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COMMISSION STAFF WORKING DOCUMENT

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

{COM(2013) 107 final}
{SWD(2013) 54 final}

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1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1. Identification

Lead DG: DG Enterprise and Industry

Other involved DGs:

Agenda Planning/WP Reference: 2012/ENTR/021

1.2. Organisation and timing

This impact assessment builds on an earlier impact assessment on the future EU involvement in space which accompanied the Communication on "Elements for an EU strategy in space for the benefit of EU citizens" adopted by the College on 4 April 2011[1].

This second and more detailed impact assessment focuses exclusively on options concerning EU involvement in the setting up of a European service to avoid collisions between spacecraft and between spacecraft and debris and to monitor uncontrolled re-entry of spacecraft which forms the basis for the protection of critical European space infrastructure.

The Impact Assessment Steering Group (IASG) set up to accompany the preparation of this impact assessment met on 26 November 2010, 8 February 2011, 8 July 2011, 5 March 2012 and 15 March 2012. The following Commission services were invited to participate in the IASG: DG SANCO, DG RTD, DG MOVE, DG ENER, DG BUDG, DG ECFIN, DG RELEX, DG JRC, DG INFSO, DG ENV, DG ECHO, DG EMPL, DG EAC, DG HOME, the Secretariat-General as well as the European External Action Service (EEAS).

1.3. Consultation and expertise

Over the past years, DG Enterprise and Industry consulted different parties interested and involved in space affairs on various areas of potential future EU activities in space and notably on the development of a European Space Surveillance and Tracking (SST) service. The development of such service has also been the subject of political debate among EU Ministers responsible for space. The conclusions of those debates are reflected in several Council resolutions[2].

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1 COM (2011) 152 final

2 The Space Council is the concomitant meeting of the EU Council (competitiveness) and the ESA Ministerial Council. With the entry into force of the Lisbon Treaty the EU Council's (competitiveness) responsibilities were enlarged to address space policy matters in 2010. The Space Council or EU Council Resolutions or Conclusions referring to the need to set up an SSA capability at European level are: Council Resolution "Taking forward the European Space Policy" of 26 September 2008 (Council document 13569/08); Council Resolution on "The contribution of space to innovation and competitiveness in the context of the European Economic Recovery Plan, and further steps of 29 May 2009 (10500/09); Council Resolution "Global challenges: Taking full benefit of European space systems" of 25 November 2010 (16864/10); Council conclusions "Towards a space strategy for the EU that benefits its citizens" of 31 May 2011; and the Council conclusions "Orientations concerning the added value and benefits of space for the security of European citizens" of 6 December 2011 (18232/11).

The main conclusions of these consultations can be summarised as follows:

– There is a consensus amongst Member States, satellite operators and other stakeholders on the need to protect space infrