dv/sede301109factsheetefcsecuritydefence_/sede301109factsheetefcsecuritydefence_en.pdf.

EU space policy and programmes – general overview (civil security)	○ EU + Space Council + ESA Min. Council (1); ○ EC (2,3,4); ○ MS (2); ○ EDA (**potential involvement** in 2, 3a); ○ ESA (3a, 3b, 3c, **potential involvement** in 2 depending on future arrangements). **Additional roles and actors:** ▪ EEAS - Support for international/security aspects; ▪ EDA - Support for defence aspects.	○ EUSC (2,5); ○ EDA (**potential involvement** in 1); ○ ESA (**potential involvement** in 1,2,3 - depending on future arrangements); ○ Industry (2,3,4,5).
Galileo	○ EU + Space Council + ESA Min. Council (1); ○ EC (2,3,4); ○ ESA (3). **Additional roles and actors:** ▪ EEAS - Support for international/security aspects.	○ GSA (1); ○ ESA (1,2,3,4); ○ Industry (2,3,4,5).
GMES/Copernicus - Security and Emergency services	○ EU + Space Council + ESA Min. Council (1) ○ EC (2, 3, 4) ○ ESA (3) **Additional roles and actors:** ▪ EEAS - Support for international/security aspects ▪ EDA - **potential involvement,** support for defence aspects	○ ESA (1,2,3,5) ○ GSA (**potential involvement** in 1) ○ DG ECHO+JRC (1,5 with respect to **Emergency service**) ○ EUSC, FRONTEX, EMSA (**potential involvement** in 1 and 5 with respect to **Security services**) ○ Industry (2,3,4,5)
ST Support Programme ([131])	○ EU + MS (1,2) ○ MS (3) ○ EC (2) **Additional roles and actors**: ▪ EEAS - **potential involvement,** support for international/security aspects ▪ EDA - **potential involvement,** support for defence aspects	○ EC (1) ○ Space agencies/space departments, relevant ministries and departments (4) ○ EUSC (5) ○ Industry (2,3)

[131] Based on the current EC's proposal (COM(2013) 107).

11. CONCLUSIONS

11.1 Final considerations

The analysis carried out in the previous two parts of the study has highlighted two major trends. On the one hand, the awareness at the EU and at the national level of the increasing benefits of space for the implementation of internal and external security policies. Such awareness encourages institutional actors to develop and retain up-to-date space-based systems, applications and services to ensure sovereign control over their security and defence activities. On the other hand, the complex governance of both the space and security sectors, with multiple interactions between the national, intergovernmental and EU levels, which in some cases produces a series of duplications and overlapping. The complexity of the EU governance is reflected in the space sector, in which it is difficult to promote a fully coherent and efficient European approach, in particular with regards to the security dimension of space.

In this context, states' sovereignty remains the essential paradigm and the policy cornerstone when it comes to space-based activities, and especially when dealing with those capabilities closely related to security and defence policies. While this paradigm still has a strong national dimension – indeed, in sectors such as EO and SATCOM countries like France, Italy, Germany and Spain are deeply involved in the development of their own dedicated systems – emphasis on pan-European autonomy and independence on space matters is clearly getting a foothold. In this sense, the completion of the two EU flagship programmes, along with the industrial and technological non-dependence in the space domain and the preservation of an independent access to space are the key priorities set at the European level.

The progressive Europeanization of the space activities for defence and security is the result of different factors. First, the growing role of the EU as security provider, not only in the framework of CSDP, but also in domains such as border control, maritime surveillance, civil protection, and management of manmade and natural threats requires fully-fledged civil and military capabilities. Thus, the direct involvement of the EU in these operations stimulates the establishment of dedicated space capabilities to be exploited by the relevant European security stakeholders for decision-making and by users on the ground. Second, the innovations introduced by the provisions of the Lisbon Treaty, which provide the EU with specific shared competences on space issues and a window of opportunity for the progressive framing of a common security and defence policy. The Treaty lays the necessary legal framework to adopt space-related initiatives to support a variety of policies areas, not least current and future capability needs to implement common defence and security policies. Finally, the reduction of the national security and defence budgets – made even more severe by the economic and financial difficulties currently affecting Europe. This condition has encouraged the establishment of European common space initiatives to improve competitiveness and cost-efficiency.

As it emerged from this study, despite its proactiveness in the space domain, not always the EU initiatives have contributed to rationalise the governance of sector and consolidate the different initiatives undertaken at the national and intergovernmental level. Contrarily, in some instances it has generated duplications and inefficiencies. While, *per se*, a certain degree of duplication among national systems has to be considered positive to ensure redundancy and resilience in terms of capabilities and services, the EU is called to encourage coordination and future integration of the different MS' assets to provide sufficient and reliable capabilities for its internal and external security operations. In this context, the strengthening of the EU crisis management and external action mechanisms (but also of

the border control and civil protection initiatives) represents a fundamental driver for the development of new European space infrastructure. In this respect, the difficulties of the EU in establishing a clear strategy for a strong and coherent common security and defence policy – the poor political and military coordination in Libya, Syria and Mali represents a clear example of the EU weaknesses in this domain – risk therefore to frustrate the efforts to establish European space capabilities for security, missing out the opportunity of making space and security mutually reinforcing.

At the same time, the insufficient coordination among the key European space stakeholders continues to limit the efficiency of the whole European space sector. Despite the efforts undertaken to enhance institutional dialogue, the EU-ESA duplications and the absence of formal policy mechanisms to ensure that initiatives taken within ESA are consistent with EU policies represents a weakness. As recently recalled by the EC Communication "*Establishing appropriate relations between the EU and the European Space Agency*" the convergence between the EU and ESA activities is a priority for the European space sector. The difficulties to be overcame, however, are still relevant, and include – first of all – the mismatch of financial rules between ESA's geographic return principle and the EC competitive approach. In addition, asymmetries in terms of membership - ESA includes non-EU countries such as Canada, Norway and Switzerland among its members - and for what concerns security and defence matters – which are not formally competences of the Agency - remain open issues with respect to institutional convergence. Similarly, the study has highlighted the need to accompany the ESA-EU rapprochement with deeper integration of the activities undertaken by the EC, ESA, EEAS and EDA in the existing and diverse frameworks for dialogue and cooperation which are losing momentum. In fact, since the EU is called to establish ever stronger links and synergies between the civil and defence dimensions of space in order to contribute to the CSDP objectives, closer and more efficient cooperation among these institutional actors is necessary, along with a consistent and significant involvement of EDA.

A rationalization of space activities for security and defence would result fundamental in addressing one of the key trends, namely, the transition towards dual-use systems driven by the progressive blurring of the dividing lines between the defence and the security domains. Blurring fostered by operational needs – the EU civil-military security approach requires military and civilian forces to be highly interoperable and able to closely cooperate in operational theatres – and by technological/industrial evolutions, which determine a relevant convergence between the solutions developed and adopted by militaries and civilians.

The advantage of investing in dual-use capabilities is currently recognized both at the national and European level. This is demonstrated, on the one hand, by the development of dual-use programmes such as Athena-FIDUS, Pléiades, and Cosmo-SkyMed; on the other, by the EU efforts in the development of the dual-use GMES/Copernicus and Galileo flagship programmes or by the EDA's SECTELSAT programme. Coordination between the different actors, in this context, would improve the cost-efficiency, robustness and competitiveness of European space assets and services.

11.2 Options

In order to address the capability gaps as well as the institutional weaknesses identified in the previous parts of the study, and to ensure a more coherent use of the space for security purposes, the study points out a series of policy options and development guidelines to be implemented under the current treaties and budget with a view to the end of this decade.

In general terms, any recommendation should be based on the assumption that the complete reorganization of the European space sector governance (see Part Two 8.2 *EU-ESA Framework Agreement*) and the definitive setting of the relationships between its main institutional actors – the EU

and ESA, along with the other relevant actors like EDA – will take some time and will be the result of an extremely complex process.

In the meanwhile, however, it is fundamental to continue undertaking initiatives under the institutional 'status quo', making the most out of the FA recently renewed to cover 2016 which has allowed to realize – notwithstanding all the difficulties – Galileo and GMES/Copernicus.

Also the systematic participation of EDA in the space domain should be further pursued. The integration of EDA-ESA initiatives, formalized by the Administrative Arrangement signed by the two agencies in 2011, should be put in place whenever security/defence capabilities are to be improved or new programmes launched. At the same time, the activities of the EFC - so far effective only in the CBRN domain - should be promptly activated also for what concerns space-related dual-use R&D, possibly exploiting the opportunities offered by the EC's Horizon 2020. While the budgets of the EFC and Horizon 2020 will remain separate, a common top-down strategy aimed at developing shared dual requirements for space capabilities and service should be pursued.

In addition, Horizon 2020 R&D funding for the development of integrated applications and services should be closely coordinated with the activities carried out by ESA in the framework of Integrated Applications Programme (IAP) – which includes a specific platform for dual-use Space-based Services -, with the objective to jointly develop services exploiting space-based capabilities such as SATCOM, EO and navigation systems which will increasingly need to be integrated so as to provide complex and complete services.

Horizon 2020 should sustain the development of critical technologies for space such as new generation of optical and interferometric sensors, space optical telecommunications, new materials and nanotechnologies, robotics and batteries. More generally it could be considered the development of independent (ITAR free) technologies. Moreover, the Horizon 2020 budget should relocate part of its R&T funding from early-stage development programmes to activities dealing with the maturation of space technologies, included technological demonstrators and validation initiatives.

In terms of industrial policy, it is important to highlight the EC's evolving orientation towards the use of space for security and defence purposes. In the draft Communication *A New Deal for European Defence – A More Efficient Defence for a More Secure Europe*, the EC explicitly aims to address the missing link between civilian and military activities in the space sector, paving the way for specific initiatives in the field "Space and Defence". Such a change in the policy objectives would necessary require a new general approach of the EC – and the EU in general – towards the issue, leading from the current scientific-oriented efforts to greater emphasis on the technological and industrial initiatives undertaken at the EU level.

At national level, the common need to develop new space infrastructure in the next years represent an important opportunity to foster cooperation and resources pooling & sharing also at the intergovernmental level. The Defence European Council of December 2013 would represent an important opportunity for MS to encourage progressive convergence of national space security policies, to be elaborated in coherence with EU's R&D efforts and defence market integration initiatives.

With respect to the development of specific space capabilities and services, the EO and the SATCOM domains are those where European institutions and national governments will be called to mostly enhance their cooperation.

In terms of infrastructure development and coordination of mechanisms, the advancement of MUSIS represents a priority for the future European EO capacity in the defence field. The programme is mainly challenged by political resistance and the financial difficulties of the European governments, which limit

their commitment to the development of the system's common ground network. As in the case of other space capabilities, also in MUSIS the transition from a system composed by integrated national assets to a system relying also upon common capabilities should necessarily be carried out through a process of Europeanization of the programme, thus including not only European co-funding, but introducing also co-management responsibilities for EU institutions. In the first phases of the establishment of the system, the division of roles and responsibilities would help, on the one side MS (i.e. France and Italy) in retaining control over the development and management of the programme, on the other to limit duplications and the related costs between national and European initiatives. European strategic considerations would justify the progressive involvement of the EU in the programme.

At the same time, the EU should reinforce the EUSC legal framework for the use of governmental imagery, strengthening the role of the Centre for what concerns the access to space data for EU External Action purposes in particular CFSP/CSDP. In addition, as highlighted above, GMES/Copernicus services for Security applications in the fields of Border Control, Maritime Surveillance and Support to External action are approaching operational maturity, and will require operators for service management, coordination and delivery mechanisms which EUSC appears in the best position to implement, both in terms of efficiency and of security in particular for the Support to External Action. In this context, the contribution of FRONTEX and EMSA, which missions are focused on the first two domains, should be further explored and defined. Concerning Support to External Action, the EEAS – as a major stakeholder and user – is called to proactively contribute with the support of the EUSC to the further development of such services in terms of organization of the internal users base and of definition of requirements, while overseeing the security aspects inherent to services in support to security in general.

Finally, considering the progressive evolution towards the development of dual-use capabilities already recognized both at the national and European level, the EU should promote coordinated activities in the EFC and H2020 framework for R&D innovative, high resolution (HR) and very high resolution (VHS), dual-use satellites which may complement GMES/Copernicus in the future.

In the SATCOM domain, the efforts undertaken by EDA to establish dual-use capabilities to ensure communications to both military and public safety forces should be consolidated. On the one hand, the activities of the ESCPC should be strengthened, in order to overcome the fragmentation of demand for commercial SATCOM for security and defence at the national level. On the other hand, the EU should take into due account the Agency's proposal to develop an integral single European-wide governmental - thus not exclusively military - satellite communication system. The system would provide SATCOM services to an extended set of public actors involved in both European and national operations and activities: these may include the EEAS, as well as FRONTEX, civil protection agencies, police forces and so forth. To manage the European SATCOM system the EU could create an *ad hoc* decentralized agency or, alternatively, the agency could be in charge of pooling the capacity of the national/intergovernmental systems and selling it to MS requiring it, while the control over the systems would remain in the hands of governments. In any case, being based on commercial and/or on dedicated capabilities, the European institutions and the MS would be called to develop mechanisms to pool and share SATCOM capabilities in order to reduce cost and enhance service reliability.

As for Galileo, steps towards better commercial exploitation of the system should be pursued at the EU level. For this reason, the GSA should be encouraged to invest in the development of market applications for Galileo, whose spinoffs could eventually contribute – compatibly with security requirements - to enlarge the supply of navigation products for security purposes.

For what concerns launchers, the direct intervention of the EU could help to fix some of the difficulties currently affecting the sector. Since the EU institutions repeatedly highlighted the strategic value of an independent access to space for Europe, the EU could consider to take the responsibility for the political

supervision and the funding of the Launchers Programme. The EC would in turn entrust ESA through delegation agreement by which ESA would action behalf of the EC during both the development and exploitation phases. Such an option would be in line with the EU proposal to reorganize its relations with ESA, which would actually be the precondition. In any case, strategic guidelines for the evolution of the launcher sector, and a definitive solution for its governance, should be necessarily identified in the years to come.

Finally, the progressive integration of the EU Space Surveillance and Tracking (SST) support programme and ESA Space Situational Awareness (SSA) programme should be pursued in order to increase the European capacity to ensure the security of space, while maximizing civil-military synergies and reducing costs. In the next few years, such a convergence between the activities of the EU and ESA should encourage the EC to investigate the possibility to launch of a new European SSA flagship programme.

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ANNEX

PART ONE: EUROPEAN SPACE CAPABILITIES

AN INDEPENDENT ACCESS TO SPACE FOR EUROPE

Current Launch Capabilities

Ariane-5

Ariane-5 is the fifth version of the Ariane launchers family, which guaranteed access to space to European countries since 1979([132]). Developed in only six years and inaugurated in 1996, thanks to 54 consecutive successful launches Ariane-5 is currently considered the most reliable heavy-lift launcher in the space transportation global market. Normally, Ariane-5 can provide both single launches for heavier payloads and launches with two satellites (double launches). Such dual strategy proved advantageous at the beginning of Ariane-5 activity, but today this approach is increasingly difficult to sustain and requires necessary developments. EADS Astrium is the sole prime contractor for the Ariane-5 launcher, which development and exploitation activities involve more than 60 companies across Europe.

Thanks to the two different configurations, the vehicle carries out different types of launch missions, in geostationary transfer (GTO), sun-synchronous (SSO), medium-Earth (MEO) and low-Earth (LEO) orbits. Access to GTO is ensured by Ariane-5 ECA, which has a launch capacity of 10 tons and usually deploys two telecommunications satellite payloads into orbit. The ECA configuration is powered during the initial flight phase by a cryogenic core stage and two solid rocket boosters, followed by the use of a cryogenic upper stage for orbital injection of the payload([133]).

Ariane-5 ES, on the contrary, has a capacity of 20 tons and is used to launch the abovementioned ATV in LEO to resupply the International Space Station (ISS). The same variant can also serve SSO for Earth observation satellites and escape orbits for scientific payloads. Finally, an adapted version of Ariane-5 ES able to deploy payloads into different orbits thanks to multiple burns in the upper stage, will be used to place in MEO - four at time - the satellites of the Galileo constellation. Its primary difference from the Ariane-5 ECA configuration is the use of a storable propellant upper stage, which can perform multiple burns to deploy payloads into the desired orbit([134]).

While a significant part of the launcher exploitation costs is financed through commercial activity, during the years Ariane-5 benefited of continuous support through the ESA-funded Ariane Research and Technology Accompaniment (ARTA)([135]) programme. Initially expected to cover the period 1996-2010, ARTA was extended to 2013 in order to maintain the qualification status of the vehicle, eliminating operational weaknesses and improving knowledge of the vehicle's functional during the flight phase. The technological support performed in the ARTA framework includes production sampling and testing, investigation of flight hardware anomalies, identification of obsolete components, as well as activities to ensure the maintenance in operational condition (MCO) of Ariane ground testing facilities at the CSG in Kourou.

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[132] Member States contribution to Ariane-5: Austria, Belgium, Germany, Denmark, France, Italy, Ireland, Norway, Netherlands, Spain, Sweden, Switzerland, United Kingdom.

[133] Arianespace Launch Services http://www.arianespace.com/launch-services-ariane5/ariane-5-intro.asp.

[134] See footnote 13.

[135] Member states contributing to ARTA: Austria, Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Norway, Spain, Sweden, Switzerland.

In addition to ARTA, the exploitation of Ariane-5 has been supported by Member States' public funding injected through the European Guaranteed Access to Space Program (EGAS). In the attempt to make Arianespace – the company in charge of marketing European launchers – self-sufficient, the program has covered selected fixed costs associated with the production of a batch of Ariane-5 for six years (2004-2010).

The need to go beyond the current Ariane-5 technical, commercial and financial settings in order to remain competitive on the global space transportation market encouraged ESA to undertake a preparatory phase for the evolution of the launcher known as Ariane-5 post-ECA Program. Planned to run from 2009 until 2011, the program was focused on development activities for system, stages and propulsion elements – with particular attention to the re-ignitable Vinci engine and the new cryogenic upper stage. Once reached a level of technical maturity, expected for 2011, ESA had to take a decision on the development phase of the Ariane-5 Midlife-Evolution (ME) baseline configuration, including critical design reviews, hardware manufacturing for test models and initial test and verification phases. At the same time, ESA is preparing the development of Ariane-6 based on the NGL studies carried out in the FLPP framework. Due to diverging approaches among ESA Member States, the final decision over the future of the Ariane-5 has been postponed until 2014.

In the meanwhile, Ariane-5 continues ensuring its commercial and institutional customers an average of five to six launches per year. Though strongly reliant on the commercial telecommunications satellite market (Ariane-5 recently deployed Intelsat, Eutelsat and Astra payloads), the launch vehicle carried out important ESA and national civil missions, but also some European military satellites for telecommunications, Earth observation and early warning. These include Syracuse (Fr), ComsatBw (De), Skynet-5 (UK), Spainsat (Es), Helios (Fr) and Spirale (Fr)([136]).

Soyuz at CSG

In order to respond to new market exigencies and capture the expanding medium-size satellite segment, in 2005 ESA signed an agreement with Russia's space agency, Roscosmos, to exploit the launch vehicle Soyuz for European space transportation exigencies. Russia's Soyuz, in continuous production since 1957, is a medium-class launcher and its performance perfectly complements that of ESA's heavy-lift Ariane-5 and lightweight Vega launchers, increasing the competitiveness and flexibility of Arianespace launch procurement and operation activities in the commercial market. The 'Soyuz at CSG Program' funded by seven ESA Member States([137]), covers the construction of the Soyuz launch complex at the CSG and the adaptation of the Soyuz launcher for its exploitation from the European spaceport. The French space agency CNES is prime contractor and system architect for the Soyuz launch system at CSG.
The adapted version of the Russian rocket was launched for the first time from Kourou in October 2011. It deployed into orbit two satellites, Galileo FM2 and Galileo PFM - the Galileo IOV-1 (In-Orbit Validation) payload - the first two operational satellites of the EU's navigation program. The European version of the Soyuz is customized to launch medium-weight telecommunications, navigation, Earth observation and scientific research satellites of up to 3.2 tons into GTO, MEO and LEO. At the same time, ESA did not rule out the possibility to exploit Soyuz's experience in manned space missions: the launch complex infrastructure at CSG is in fact designed to be smoothly adapted to possible European human spaceflight exigencies.

[136] Skynet, ComsatBw, and Spainsat launches, however, are considered commercial launches as they were bought by EADS Astrium in the first two cases and by Hisdesat and in the third. http://www.arianespace.com/news/mission-status.asp.
[137] Member states contributing to Soyuz at CSG: Austria, Belgium, France, Germany, Italy, Spain and Switzerland.

A key feature of the four stages vehicle is its autonomous and flexible Fregat upper stage, fully independent from the lower three stages thanks to its own guidance, navigation, control, tracking, and telemetry systems. Using storable propellants, Fregat can be restarted up to 20 times in flight, ensuring access to a full range of orbits and allowing the deployment of satellite constellations such as Galileo.

Since 2011 Arianespace has operated four Soyuz launches deploying into orbit a number of institutional payloads([138]). Besides the already mentioned satellites FM2 and PFM IOV-1, the European version of Soyuz operated from CSG launched two other Galileo's payloads in 2012. It also allowed France to put into orbit two strategic governmental missions, the dual-use Pléiades Earth observation payloads and ELISA electronic intelligence demonstrator's four satellites. The Russian rocket will be also used for the launch of four more satellites of the EU's navigation system. In 2013, in fact, it will launch the first Galileo's Full Operational Capability (FOC) satellites, while between 2013 and 2014 it will deploy also the first GMES/Copernicus satellite Sentinel-1A. Thanks to the exploitation of Soyuz, Arianespace expects not only to ensure the deployment of the European institutional payloads, but also to become increasingly competitive in the global commercial market.

Vega

Vega, the smaller of the European launch vehicles operated from the CSG, aims to improve Arianespace's launch flexibility, filling its operational gap in the market of small satellites([139]). As demonstrated by its maiden flight in February 2012 - during which Vega carried a primary payload, a scientific laser relativity experiment (LARES), an educational microsatellite (ALMASat-1), and seven ESA pico-satellites (CubeSats) - the exploitation of the small launch vehicle would open significant opportunities in the markets of mini-, micro- and pico-satellites([140]), given its capacity to deploy various payloads at the same time into LEO and SSO.

The light-lift launcher has a single-body structure divided in three solid-propellant stages - P80, Zefiro23, Zefiro9 - and a liquid propelled restartable upper module, the Altitude and Vernier Upper Module (AVUM). AVUM can be restarted up to five times, making Vega extremely flexible and adaptable to customers' exigencies. In fact, it is compatible with payload masses ranging from 0.3 to 2.7 tons, depending on the type and altitude of the orbit required by the customer. Contrary to Ariane-5, the development of Vega is organized in three separate programs, managed by different prime contractors([141]). ELV leads the development of the launch vehicle, Avio with a program management delegation to Europropulsion is in charge of the sole P80 motor, and Vitrociset is prime contractor of the Ground Segment at CSG.

The benchmark for Vega's in orbit launch capacity is 1500 kg into a 700 km-altitude polar orbit, which makes the launcher perfectly suitable to deploy environmental scientific satellites or satellites for Earth observation such as GMES/Copernicus. As well, thanks to its high degree of adaptability, the small launcher offers the opportunity to readily replace satellites within constellations, avoiding the delays associated with Ariane-5's double launch strategy. In this sense, the availability of Vega as a back option represents an added value for the deployment of European security and defense payloads, for which responsiveness and flexibility are priorities.

[138] During its second flight in December 2011 the launcher deployed also the Chilean earth observation satellite, Sistem Satelital para Observación de la Tierra (SSOT).

[139] Member States contributing to Vega: Belgium, France, Italy, Netherlands, Spain, Sweden, Switzerland.

[140] Micro-satellites: from 10 to 500 kg; pico-satellites: from 0.1 to 1 kg.

[141] Italy funds almost 60% of the whole Vega program.

On May 7th 2013 Vega was launched for the second time, successfully delivering three different payloads into orbit: ESA's Proba-V miniaturized environmental satellite([142]), the Vietnamese Earth observation optical payload VNREDSat-1 and the Estonian ESTCube-1 scientific satellite. The demonstration launch - the second performed in the framework of the Vega Research and Technology Accompaniment (VERTA)[143] program - was extremely important because it inaugurated both the new Vega guidance, navigation (VGN) and control software developed by ELV, and the VESPA (Vega Secondary Payload Adapter) dual payload adapter. The VERTA program includes the procurement of other four demonstration flights aimed at proving the flexibility of the vehicle in terms of nature of the missions (science, technology, Earth observation, etc.) and of configuration of satellites (single or clusters), with the key objective of consolidating its multiple-payload launch capability. The remaining VERTA launches will carry three different ESA missions (Aeolus, LISA Pathfinder and the Intermediate eXperimental Vehicle - IXV), while the first two contracted services will deploy the GMES/Copernicus payloads Sentinel-2 and Sentinel-3.
Besides the procurement of five demonstration flights, the VERTA program focused also on customer service improvements and on production accompaniment and technological activities included the already mentioned development of the launcher's flight software.

Initiatives undertaken by national space agencies integrate the work done in the VERTA framework. In particular, both ASI and DLR are developing new propulsion systems to replace current VEGA's upper stages. On the Italian side, Avio expects to develop a liquid oxygen-methane motor- based on the LYRA/MIRA studies -to substitute both Zerfiro 9 and AVUM. On the German one, DLR and EADS Astrium work together on VENUS (VEga New Upper Stage), which is aimed at replacing AVUM using a single storable propellant engine.

The November 2012 ESA ministerial Council has formalized the Agency involvement in these activities, adopting the new VEga Consolidation and Evolution Preparation Programme, VECEP (see below) to which, for the first time, Germany decided to directly contribute([144]).

Eurockot

Although neither developed nor exploited in the ESA framework, the Rockot light-lift launch vehicle - operated by the Bremen-based Eurockot Launch Services GmbH - can be potentially included in the 'enlarged' family of European launchers. Eurockot Launch Services GmbH, in fact, is a joint venture between the European EADS Astrium – which holds 51% of the company – and Russia's Khrunichev State Space Research and Production Space Center (KhSC). The Rockot launcher is based on the Soviet SS-19 intercontinental ballistic missile, equipped with a Breeze KM restartable upper stage.

Thanks to Rockot's two tons payload capacity, Eurockot provides commercial launch services to operators of LEO scientific, observation and communications satellites from its dedicated satellite preparation and launch facilities at the Plesetsk Cosmodrome in northern Russia. The company offers a broad range of launch services: these include the incoming transportation logistics of the spacecraft importation, different types of payload adapters and dispensers, different types of trajectories such as polar and sun-synchronous orbits, multiple re-start capability of the upper stage for plane changes and orbit raising, injection of spacecraft into different orbits in one mission and more.

Eurockot has so far performed launches for commercial and institutional customers in Europe, included three ESA satellites - GOCE, SMOS and Proba II – successfully put into orbit in 2009. In 2012

[142] Proba-V is part of the GMES/Copernicus Contributing missions.
[143] Member states contributing to VERTA: Belgium, France, Italy, Netherlands, Spain, Sweden, Switzerland.
[144] VECEP financial envelops agreed on 2012 ≈ EUR 157 million. Contributing Member States: Belgium, Germany, France, Italy, Netherlands, Sweden, Switzerland.

the company has signed an agreement with the Agency for the launch of the GMES/Copernicus satellites Sentinel-2A and Sentinel-3B, while the deployment of three satellites of the ESA Swarm mission has been repeatedly delayed by an investigation on the Breeze KM upper stage malfunction after a Rockot launch lost a Russian science satellite in February 2011. Since the number of Rockot vectors available in the Russian arsenals is limited and progressively reducing, the launcher does not represent a real competitor for the future activities of Vega.

The future of Ariane-5

At the heart of the debate on launchers is the future of Ariane-5, about which the positions of France and Germany - the two states mostly involved in the program – largely diverge. In fact, while Germany wants to continue the development of the Ariane-5 ME configuration, on which Berlin has already invested significant funds, France supports the development of a new vehicle – Ariane-6.

As mentioned above, the activities for the development of Ariane-5 ME began in 2009 in the framework of the Ariane-5 Post-ECA Program preparatory phase. Thanks to new versatile cryogenic upper stage concepts, this Ariane-5 configuration would be a medium-term solution to increase the launcher's performances while maintain unvaried production costs. In fact, while the two solid-propellant boosters and the cryogenic main stage would remain identical to those currently equipping the ECA version, the new VINCI motor and the cryogenic upper stage engine would increase the launch capacity by about 20% (two more tons). In addition, VINCI's re-ignition capability would allow for launches over a wider range of missions. Thanks to these technical adaptations, the more powerful and versatile Ariane-5 ME would ensure the operational performances of both the ECA and ES configurations. The greater mission flexibility obtained through the development of this single launcher is expected to sensibly reduce the industry's request of public support for exploitation activities. Ariane-5 ME had been planned to be operational from 2016 but, if approved, its potential inauguration will be almost certainly delayed.

Ariane-6 is the result of studies on the Next Generation Launcher (NGL) carried out in the framework of the already mentioned FLPP. According to Ariane-6 developers, since satellites are getting ever heavier making Arianespace's dual-launch strategy increasingly difficult to sustain, a simpler and more responsive single-payload rocket is the best option for Europe to compete in the global launch market. Starting from these assumptions ESA, backed by CNES, expects to develop a launcher capable of orbiting commercial satellites weighing up to 6.5 tons or smaller institutional satellites, sustaining a rate of 3 to 4 launches a year([145]). The new vehicle would cover a wide range of missions, from GEO - either directly or through intermediate orbits, such as GTO and LEO - SSO, and MEO. The Ariane-6 three-stages configuration (PPH) would consist in two solid propulsion stages – the first of which may have two or three solid busters to be adaptable to the different weights of satellites - and a third cryogenic stage which would significantly enhance the launcher's performance. The vehicle is scheduled to make its first flight in 2021.

While the 2012 ESA ministerial Council was expected to decide on which one of the two programs the Agency had to channel its financial, technological and industrial efforts, in reality the meeting simply postponed any definitive choice to 2014. Until then, in fact, ESA will continue to fund the development of both launchers. The integrated activities for the development of Ariane-5 ME/Ariane-6 during the period 2013-2014([146]) have been divided into three sub-envelopes. The first concerning the 'adaptation' of Ariane-5 ME, the second studying Ariane-6's solid propulsion stage in its PPH

[145] The targeted payload performance of Ariane-6 is 4 tons for SSO missions at 800 km altitude and 3–6.5 tons, with two main segments (3–3.5 t and 6–6.5 t) in GTO equivalent.

[146] Adapted A5ME/A6 financial envelops agreed on 2012 ≈ EUR 670 million. Contributing Member States: Austria, Belgium, Germany, France, Italy, Ireland, Norway, Netherlands, Romania, Spain, Sweden, Switzerland.

configuration, and the third one aimed at developing a 'common' cryogenic upper stage for both Ariane-5 ME and Ariane-6.

Following the Council's decision, on January 2013 ESA has awarded Astrium EUR 108 million contracts covering the development of the two launchers. As the prime contractor, Astrium is expected to start the initial definition and feasibility studies for the future Ariane-6 launcher, to continue the development of Ariane-5 ME, and to identify all possible synergies between the two programs, obviously starting from the VINCI restartable engine for the upper stage of both launchers.

The Guyana Space Centre (CSG)

Arianespace operates the European launchers from CSG in Kourou. Located on the Atlantic coast between the latitudes 2° and 6° North and the longitude of 50° West, it is the ideal spot for launches into GTO, both in terms of security - the launch trajectory over the ocean reduces the possibilities of damages to third parties – and of performances, since the proximity to the equator reduces the energy required for orbit plane change maneuvers.
ESA, in the framework of the European launchers program, is in charge of investment, maintenance and upgrade of the CSG infrastructure for Ariane-5, Soyuz and Vega. The Agency – which directly covers 2/3 of the spaceport's fixed costs([147]) - is the owner of such infrastructure. These include launcher and satellite preparation and integration buildings, dedicated launch operations site for each vehicle, and other units such as the Jupiter Control Center.

In this context, ESA outsources the management of the day-to-day life of CSG to CNES. Besides infrastructure maintenance and safety procedures during and after the launches, French technicians provide essential support for launcher and satellite preparation, coordinating operations during tests and launches. Arianespace performs the core of launch operations. Its launch services include the engineering tasks conducted to insure the system compatibility between the spacecraft, its mission, and the launch system. Interacting constantly with the customers, Arianespace performs the spacecraft integration with the launch vehicle, the verification procedures, and the transfer to the launch pad. Other European companies among the forty involved in the launchers' exploitation phases – such as Europropulsion, Regulus and Air Liquid - operate their facilities at the spaceport([148]).

Thus, CSG is a core element of the European launch system, as it clearly emerges from the constant financial commitment of ESA and its MS, confirmed once more last March, when ESA and CNES signed a EUR 438 million contract which guarantees the availability of CSG for ESA programmes and activities and for the exploitation of Ariane, Vega and Soyuz launchers for the period 2013-2017.

Vega Consolidation and Evolution Preparation Programme (VECEP)

Despite its significant contribution in enhancing the flexibility of European launch capabilities and in broadening the market for Arianespace's launch services, Vega will need to improve its performances according the current market trends. In order to reach this goal, during the November Council meeting ESA formalized its involvement in the consolidation and evolution activities of the Vega launcher. The ESA-funded VECEP initiative, in fact, is proposed to prepare a consolidated version of Vega by the second half of the decade. It will respond better to market evolutions and to European

[147] To date, ESA has invested more than EUR 1.6 billion in improving and developing the ground facilities at Europe's Spaceport.

[148] The Guyana Propellant Plant (*Usine Propergol Guyane*, UPG) of Regulus (joint company, 60% Avio and 40% Safran), the Booster engine test stand (BEAP), the Booster Integration Building (*Batiment Integration Propulseur*, BIP) of Europropulsion (joint company, 50% Avio and 50% Safran), Booster Storage Building, Booster Logistics Building, the Exploitation and Booster Casing Preparation Building (BPE), LH2 and LOX plants for liquid hydrogen and liquid oxygen of Air Liquid.

institutional needs – for instance the increasing number of LEO and MEO satellites for civil and military missions - by increasing the robustness and competitiveness of the launcher and reducing recurring costs and dependency on non-European sources (i.e. the AVUM's RD-869 Ukrainian engine).

In VECEP, space agencies and industrial players will work on the upgrade of the propulsion and weight lift-off capacities of two new Vega configurations: Vega consolidated (C) and Vega Evolution (E) launchers. The former will be equipped with a new first stage, the P120, which development began in the VERTA framework. The latter will not only include the new Zefiro40 motor developed by Avio, but will be equipped with one between the German engine Venus and the Italian oxygen-methane MIRA thrusters for the upper stage. As a whole, the two upgrades would enhance the launcher capacity lift to 2 tonnes in LEO, thus opening significant opportunities for new scientific exploration.

A new governance approach

In order to identify innovative options for the launchers' development/exploitation governance scheme, in April 2012 ESA launched an invitation to tender for a feasibility study for a New European Launch Service (NELS). The aim of the tender is to identify a solution that would ensure an independent, competitive and economically self-sufficient access to space, by achieving a self-sustained exploitation phase with no need for public support to cover its costs. Two separate consortia have been selected to carry out NELS 1-year study, one led by the German MT Aerospace([149]) (a subsidiary of OHB) and the other by Astrium ST in team with ELV.

The most innovative element introduced by the NELS initiative is the focus on new industrial policy principle to manage ESA procurement. In fact, the Agency's Member States participating future development programs would fund development activities on the basis of the newly-introduced "fair contribution" principle rather than adopting ESA's traditional "geographic return" rule. Thanks to this innovation, ESA expects that the industrial distribution of work would be based on best technical competence and cost effectiveness, and not strictly commensurate Member States' financial contribution to the budget of the program.

The reform process envisaged by NELS is both extremely ambitious and difficult to achieve. In fact, today's European launchers value chain is the intricate result of decades of political mobilization, financial commitment and technological processes. In this delicate context, resetting the current organizational model to move to a governance solution that would leave apart any of the relevant institutional and industrial players may bring about problematic and potentially inappropriate consequences, both at the political, financial and industrial level.

To comprehend this complexity, it's enough to think at the peculiar role of ESA – manager, developer and funder of the European launchers programs, but also the key European institutional customer. Or the role of EADS Astrium, at the same time involved as a prime contractor in the production of the launch vehicle (Ariane-5) and in the marketing of this launcher through Arianespace (holding the majority share among industrial partners). Or the interests of CNES, at the same time majority stakeholder in Arianespace, responsible over CSG, and leader in the development of the Ariane launcher. Therefore, any solution adopted to improve the effectiveness and efficiency of the European launch service, will necessarily have to take into due account the different - and sometimes even diverging - interests of these and other relevant actors involved in the European space transportation sector.

[149] The team includes Roland Berger Strategy Consultants, Safran, RUAG Space, ASTOS Solutions and other independent experts.

EARTH OBSERVATION

National and cooperative systems

In general terms, **France** has the most comprehensive space program among European nations. Regarding EO in particular, two families of satellites for institutional and commercial purposes have been developed since the mid-1980s. The first family, called **SPOT** had its first launch in orbit in 1986. The SPOT series has been designed to accomplish environmental remote sensing and monitoring missions. The limited ground resolution of the system has kept the military use of this series of satellites at a relatively low level. Subsequent modifications allowed the current SPOT-4, SPOT-5 and SPOT-6 satellites to serve both civilian and military users. The SPOT-7 satellite is scheduled to be launched in 2014 and will join SPOT-6 and **Pléiades**-1A and 1B, launched in 2011 and 2012, in the same orbit, thereby creating a constellation of four high resolution optical satellites for dual use. The exploitation of the current SPOT system is the responsibility of two entities, namely, CNES and Astrium Geo Information Services, whereas Pléiades also sees the involvement of the Ministry of Defence (MoD).

The second family gave birth to the first exclusively military system launched by a European nation in 1995 - that is **Helios-**1A - joined by the more advanced Helios-1B in 1999. The constellation of the two satellites provided global imaging coverage, which enabled precise military planning. The Helios-1 series of satellites has also the merit to have initiated the first collaboration among European nations in the field of EO for security and defence. In fact, **Italy** and **Spain** participated in the development of the satellites in exchange of data access rights. This collaboration is ongoing with the **Helios-2** satellites, the first launched in 2004, and the second in 2009. France separately agreed with Italy and **Germany** the exchange of data between Helios-2 and **COSMO-SkyMed** and **SAR Lupe** respectively to bring together optical and radar capabilities. Moreover, **Spain**, **Greece**, **Belgium** and **Denmark** contributed to the development of the system, thereby obtaining Helios-2 data access.

Indeed, Italy and Germany have followed France in the development of their own satellite systems for dual (Italy) and military (Germany) applications. Both nations concentrated their efforts on the development of SAR capabilities, resulted in the launch of the Italian COSMO-SkyMed constellation, four satellites between 2007 and 2010, and German SAR Lupe series, five satellites for defence purposes launched between 2006 and 2008.

COSMO-SkyMed represents an innovation in Europe, being the first truly dual-use constellation conceived. Indeed, the system is funded by both the Italian Ministry of Education, University and Research and the MoD. Civil services can be exploited by both institutional and commercial users for applications such as seismic hazard analysis, environmental disasters monitoring and agricultural mapping. The civil component of the system is managed by the Italian Space Agency (ASI) for institutional uses and e-Geos (joint-venture between Telespazio and ASI purposely created) for commercial ones; whereas the military component is fully controlled by the MoD with priority rights over the use of the system. Recently, Thales Alenia Space Italy signed the contract for the development and construction of two **COSMO-SkyMed Second Generation** (CSG) satellites, scheduled to be launched in 2016.

In addition to the SAR Lupe military constellation, Germany launched two SAR satellites for civil use: the **TerraSAR-X** put into orbit in 2007 and the TerraSAR-X Add-On for Digital Evaluation Measurement, named **TanDEM-X**, launched in 2010. The two satellites are absolutely complementary and useful, for instance, for topographic mapping, land use and cover mapping, surface movement monitoring and emergency response information. Both systems were developed in the framework of a PPP, in particular through co-funding from the Deutsches Zentrum für Luft und Raumfahrt (DLR-German Centre for Aerospace) with the support of the Ministry of Science and Education and of

Astrium. The latter, by means of Infoterra, is the private service provider for commercial and governmental uses, while the governmental operator and service provider for scientific purposes is DLR, which is also the owner of the satellites.

Spain is developing its **PAZ** military SAR satellite that will be later joined by **INGENIO** dual use optical satellite. Both projects are fully funded by Spanish Ministry of Defence and developed by Astrium. Their launches are scheduled for 2014.

Italy and France are also parties to the bilateral agreement **Optical and Radar Federated Earth Observation** (ORFEO), in which the French Pléiades and the Italian COSMO-SkyMed are the optic and radar components respectively. Although the agreement was signed in 2001, it has been "operationally" in force since the launch of Pléiades, thereby providing France and Italy with direct tasking and access to the other's mission for an agreed quota of data and on reciprocity bases.

In line with these positive collaborations, France, Italy, Spain, Belgium, Germany, Greece, **Poland** and **Sweden** agreed to collaborate in an innovative intergovernmental EO programme, the **Multinational Space-based Imaging System** (MUSIS).The cooperation aims to integrate the ground segments of the future EO systems for a mutual access to data in a logic of "System of Systems", while the partners traditionally engaged in EO systems will continue to develop the relevant components. The Organisation Conjointe de Coopération en matière d'ARmement (OCCAR) was entrusted with the realization of the programme starting in 2009 and EDA with the enlargement of the initiative to other interested countries([150]). After the first advancements between 2009 and 2011, the programme does not seem to have further evolved. Indeed, MUSIS federating activities were pushed forward by France and Italy to define a Common Interoperability Layer (CIL) between the ground segments of the Italian COSMO-SkyMed Second Generation and the future French CSO (Composante Spatiale Optique, see below) constellations([151]).

GMES/Copernicus

The **Global Monitoring for Environment and Security** (GMES)/Copernicus is the European EO programme relying on a federation of systems. The program is co-funded by the EC and ESA, under the overall responsibility of the EU. Started in 1998 with the goal of establishing a sustainable pan-European information system to specifically support environmental security, it was eventually reoriented to both environment *and* security at a time when the stiff line dividing security and defence was put into question and security was progressively appreciated as a broader concept.

The GMES/Copernicus program is divided in three components: the in-situ component, the services component and the space component. The in-situ component is composed of airborne and ground-based monitoring networks supporting GMES/Copernicus services and validation and managed by the European Environment Agency (EEA).

[150] See OCCAR website http://www.occar.int/174 and European Defence Agency Press Release 'New EDA project on space-based Earth Surveillance System', 5 March 2009 http://www.eda.europa.eu/docs/news/New_EDA_Project_on_Space-Based_Earth_Surveillance_System.pdf?Status=Master.

[151] See Thales Press Release, 'Thales Alenia Space Italia awarded lead mandate for MUSIS-CIL Program', 18 July 2011 http://www.thalesgroup.com/Press_Releases/Markets/Space/2011/Thales_Alenia_Space_Italia_and_the_MUSIS_Program/.

The services component is based on data from the space and in-situ components; these services, when fully operational, will provide Europe with information at global level in the environment, climate and security domains([152]), while contributing to the growth of the EO market in Europe.

The space component of the program is at a pre-operational stage, using data from satellites currently in orbit. These satellites are part of the GMES/Copernicus Contributing Missions which federates space systems at national, European and international levels. ESA is working to provide a reliable mechanism to integrate data coming from such different satellite systems as well as to develop the dedicated satellites, named Sentinels.

GMES/Copernicus services are structured around six thematic areas: Land Monitoring (operational), Marine Monitoring (pre-operational), Atmosphere Monitoring (pre-operational), Emergency Management (operational), Security (pre-operational) and Climate Change (under development)([153]).

Some security pre-operational products and services have been developed in Maritime surveillance, Border control and Support to the EU External Action and should become operational by 2014. The overall objective of Maritime surveillance is to ensure the safe use of the sea and to secure Europe's maritime borders by monitoring sea borders and counter illegal immigration and illegal trafficking activities. The main objectives of Border surveillance are to reduce the number of illegal immigrants entering the EU undetected, to reduce the illegal immigrants' death toll and to prevent cross-border crimes by monitoring land borders and critical infrastructures sites([154]).

GMES/Copernicus areas of support of European External Action (SEA) are: support to EU peace-keeping operations, intelligence for humanitarian-aid operations, border monitoring outside the EU, assessment of security risks related to urban resilience, food security, water management, illegal exploration of natural resources and illicit crops. In order to support European external actions, in the framework of the FP7 the EC has funded the project G-MOSAIC, providing services to the end users in a pre-operational mode. Operational areas covered by the project include natural resources and conflicts, migration and border monitoring, nuclear and treaties monitoring, critical assets, crisis management and assessment([155]). In case of complex emergencies, G-MOSAIC services were activated in synergy with those provided by the SAFER project for emergency response, confirming the need of strong synergies between the two services to better serve the respective communities of users([156]). The G-MOSAIC services were activated in a number of occasions in 2010 and 2011, by a variety of institutional EU and non-EU actors and for different purposes. The DG RELEX/EEAS, for instance, in 2010 activated both the migration and border monitoring, and the crisis management and assessment services to monitor the Nicaragua-Costa Rica border dispute, while in 2011 the services related to crisis management and assessment was activated to cope with the crisis in Libya. Other simultaneous and complementary activations along 2011 regarded crises in Ivory Coast, Yemen and DRC.

The satellites which currently contribute to GMES/Copernicus are divided in four categories:

- **SAR Missions**

[152] Josef Aschbacher, Maria Pilar Milagro-Pérez, 'The European Earth monitoring (GMES) programme: Status and perspectives' in *Remote Sensoring Environment*, Volume 120, 15.5.2012, p. 4.

[153] See http://copernicus.eu/pages-principales/services/.

[154] The three areas of GMES/Copernicus security services were mentioned in the Regulation (EU) 911/2010 of the European Parliament and the Council of 22September 2010 on the European Earth monitoring programme (GMES) and its initial operations (2011-2013) http://copernicus.eu/pages-principales/library/policy-documents/.

[155] For additional information about GMOSAIC visit http://www.gmes-gmosaic.eu/.

[156] For additional information about Safer visit http://safer.emergencyresponse.eu/site/FO/scripts/myFO_accueil.php?lang=EN.

  - COSMO-SkyMed
  - TerraSAR-X
  - TanDEM-X
  - Radarsat-2
- **Optical Missions**
  - SPOT
  - Pléiades
  - Rapid Eye
  - UK-DMC-2
  - Proba V
- **Altimetry Missions**
  - CryoSat
  - Saral/Altika
- **Atmospheric Missions**
  - Calipso
  - Meteosat Second Generation
  - MetOp.

GMES/Copernicus will be fully operational when its own space component will be launched in Earth orbit. This component is composed of five Sentinels missions and one named Jason CS. As said, these satellites and payloads are under development by ESA specifically for the operational needs of the GMES/Copernicus program. The Sentinel missions are based on three constellations of two satellites each and two payloads to be embarked upon other satellite platforms. ESA has planned the first launch of a Sentinel satellite, which should be Sentinel-1A, no earlier than 2014.

The **Sentinel-1** constellation will be a polar-orbiting, all-weather, day and night radar imaging mission for land and ocean services. ESA is using the Canadian satellite Radarsat-2 as technology demonstrator for the Sentinel-1 series. The two satellites are being developed by Thales Alenia Space.

The **Sentinel-2** constellation will be a polar-orbiting, multispectral high-resolution imaging mission for land monitoring. The system will also deliver information for emergency services. The satellites are being developed by Astrium.

The **Sentinel-3** constellation will be a polar-orbiting multi-instrument mission to measure variables such as sea-surface topography, sea and land surface temperature, ocean colour and land colour with high-end accuracy and reliability. The satellites are being developed by Thales Alenia Space.

Sentinel-4 will be a payload that will be embarked upon a Meteosat Third Generation-Sounder (MTG-S) satellite in geostationary orbit (GTO) to be dedicated to atmospheric monitoring.

Sentinel-5 will be a payload that will be embarked upon a MetOp Second Generation satellite to be dedicated to atmospheric monitoring([157]).

In addition to the Sentinel program, another segment of the GMES/Copernicus own space component will be the **Jason-CS** satellite that will be equipped with a new generation SAR and will be dedicated to oceans and climate monitoring.

Recent developments

In the field of national EO systems France, Italy and Germany dominated the scene in the last decade and such trend will be certainly confirmed through 2020. France recently launched its first dual use system, Pléiades, allowing the full application of the ORFEO agreement with Italy. Spain will soon join the group with its two EO satellites, while France will launch its third system for military purposes, CSO. On their part, Italy and Germany will complete their second SAR systems for dual and military uses respectively, namely, CSG and **SARAH** (2017?). Moreover Italy -which intends to strengthen its position in the EO segment with the realization of the OPSIS (Optical System for Imaging and Surveillance) satellite dual-use system – is also involved in extra-EU initiatives, such as the development of the hyper-spectral satellite Shalom in cooperation with Israel. The establishment of these new European capabilities will potentially contribute to the success of MUSIS, although at the time of writing no relevant development can be highlighted in that respect.

At the same time, it has to be noticed the increasing role of private actors in the geospatial information market. This is, for instance, the case of Astrium Services, which has exclusive access to data from the SPOT and Pléiades optical satellites as well as the TerraSAR-X and TanDEM-X radar satellites, and can therefore offer a complete set of EO products and services to the end-users.

Concerning GMES/Copernicus, 2012-2014 represent crucial years for the success of the programme in general and of its Security dimension in particular. Indeed, decisions on funding and on the governance of the programme, as well as the success of recently started FP7 projects are the main variables. Negotiations all along 2012 on the EU budget have allowed to reintegrate the flagship programme in the MFF, as decided by the European Council in February 2013. According to its conclusions, the programme will fall under the Sub-Heading 1a (Competitiveness for growth and jobs)([158]) for an amount of EUR 3.786 billion. This long waited result came after the EC had unexpectedly proposed to fund GMES separately, within a special intergovernmental fund, under its management in 2011([159]). This would have made of GMES an intergovernmental programme, contrary to the Galileo flagship programme and to the original idea of a Union initiative to the benefit of EU citizens. For this reason, the EC's proposal faced a strong opposition by MS and the EP. Even so, considered the financial needs of GMES/Copernicus for the transition from the pre-operational to the operational stage, the EP evaluated that EUR 3.786 billion cannot be sufficient. It should be recalled that in the original EC's proposal for a special fund the amount reached EUR 5.8 billion. The reduced funding would be supposed to cover Services, the In-Situ Component and the Space Component. In

[157] For further information about the GMES dedicated missions visit http://www.esa.int/Our_Activities/Observing_the_Earth/GMES/Overview4.

[158] Conclusions of the European Council, EUCO 37/13, 8 February 2013.

[159] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions 'A Budget for Europe2020', COM(2011) 500 Part I, 29 June 2011 http://ec.europa.eu/budget/library/biblio/documents/fin_fwk1420/MFF_COM-2011-500_Part_I_en.pdf
Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the European Earth monitoring programme (GMES) and its operations (from 2014 onwards), COM(2011) 831, 30 November 2011
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0831:FIN:EN:PDF.

this context, it is not clear how the EC would allocate funds to the three components. As a result, today it is unknown if and how the cut on the overall budget would impact on the Security dimension.

Thus, unsatisfied with the overall cuts to the EU budget as a whole operated by the Council, in March 2013 the EP rejected the Council's conclusions judging it too restrictive and not sufficiently focused on investments in research and development, innovation and infrastructures for stimulating the growth of Europe and overcome the economic and financial crisis ([160]). All these three aspects can be considered fundamental for the success of GMES/Copernicus too.

Regarding the governance of the programme as a whole, the EC is about to issue a proposal for a Regulation. In this respect, the organizational setting of the Security dimension and related services is still unclear and currently studied by the FP7 project BRIDGES([161]). Of course, great attention is paid to this point by MS, which are concerned about the proper handling of security aspects in general and of data security policy in particular. In this sense, the EC is also preparing a proposal for a Delegated Regulation on the access to GMES dedicated data and GMES service information.

In the FP7 framework, the EC has decided to fund a series of research projects dealing with SEA, This is the case, first of all, of G-NEXT and G-SEXTANT([162]), two complementary projects especially build on the experience of G-MOSAIC, but also of SAFER. G-NEXT aims to contribute to the transition from the pre-operational to the operational mode of such services, supplying information and intelligence data in support of the European external actions, including mapping and geo-information products ready for deployment in emergency and crisis situations. G-SEXTANT, at the same time, aims to develop the portfolio of EO products and services for the EU External Action users and stakeholders addressing a number of scenarios: intelligence for humanitarian aid and civil protection operations, exploitation of natural resources, monitoring of land use, tools for monitoring of nuclear sites and activities, monitoring of illicit crops, and border monitoring outside the EU. Both projects benefit from the inputs provided by the *ad hoc* Working group GMES/Copernicus Security in support to EU external actions (WG-SEA) established in 2010 is defining a service/product portfolio for SEA to be validated by users ([163]).

Similarly, the FP7 funds initiative in the field of border control and maritime surveillance. The two main projects in this domain are LOBOS([164]) and SAGRES, whose goal is to implement, test and put into service the main outcomes of EO research to support the operational deployment of high time critical, intelligence-driven border control and maritime surveillance pre-operational services to be delivered to FRONTEX via EUSC and EMSA. Once operational, all these services will complement the products offered by GIO EMS([165]), which is one of the first GMES services becoming operational, and provided products based on satellite imagery to actors in the management of natural and man-made disasters. GIO EMS, which started operations on April 1st 2012, is the operational version of the pre-operational emergency management service initially provided by SAFER.

SATELLITES TELECOMMUNICATIONS

[160] European Parliament resolution of 13 March 2013 on the European Council conclusions of 7/8 February concerning the Multiannual Financial Framework.

[161] Building Relationships and Interactions to Develop GMES for European Security (BRIDGES) http://www.gmes-bridges.eu/.

[162] For additional information about G-NEXT and G-SEXTANT visit http://copernicus.eu/pages-principales/projects/other-gmes-projects/security/.

[163] The areas analysed by the WG-SEA include support to peace-keeping operations; intelligence for humanitarian-aid and civil protection operations; border monitoring outside the EU; assessment of security risks related to urban resilience; food security; water management; illegal exploitation of natural resources or monitoring of illicit crops and land use planning.

[164] See GMES/Copernicus website http://copernicus.eu/pages-principales/projects/other-gmes-projects/security/.

[165] For additional information about GIO EMS visit http://portal.ems-gmes.eu/.

National systems

European countries have adopted different approaches towards the establishment of SATCOM for defence and security purposes. On the one hand, the main space faring nations in Europe - **France**, **Germany**, **Italy**, **Spain**, and the **UK** - have developed, and are currently updating, their own national satellite communication systems. While governments - and in particular MoDs - play a pivotal role in the procurement of SATCOM assets and services, the development of sovereign and secure satellite communication capabilities for military forces, is today based on different, and still evolving, development, business and ownership models. New approaches also envisage the establishment of government-owned dual-use systems for military and public safety requirements (See Athena-FIDUS, below).

On the other hand, other European countries completely rely on commercial operators for their military SATCOM since these are providing increasingly secure services. In addition, there emerges a clear trend towards the PPP form of procurement based on service provision rather on asset purchase. Such trend reflects not only the maturity of SATCOM applications and services, but also the need for governments to prioritize resources in a critical time of shrinking defence budgets. In addition, the French-Italian cooperation in the field of military SATCOM could pave the way for other pooling and sharing initiatives in Europe, as those launched in the framework of EDA.

At present Europe relies upon five almost dedicated SATCOM systems, composed by twelve different communication satellites and 10 ground control stations. An account of the most relevant governmental/national initiative is provided here.

The UK MoD is procuring satellite communications services through **Skynet-5**. The Skynet-5 system is developed within a Private-Finance-Initiative (PFI), whereby the military procures SATCOM services - including maintenance and operation of the complete ground infrastructure - from Paradigm (subsidiary of Astrium, purposely created). Astrium designed and built the complete Skynet-5 system. Paradigm is the prime contractor of the MoD, but can provide spare service to other governments (Slovenia, Czech Republic, Portugal and Norway) and organizations (NATO). In 2022, when the contract with Astrium will expire, the UK government will take ownership of the four satellites and will launch another competition to assign service operations.

Also in Germany the provision of secure satellite communication services is contracted to a commercial entity. In fact, while the **SatcomBw**'s satellites are owned by the MoD, the 10-year programme is managed by MilSat Services, a joint-venture company between Astrium Services and ND SATCOM. The SatcomBw programme also contributes to strengthen Germany's ground communications network and control system, in order to connect command centres, vehicles, aircraft and ships in their mission areas through voice, video, database access, and IP services. Additional C- and Ku-band capacity is acquired through long-term leases from commercial operators such as Intelsat.

Spain has adopted a hybrid approach. In fact, the Spanish MoD procures a relevant part of its secure military communication services from a partly-commercial system, **Secomsat**. Secomsat is composed by two satellites: SpainSat, which services are provided by HisdeSAT - a government satellite services operator - for the MoD, and XTAR-EUR, a spacecraft operated by XTAR LLC, a US-based joint venture between HisdeSAT (44 %) and Loral (56 %). Both operators lease their satellites' transponders to the Spanish MoD, while the remaining capacity is allocated to defence customers in the US and other allied governments.

France's military forces, on the contrary, rely upon **Syracuse-3**,the third generation of the French dedicated military SATCOM system, owned and operated by Direction Générale de l'Armement (DGA-

General Directorate for the Armament), the MoD's procurement agency. The two satellites composing the system were built by Thales Alenia Space France and were launched, respectively, in 2005 and 2006. Under Sarkozy's Presidency - France has explored the possibility to privatize the system by selling and leaseback the Syracuse 3 constellation to a commercial operator (Thales Alenia Space, indeed, had expressed interest in the sale-and-leaseback scheme adopted by Astrium Services in the UK), but such possibility was finally rejected for strategic reasons. In 2007 France was expected to order a third Syracuse spacecraft, but this option was eventually ruled out in favour of including the Syracuse-3C payload on the Italian X-band/EHF satellite system, Sicral-2.

Sicral is Italy's family of military SATCOM system. The first generation of Sicral – operated by the Italian MoD - is composed of two satellites (Sicral-1A and 1B) for military telecommunications. The first satellite was built by the consortium SITAB composed by AleniaSpazio (then controlled by Finmeccanica), Fiat Avio and Telespazio. The second spacecraft and the related ground network, were realized by Thales Alenia Space and Telespazio, today joint-ventures between Finmeccanica and Thales. The system can operate simultaneously on several frequency bands (SHF, EHF and UHF). In 2010 the Italian MoD announced, in collaboration with its French counterpart, the development of the second generation of the military communications satellite (Sicral-2) together with its ground segment. Sicral-2 – which will separately host the French SHF Syracuse-3C payload - represents the first cross-border cooperation in military SATCOM in Europe. The joint Italian-French programme, which will be carried out by Thales Alenia Space and Telespazio, is scheduled for launch in late 2013 or 2014. Significantly, Telespazio financed a portion of the construction of both Sicral 1B and Sicral-2, in return for ownership of a fraction of their capacity for resale.

Cooperation (bilateral and multilateral)

The Franco-Italian cooperation is expected to produce further innovation in the security satellite communications domain. In fact, Italy's MoD and ASI together with France's DGA and Centre National d'Etudes Spatiales (CNES-National Centre for Space Studies) have launched the **Athena-FIDUS** initiative, aimed at realizing the first dual-use Ka-band broadband SATCOM system that will complement Syracuse 3 and Sicral 2 (2014). Once operational - the system jointly realized by Thales Alenia Space and Telespazio - will be used by both the French, Belgian and Italian armed forces as well as the civil protection services of France and Italy.

Italy and France, together with the UK, also contribute to NATO's satellite communication capacity. Under the framework of the **NATO Satcom Post-2000** (NSP2K) programme, the three countries provide the Alliance with their SATCOM capabilities (the French Syracuse-3, the Italian Sicral-1, and the British Skynet-4 and 5) for a 15-year period, from January 2005 until the end of 2019. The European satellites ensure both Super High Frequency (SHF) communications for static and deployed ground stations with larger antenna dishes, and Ultra High Frequency (UHF) communications for tactical connectivity. At the end of 2012, Germany announced the possibility to offer part of its SatcomBw's capacity to the NATO community.

At the European level, important cooperative initiatives have been undertaken both at the ESA and EDA level. ESA is currently developing a **European Data Relay Satellite** (EDRS) system, expected to contribute to overcome the delays in the delivery of time-critical data to users. The satellites will be able to rely on data from/to other satellites and space-crafts, as well as ground stations and antennas. The system is being built through a Public–Private Partnership (PPP) between ESA and Astrium Services, using payloads carried by two satellites in geostationary orbit. The subcontractors include Germany's TESAT and OHB, the former in charge of the realization of the laser terminal exploiting a technology developed by DLR, the latter expected to build the second EDRS satellite (the first two payloads will be carried on Eutelsat-EB9B satellite built by Astrium) using the SmallGEO platform.

In the light of the emerging need of secure and reliable satellite telecommunication for military purposes, EDA has undertaken an ambitious programme to strengthen the European capabilities. The first, short-term, step in this context is the establishment of the European Satellite Communication Procurement Cell (ESCPC), in charge of coordinating the EU Member States' orders (currently France, Italy, Poland, Romania, and the United Kingdom) of commercial satellite communications services. Astrium Services has been awarded the ESCPC framework contract by the EDA, and is the first provider of commercial satellite communications for European military needs. EDA's initiative, however, has even more ambitious goals. In fact, the Agency is also involved in two projects, the mid-term European Tactical Interim Satellite Capacity (ETISC) and the long-term Secure Telecommunication by Satellite (SECTELSAT), which aim at responding to the increasing needs of space-based secure and reliable telecommunications taking into due account current and future cuts in public – and particularly defence – budgets.

NAVIGATION AND POSITIONING

Galileo

The first steps of the Galileo program were the launches of the **Galileo In-Orbit Validation Element** (GIOVE), a constellation of two satellites, launched in 2005 and 2008, as technology demonstrators.

The GNSS Galileo will be a constellation of 30 satellites, 27 operative and three in-orbit spares, that will provide users with 4 different kinds of services: the OS, the SoL, the Search and Rescue (S&R), the Commercial Service (CS) and the Public Regulated Service (PRS).

The most relevant service for security and defence, the **PRS**, will be a highly encrypted signal. Its utilisation will be reserved to the Council, the EC, the EEAS, MS and, under specific arrangements and agreements, to EU agencies as well as third Countries and International Organisations. It shall be for each individual MS, the Council, the EC and the EEAS to decide whether to use the PRS within their respective competences. In this sense, each MS shall decide independently which categories of national natural and legal persons are authorised to be PRS users, as well as the uses they should make of it, including security-related uses. This is true for the Council, the EC and the EEAS too, which shall decide which categories of their agents are authorised to be PRS users([166]).

PRS applications may be very sensitive from a political and strategic viewpoint and its use will be closely monitored and controlled for safety and security reasons. In this sense, the Galileo Security Monitoring Centre (GSMC) – entity directed by the European GNSS Agency - will play a major role. In fact, GSMC will be responsible for the operation of the PRS and will be the single interface between the system and users (i.e. organization of users community, access to the service, etc.). At the same time, the GSMC will be also in charge of operational security issues related to the whole system, such as monitoring performances and threats. The GSMC is composed of two centres located in France – in a military complex - and in the UK and will turn operational together with the PRS, while expected to be ready by the end of 2013. PRS applications will be used for emergency services, critical

[166] Decision 1104/2011/EU of the European Parliament and of the Council of 25 October 2011 on the rules for access to the public regulated service provided by the global navigation satellite system established under the Galileo programme http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:287:0001:0008:EN:PDF.

transportation, energy, internal security and defence: even if Galileo is the first civilian GNSS in the world, nothing prevents MS from the use of it for military purposes([167]).

Galileo's state of play

As a result of the GIOVE constellation's success as technology demonstrators, on October 10th 2011 the first couple of Galileo satellites, for the In-Orbit Validation (IOV) phase, were launched by a Soyuz rocket from Kourou spaceport and two months later all their systems were up and running. The second pair of Galileo satellites was launched on October 12th 2012. The IOV constellation has been developed by Astrium, with satellites' integration made by Thales Alenia Space.

After a series of tests of the systems onboard the platforms, in January 2013 the Search and Rescue (S&R) signal has been activated for the first time to test it and almost two months later engineers of the ESA's navigation laboratory in the Netherlands determined a position relying only on the four Galileo satellites and ground infrastructure which includes the control centres in Italy and Germany and the global network of ground stations([168]).

The two ground control centres for Galileo are the Fucino Control Centre in Italy, which is the Ground Mission Segment (GMS), and process data collected from a worldwide network of stations and the Oberpfaffenhofen Control Centre in Germany, which is the Ground Control Segment (GCS). It monitors and controls the constellation with a high degree of automation.

Both Centres are managed by Spaceopal company, a joint venture between the DLR and Telespazio created in October2010.

During the IOV, these two centres have two distinct roles. After IOV they will work together as backups with real time data synchronization. In the event of a shutdown of one of the two centres, the other will be able to continue operations independently.

The four IOV satellites' testing has to be terminated before launching the next phase of the program called Full Operational Capabilities (FOC). The first two satellites of this second phase are scheduled to be launched in September 2013 by a Soyuz rocket; other 20 are on order and will be manufactured by the German company OHB. Galileo is expected to be in FOC-1, with 18 operative satellites, by the middle of the decade. In this phase Galileo will provide the OS, S&R and PRS services. The FOC-2, with the complete constellation, is expected to start operations by the end of the decade and will provide all the Galileo's services.

To accelerate the pace of launches, EADS-Astrium is currently developing a special version of its Ariane-5 ES to carry four Galileo satellites in MEO. The project is co-funded by ESA and EC([169]). On February 2nd 2012 ESA procured the booking for an Ariane-5 launch in 2014 and two launch options for 2015/2016.

The EC proposed to put the funding of Galileo in the forthcoming MFF 2014-2020, allocating EUR 7 billion, reduced to EUR 6.3 billion by the European Council's conclusions of February 2013.

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[167] European Commission, Enterprise and Industry, Satellite navigation, Galileo: Public Regulated Services http://ec.europa.eu/enterprise/policies/satnav/galileo/applications/public-regulated-services/index_en.htm.

[168] EC Press Release 12 March 2013: 'First steps of Galileo - European satellite navigation system achieves its first position fix'.

[169] ESA Factsheet 'Galileo Full Operational Capability Procurement' http://download.esa.int/docs/Galileo_IOV_Launch/FOC_factsheet_20111003.pdf.

SPACE SITUATIONAL AWARENESS

Cooperation (bilateral and multilateral)

The European Incoherent Scatter Scientific Association (EISCAT) is a consortium composed by Norway, **Sweden**, **Finland**, Japan, China, UK, Germany and France, which manages a network of radar stations located in the Scandinavian Peninsula and Svalbard islands. The system is used for ionospheric research but its radar echoes can track objects in LEO down to 2 centimetres at an altitude between 500 and 1,500 kilometres. These measurements are not sufficient to determine an entire orbit so EISCAT benefits as a SST system are limited. EISCAT is planning to upgrade the radars with 3D imagery capabilities starting from 2015.

ESA began its SSA program in 2009 as an optional program with 14 member States' financial participation. The 2012 ESA Ministerial Council extended the program mandate to 2019. The Phase II is currently funded for the period 2013-16.

To achieve the objective of acquiring new SSA capabilities, the program is focusing in three main areas: Space Surveillance and Tracking (SST); Space Weather (SWE); NEO. Each of these activities is being developed as a segment in parallel with setting of capabilities and services, supported by data centres and a Taking Centre with contributions by existing European structures([170]).

The Phase II activities are focusing in developing SWE and NEO technologies while for the SST segment testing and validation activities are on-going.

Between 2009 and 2012 some facilities has been established in many countries including: Space Weather Coordination Centre in Brussels (Belgium); Space Weather Data Centre at ESA Redu Centre (Belgium); NEO Data Centre at ESA/ESRIN (Italy); Space Surveillance and Tracking Data Centre at ESA/ESAC (Spain); SSA Tasking Centre at ESA/ESOC (Germany); development and installation of a mono-static test radar in Spain; development and installation of a bi-static test radar in France; initial design of the SSA **WideEye** automated telescope to enable a full-sky NEO scan.

During Phase II, in the SWE segment, will be developed new data collecting centres and payloads to be hosted in space missions. In addition the ESA's solar probe **Proba II** will be fully exploited to monitor the Sun activity. In the SST segment will be increased the coordination among existing national infrastructures and the new radars, in Spain and France, will be made operational. In the NEO segment the existing facilities on the ground will be coordinated and new data centres are going to be operational; in the near future ESA is expecting to launch and exploit the **Gaia** probe([171]) to use its data for NEO observation and tracking. The ESA program aims to establish collaboration with US agencies, such as NASA, National Oceanic and Atmospheric Administration (NOAA) and the DoD and with the United Nations.

Since the Council Resolution *Taking forward the European Space Policy*([172]), the EU confirmed its intention to develop a European SSA system through a coordination of efforts in Europe and among the MS. However, in the White Paper on European Space Policy of 2003, the EC had already recognized SSA as strategic for European security. The EP Resolution of 19 January 2012 on a *Space strategy for the European Union that benefits its citizens* stated that the creation of a European SSA

[170] ESA SSA website http://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness/SSA_Programme_overview.
[171] ESA Gaia website http://sci.esa.int/science-e/www/area/index.cfm?fareaid=26.
[172] Council Resolution 13569/08 'Taking forward the European Space Policy', 26 September 2008.

system will be an essential asset to improve the protection of space and ground infrastructures from impacts with space-borne objects. The GMES/Copernicus and Galileo programs are essential for the European space strategy and they will have a great economic and safety-security impact. For this reason not acting in the SSA field could affect their long-term security and sustainable exploitation([173]).

The new European program should be based on existing capabilities and infrastructures, with new MS' investments to close the existing gaps. The SSA development will benefit the EU External Action Service (EEAS), improving the EU position in international space negotiations. The EEAS is supposed to be an essential entry point for discussions on space policies with foreign and security policy implications. EEAS is a user of space services and the principal actor involved in EU external action under the direction of the High Representative for Common Foreign and Security Policy. For these reasons, the involvement of the EEAS in the development and definition of a European SSA program should be strongly encouraged.

The EC Proposal *Establishing a space surveillance and tracking support programme*([174]) just recently released, stresses the intention of the EU to not develop new systems and infrastructures but to establish a SST joint service to prevent collisions between spacecrafts and between spacecraft and debris. The objective is to create a partnership where MS will contribute with their existing and future assets to the SST capability at European level and the Union will provide a legal framework and a financial contribution to the implementation of the actions defined. The legal framework will define the governance scheme and the data policy in accordance with the relevant Council conclusions([175]). The Proposal stated that there is a consensus among EU and ESA Member States that the EU shall lead the constitution of the SST support service because it has a security dimension([176]) of which the Union has the competence, given by the TFEU, to deal with, unlike the ESA. The MS are in favour of ESA's development of technologies and infrastructures and EU managing of SST services through the contribution of the EUSC. In this collaboration, EDA had taken the responsibility to integrate the military requirements for the systems and services, due to the intrinsic dual nature of SST, and to coordinate the military expertise if necessary. The financing of the program will be kept into the margins of the MFF 2014-20, drawing resources, if necessary, from existing space programs.

Challenges and Perspectives

The US National Security Strategy (NSS) released in May 2010 stated that maintaining the benefits of space for the US and allies are vital for National Security and a deeper cooperation with allies and friends is desirable([177]).

The US Space Surveillance Network (SSN) is the operator of the word largest network of SSA systems and manages the most complete catalogue of space objects. The SSN infrastructures consist in phased-array radars, conventional radars, electro-optical sensors, the Space-Based Space Surveillance (SBSS) satellites and the Ground-Based Electro-Optical Deep Space Surveillance sites([178]). Some of

[173] SWD (2013) 54, Commission Staff Working Document, Executive Summary of the Impact Assessment accompanying the document Proposal for a Decision of the European Parliament and of the Council establishing a space surveillance and tracking support programme.
[174] Proposal for a Decision of the European Parliament and of the 'Council Establishing a space surveillance and tracking support programme', COM(2013) 107, 28 February 2013.
[175] See footnote 78.
[176] Data from SST could be information about third States' civil and military space operations.
[177] National Security Strategy, May 2020:
http://www.whitehouse.gov/sites/default/files/rss_viewer/national_security_strategy.pdf.
[178] http://www.stratcom.mil/factsheets/USSTRATCOM_Space_Control_and_Space_Surveillance/.

these infrastructures are located in Europe: the British Fylingdales radar and the Norwegian **Globus II** radar([179]). The US government relies on the US Air Force (USAF) to provide continuous SSA coverage. Data from the SSN sensors are collected by the Joint Space Operation Centre (JSpOC) located in the Vandemberg Air Force Base in California. The JSpOC operations are managed by the US Strategic Command (USSTRATCOM).

Since late 1950s the US has shared their SSA data. Today the sharing is managed by the USSTRATCOM through the permanent SSA Sharing Program, which consist in three users levels, basic, emergency and advanced([180]).

In the aftermath of the 2007 Chinese Anti-Satellite (ASAT) technology test, which caused thousands of space debris, the Council of the European Union proposed a Draft Code of Conduct for Outer Space Activities (the 'Code')([181]) that, however, has not yet been adopted. In 2012 a new version of the Code was presented([182]). The document concerns the whole community, adopts an approach that does not require the definition of space weapon and is politically but not legally binding([183]). The Art. 4 (2) of the Code states that subscribing States shall refrain from any action which could damage or destroy space objects. Such action is permitted only if is conducted to reduce the creation of space debris or is justified by the right of individual or collective self-defence as recognised in the United Nations Charter or by imperative safety needs. States shall undertake these actions, if they are necessary, in a manner so as to minimize the creation of debris, especially long-lived debris. In addition, the Article encourages the subscribing States to take necessary measures to minimize collision's risk. In order to accomplish these objectives, the subscribing States shall notify a relevant number of actions such as space manoeuvres which can cause risk of collisions, launch of space objects, collision and breakups in orbit, high risky atmospheric re-entry trajectories of objects which can cause damages or radioactive contamination and space objects' malfunctions that could lead to an uncontrolled atmospheric re-entry.

After an initial US opposition under Presidency of George W. Bush, the Obama Administration is considering to join the EU efforts and to collaborate to the drafting of the Code. The National Security Space Strategy([184]), released in January 2011, defines space as "congested, contested and competitive". In particular, it is congested because of the large and increasing amount of space debris and inactive satellites in orbit. The Strategy aims to secure the space access and utilization for the US, through improving space capabilities and promoting partnership with other responsible Nations and International Organisations. On January 2012 the US Secretary of State, Hillary Clinton, stated that US should partner with EU to elaborate an International Code of Conduct for Outer Space Activities based on the EU Code, specifying that these works should not limit or constraint US National Security and defence capabilities([185]).

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[179]These two radars are managed by local military personnel and data are shared with the US through bilateral agreements.

[180] To be part of the SSA Sharing Program advanced data is necessary to sign the USSTRATCOM SSA Sharing Agreement.

[181] Draft Code of Conduct for Outer Space Activities as approved by the Council on 8-9 December 2008 http://register.consilium.europa.eu/pdf/en/08/st17/st17175.en08.pdf.

[182] Working Document Revised Draft 'International Code of Conduct for Outer Space Activities', 5 June 2012: http://www.consilium.europa.eu/media/1696642/12_06_05_coc_space_eu_revised_draft_working__document.pdf.

[183] Lucia Marta, 'The Hague Code of Conduct Against Ballistic Missile Proliferation: "Lessons Learned" for the European Union Draft Code of Conduct for Outer Space Activities', *ESPI Perspectives* 34, June 2010.

[184] National Security Space Strategy, Unclassified Summary, January 2011: http://www.defense.gov/home/features/2011/0111_nsss/docs/NationalSecuritySpaceStrategyUnclassifiedSummary_Jan2011.pdf.

[185] 'US joins EU effort to develop space 'code of conduct'' in *The Telegraph*, 17.1.2012 http://www.telegraph.co.uk/science/space/9021800/US-joins-EU-effort-to-develop-space-code-of-conduct.html.

Today Europe does not have a comprehensive SSA system yet. Notwithstanding the good progress of the ESA's program, most of EU MS are still largely dependent on US SSA data. As mentioned above, only few States, such as France, Germany and UK, possess operational SSA infrastructures. A European SSA system, supposing that the EU, ESA and MS cooperation is successful, cannot substitute the long established expertise and capabilities of the US([186]). For this reason, a transatlantic cooperation continues to be essential and a common EU-US draft of an International Code of Conduct for Outer Space Activities could represent an important contribution to the space's security.

PART TWO

ACTORS AND ROLES IN SPACE TODAY AS RELATED TO SECURITY

The EC

Galileo

Before considering the role of the EC, it important to recall that the EU is the owner of all tangible and intangible assets created or developed under the satellite navigation programmes Galileo/EGNOS. This absolute innovation and the current public governance of the programmes([187]) are established by Regulation (EC) No 683/2008 on the further implementation of the European satellite navigation programmes (EGNOS and Galileo)([188]) which will be soon repealed by a new regulation, taking into account the concurrent deployment and exploitation phases of Galileo for which a further modification of the governance is needed. This stems from the fact that the diverse phases that bring to the completion of a satellite system and to its operations, envisaging different activities at diverse levels, require specific mechanisms and organizational arrangements. In other words, in the new regulation governance is adapted to the operational requirements of the system. Nevertheless, the main actors involved in the upcoming governance coincide with those set in 2008, while specific roles and relations among each other will partially change([189]).

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[186] J. Robinson, 'Space Security through the Transatlantic Partnership: Conference Report and Analysis', p. 21.

[187] As opposed to the first governance model proposed for Galileo, that is, a PPP form. See A. Veclani; with research support from Jean-Pierre Darnis, Valérie Miranda, The Galileo programme: management and financial lessons learned for future space systems paid out of the EU budget, Brussels, European Parliament, October 2011 (Policy Department External Policies Study).
http://www.europarl.europa.eu/committees/en/studiesdownload.html?languageDocument=EN&file=67675

[188] Regulation (EC) No 683/2008 of the European Parliament and of the Council of 9 July 2008 on the further implementation of the European satellite navigation programmes (EGNOS and Galileo)
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:196:0001:0011:en:PDF.

[189] The description of the Galileo governance combines relevant elements of Regulation (EC) No 683/2008 and those new ones as they appear in the partial general approach of the Council adopted in June 2012 on the Proposal for a regulation of the European Parliament and of the Council on the implementation and exploitation of European satellite navigation

It should also be borne in mind that at the highest level, the EP and the Council exercise the overall political oversight, with the EC keeping them duly informed on the progresses of the programmes implementation. In addition, the Galileo Inter-institutional Panel (GIP), composed by representatives of the EC, the EP and the Council, guarantees tight cooperation among the three institutions, while closely following the progress, management and governance of the programmes among other things.

The implementation of the programmes and related budget implies both **direct and indirect management** by the EC, based on the strict division of tasks and responsibilities, under the overall responsibility of the EC. This means that additional entities other than the EC intervene in the governance of the systems, with the EC entrusting them with specific tasks through delegation agreements, as established by the Financial Regulation on the financial rules applicable to the general budget of the Union([190]). Such regulation is a reference legal act containing the principles and procedures governing the establishment and implementation of the EU budget in general. The regulation also addresses procurement and grants.

Thus, the EC has the overall responsibility for the programmes (direct management), in particular management of funds and supervision of the implementation of all programmes activities (i.e. cost, schedule, performance). In doing so, the EC shall be assisted by the European GNSS Programmes Committee, composed of representatives of MS and chaired by the EC([191]). Beside allocating tasks through delegation agreements to other entities, namely the European GNSS Agency (GSA, see further) and ESA (see below), the EC is in charge of (among other things):

- managing, on behalf of the EU and based on competence, relationships with third countries and international organizations;
- keeping MS informed on relevant aspects (i.e. costs, risk management, revenues, schedule, etc.);
- ensuring timely implementation of the programmes within the allocated funds, while identifying, controlling, mitigating and monitoring the risks associated with the programmes;
- defining priorities for the implementation of the programmes (service provision, risk management, revenues, etc.) and mission evolution;
- ensuring the security of the programmes, including of the systems and their operations, establishing coordination mechanisms between the various bodies.

Since 2008 when the programmes have been funded by the EU budget and the governance has been reorganized, Galileo has achieved major successes and proceeded on a sustained path. Nevertheless the real challenge with which the EC is confronted is the timely entrance into operations of the first services and exploitations itself.

GMES/Copernicus

systems COM(2011) 814 of 30 November 2011. In fact, although the new Regulation has already been adopted, it was not published awaiting the approval of the general budget of the EU.
http://register.consilium.europa.eu/pdf/en/12/st11/st11105.en12.pdf.

[190] Regulation (EU, EURATOM) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:298:0001:0096:EN:PDF.

[191] Based on the general rules established by the Regulation (EU) No 182/2011 of the European Parliament and of the Council of 16 February 2011 laying down the rules and general principles concerning mechanisms for control by Member States of the Commission's exercise of implementing powers.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:055:0013:0018:EN:PDF.

The GMES/Copernicus governance is certainly more complex than Galileo's, given it is a federation of systems and that it includes a Space component (Sentinels and Contributing Missions); a Service component which is characterized by six reference areas of services (atmosphere, land, marine, emergency, security, climate change) and related "sub-services" (i.e. Services for Security applications include border control, maritime surveillance, support to EU external actions); and an In-situ component. In addition, the governance is evolving from that of initial operations (2011-2013) to that of full operations (2014 onwards). GMES/Copernicus Initial operations (GIO) and related governance are governed by Regulation (EU) No 911/2010, while for operations a regulation is still under preparation. Similarly to Galileo, the implementation of the programmes and related budget implies both **direct and indirect management**. Notwithstanding, the EC in GMES/Copernicus has more responsibilities in terms of direct management and many more tasks to entrust to numerous and diverse entities. As a result, the governance of operations may also include private actors in the form of PPPs for the management of certain tasks, but this is still uncertain.

Based on the GIO Regulation, the EC, with the support of the GMES Committee, composed of MS representatives and chaired by the EC([192]), is responsible for:

- ensuring the coordination of the GMES programme with activities at national, Union and international levels (notably the Global Earth Observation System of Systems, GEOSS);
- managing the funds allocated to the activities;
- establishing a transparent mechanism for regular user involvement and consultation, enabling identification of user requirements at Union and national level (User Forum);
- allocating tasks through delegation agreements to other entities for:
    - technical coordination and implementation of the Space component,
    - coordination of the technical implementation of Services to competent to Union bodies or intergovernmental organisations.
- Implementing the GMES security policy, assisted by the Security Board (specific configuration of the GMES Committee);
- producing delegated acts in respect of registration and licensing conditions for GMES users and of criteria for restriction of access to GMES data and information, while taking into account information and data policy of providers and without prejudice to national rules and procedures applicable to space assets under national control.

In GMES/Copernicus the EC is involved in the direct management of certain technical tasks, in particular within the Service component, where it is in charge of the implementation and technical coordination of the Emergency Management Service (EMS). Specifically:

- DG ENTR is in charge of the overall coordination of the EMS and of policy supervision (coordination with other DGs, the EEAS and other GMES/Copernicus services, interface with GMES/Copernicus Security Board and User Forum).
- DG ECHO/European Emergency response Centre (ERC) is responsible for operational coordination and interface with authorised users, while authorizing activations of the service based on agreed criteria and prioritization. It also serves as focal point for EC DGs and EU bodies willing to activate the services. Finally, it addresses sensitivity issues pertaining to specific requests.
- JRC is the technical coordinator providing technical support, in particular contracting service providers (private or public) which produce the services/products and managing technical aspects (i.e. monitoring of activations, managing quotas, hosting a catalogue of products, etc.).

[192] See footnote 123.

The decision to manage the EMS service is a serious test case for the EC. The service has been operational for a year and was activated almost 40 times([193]), mainly for emergencies in Europe and Africa, but also in the Middle East and Asia. These numbers are beyond expectations([194]), and - supposedly - also the associated work. Lessons learned will be surely drawn and will allow to either confirm this organizational structure for EMS or to delegate other entities to indirectly manage technical coordination and implementation of the service. For the time being an independent interim evaluation carried out between April and December 2012 has found that management and implementation of initial operations as a whole under the overall coordination of DG ENTR (GMES Unit) was efficient and effective([195]). JRC in particular is considered to have the necessary technical expertise to perform its task and jointly work with the service providers. The mechanisms for activation set within DG ECHO are also judged to have effectively worked. Concerning users, the fact that the EC has involved them in precursor FP7projects and through the User Forum in the definition of requirements resulted beneficial in terms of legacy of knowledge and expertise.

Finally, it is deemed that EMS service contracts awarded to remote sensing companies for maps production are expected to provide strong value for money. Nevertheless, it should be underlined that the report based its analysis on only five activations. Yet, these considerations are important for the future of the EMS, but could also be useful for other services, and in particular those for Security applications. In fact, the two services share certain similarities in terms of public users, scenarios, and sensitivity issues over some activations, while also being complementary in some situations. In addition, lessons learned from this experience may serve the definition of governance mechanisms in the domain of security services. Indeed, these services are still in a pre-operational phase and the related governance is currently being defined. A FP7 project named BRIDGES([196]) is exploring the possibilities in this sense, taking into account the intrinsic security aspects of the service. This is all the more complex, considered that the service serves the three domains of border control, maritime surveillance, and support to EU external actions.

FP7 and H2020

As already mentioned, the FP7 complements the activities carried out by MS in the research area as well as other EU initiatives, such as those run under the structural funds and those relating to various policy areas (i.e. agriculture, competitiveness and innovation, industry, employment, environment, etc.). The Space and Security Themes of the FP7 constitute an industrial policy tool, as they aim to strengthen the EU scientific and technological base, while fostering innovation and competitiveness and guaranteeing that SMEs are fully involved through concrete measures and specific actions.

DG ENTR contributes to bring space and security into FP7, along with the related objectives and prioritization of actions. Following an intense consultative process between the EC and institutional and research stakeholders as well as end users, in 2004 the EC firstly identified space and security as

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[193] List of activations, EMS Portal, http://portal.ems-gmes.eu/ActivationPage/gioActivations.html.

[194] As it emerged from interviews with service providers.

[195] Centre for Strategy and Evaluation Services (CSES), Interim evaluation of the European Earth Monitoring Programme (GMES) and its Initial Operations (2011-2013), Final Report, January 2013 http://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCwQFjAA&url=http%3A%2F%2Fcopernicus.eu%2Fpages-principales%2Flibrary%2Fstudy-reports%2F%3Fno_cache%3D1%26cHash%3D87e9a8c6fbd6f67d63ec978f5bda6de9&ei=GbOQUZvZCMnXObq3gDA&usg=AFQjCNHz3ldpoToXvN5SC_2s_u_FPjHTCQ&bvm=bv.46340616,d.ZWU.

[196] Building Relationships and Interactions to Develop GMES for European Security, 2012-2014. BRIDGES especially focuses on the governance of the domain support to EU external action and on the role EUSC might play therein. http://www.gmes-bridges.eu/.

new thematic priorities([197]). A similar process is currently on-going for the new programme Horizon 2020 (H2020), so as to gather inputs from the European space research community to feed the proposal for space and security Research under the programme and the corresponding implementation strategy([198]).

The FP7 is implemented under direct management of the EC, namely through the Research Executive Agency (REA), purposely created. Indeed, REA was founded on the basis of the statute set by Council Regulation (EC) No 58/2003 ([199]) to be entrusted, under the direct control and responsibility of the EC, with the management of a large part of the FP7 all along its life time. Nevertheless, the REA is expected to remain operational beyond 2013 and until 2017 to cover the management of all the projects funded under the programme. Meanwhile, H2020 will have taken off and the agency's mandate might be extended to continue to cover the management of research activities.

It should be recalled that the FP7 provided for more than EUR 1.4 billion for space and 1.35 for security. The largest part of the funds available under the FP7 Space Theme (85%) were used for GMES components, while the remaining for space foundations to develop cutting-edge technologies enabling the potential of space sciences([200]).

Space industrial policy

Space has been repeatedly recognized since 2010 as an important component of an integrated European industrial policy by the EC Communication on an integrated industrial policy for the globalization era, supporting the Europe 2020 strategy([201]). The Communication acknowledged space as a "driver for innovation and competitiveness at citizens' service", emphasizing societal, economic and strategic imperatives that must drive space policy([202]).

Since then the EC has been working on a specific space industrial policy, aware that the sector bears certain specificities. In early 2013 the EC issued the Communication *EU space industrial policy releasing the potential for economic growth in the space sector*([203]), which identifies current challenges, sets the related objectives and concrete measures to achieve them.

The objectives include a stable regulatory framework, a solid industrial base, efficiency of the value chain to foster global competitiveness, development of for space applications and services,

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[197] See for instance the Group of Personalities' report "Research for a Secure Europe" (2003), the European Security Research Advisory Board's activities, the ASTRO+ project as part of the EC's Preparatory Action for Security Research (PASR), etc.

[198] Hearing on Space Research in FP8, Preparation for the future of space research in Europe begins, DG ENTR. http://ec.europa.eu/enterprise/policies/space/research/hearing_fp8_en.htm.

[199] Council Regulation (EC) No 58/2003 of 19 December 2002 laying down the statute for executive agencies to be entrusted with certain tasks in the management of Community programmes.

[200] See Space – Framework Programme 7, DG ENTR, http://ec.europa.eu/enterprise/policies/space/research/fp7/index_en.htm.

[201] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – *An Integrated Industrial Policy for the Globalisation Era, Putting Competitiveness and Sustainability at Centre Stage*, COM (2010) 614, 28 November 2010, pp. 24-25 http://ec.europa.eu/enterprise/policies/industrial-competitiveness/industrial-policy/files/communication_on_industrial_policy_en.pdf.

[202] See Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *An integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage*, COM(2010)614, 28 October 2010.

[203]See Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *EU Space Industrial Policy*, COM(2013) 108, 28 February 2013 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0108:FIN:EN:PDF.

technological non-dependence. Therefore, measures stretch from regulatory actions in diverse fields of competence to sustained investment in research and innovation, through better use of procurement policies and the establishment and implementation of a real launcher policy.

Finally, the EC is about to issue another Communication relating to the internal market and defence industry which obviously touches the aerospace sector([204]). The EC has been working on such Communication with a purposely established inter-service and inter-institutional task force (EC-EEAS-EDA) to identify options to strengthen the European defence equipment market and further enhance the competitiveness of the defence industry. This is an important initiative which obviously has implications in the space industrial sector, which should be clearly mentioned in the Communication with related measures that the EC might put forward in the fields of SATCOM and EO.

ESA

Launcher programme

The Launcher programme is one of ESA's optional activities, that is, MS voluntarily contribute to it with a level of financial commitment they decide. Beside ESA and MS with their national space agencies, the industry and the company Arianespace play a major role in the European space transportation sector.

The programme is rather broad, as it includes activities dedicated to Ariane-5 and Vega and their evolution, but also to new rockets, while taking forward specific technological research and demonstration activities, the Soyuz at CSG programme, and work at the spaceport (investment, maintenance and upgrade of launch infrastructures).

The ESA Launchers Directorate is responsible for the overall management of the programme, contributing to the definition of the launcher strategy, including launch systems developments and technical evolutions, and maintenance of launchers' qualification over time. Other main tasks are:

- Contributing to the definition of the budget, supervising the advancements, and monitoring costs;
- participating and overseeing the preparation phase, while supervising the implementation;
- managing the tenders system, contracting the entities and industries for the definition, design, and development of launchers;
- entering into working arrangements with the service provider Arianespace for the procurement of launches, marketing and exploitation of vehicles.
- Concluding agreements with the French space agency (CNES) for the management and use of the CSG.

The main contributing national agencies of the European launcher program, such as CNES, ASI and DLR are also directly involved by providing technical assistance in all main activities.

Concerning industry, the system of tenders for Ariane-5 and Vega envisages a prime industrial contractor for each launcher, thereby making it responsible for the development and production. The launchers are subsequently taken over by Arianespace, responsible for marketing and

[204] See European Commission Task Force on Defence Industries and Market, DG ENTR, s http://ec.europa.eu/enterprise/sectors/defence/conference/.

commercializing them and for operations, performing all the remaining work directly related to the integration of payloads.

SSA programme

Similarly to the Launcher programme, SSA is fully managed by ESA. The overall responsibility is held by the Directorate of Human Spaceflight & Operations, while a dedicated SSA Programme Office was also established (Spain). Nevertheless, considered the three different SSA segments (SST, SWE, NEO, see Part One *Space Situational Awareness*) and the multiplicity of technologies needed for such a complex endeavour, other teams spread within the agency and its sites, as well as partner agencies and organizations, are also involved. Again, beside ESA and the MS' agencies, the programme benefits from the involvement of those industrial players which have specific and diverse expertise in the field. Management functions performed by the SSA Programme Office and its Manager are similar to those under the Launcher programme, however SSA also aims to federate and network existing assets. Therefore, the SSA Programme Manager, supported by a team, is also in charge of identifying potential assets that may be pooled into the European SSA and provided by MS or other governments, scientific and research institutions and future customers([205]).

Galileo

The different phases leading to the completion and exploitation of a satellite system, in this case the European GNSS, may have different funding schemes and governances. For instance, during the development and validation phase, before Galileo came under a public governance and was funded by the EU budget in 2008, the EU channelled its funds through the ESA GalileoSat optional programme, leaving to ESA the management, while a PPP was supposed to take the lead of the deployment and operations phases([206]). At the same time the Galileo Joint Undertaking (GJU) was established – the founding members being the EC and ESA - so as to ensure the unity of the administration and the financial control of the project, in particular the implementation of the development and validation phase([207]).

Regulation (EC) No 683/2008 established that development and validation were still to be funded by both the EU and ESA, while the deployment phase by the EU only. Hence, in the latter phase the EC delegated ESA to be the procurement agency for the ground and space infrastructures (indirect management). ESA, therefore, covers the technical and planning aspects of the programme, while guaranteeing that public procurement complies with the EC rules.

In the upcoming regulation ESA will continue to be delegated by the EC for the completion of the deployment phase, however it will need to enter into working arrangements directly with the GSA for any further activity during the exploitation phase, in particular relating to system infrastructure management, maintenance, on-going improvement, certification and standardisation, as well as service provision.

GMES/Copernicus

[205] The description of ESA's role in the SSA programme is based on information available on the programme's website, http://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness/SSA_team.

[206] For further details see The Galileo programme: management and financial lessons learned for future space systems paid out of the EU budget.

[207] Council Regulation (EC) No 876/2002 of 21 May 2002 setting up the Galileo Joint Undertaking, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:138:0001:0008:EN:PDF.

ESA is not only involved in the management of the programme, but also in co-funding it with the EU. Indeed, the agency has funded both services and the space component starting from 2001 and 2005 respectively, based on the FA and *ad hoc* arrangements with the EC. Services were included under the GMES Service Element optional programme within the overall ESA Earthwatch programme, which duration and projects were extended up to 2013. Concerning the space component, ESA has also a dedicated optional programme. The Directorate of Earth Observation Programmes has the overall responsibility, but the GMES Space Office (Italy) is in charge of laying down programmatic aspects. The office also interacts with external key actors, like the EC([208]).

The delegation to ESA of the technical implementation of the GMES/Copernicus space component was formalized by the GIO Regulation. Tasks include the procurement and development of the Sentinel satellites and related infrastructures as well as the coordination of data access coming from Contributing Missions (GMES space component data access system, GSCDA). Moreover, ESA is responsible for the definition of the overall GMES Space Component architecture and for the planning of future GMES elements.

[208] Joseph Aschbacher, Thomas Beer, Antonio Ciccolella, M. Pilar Milagro, Eleni Paliouras, 'Observing Earth, for a Safer Planet, GMES Space Component: status and challenge's in *European Space Agency, Bulletin 142*, May 2010 https://earth.esa.int/pub/ESA_DOC/ESA_Bulletin142_GMES.pdf.

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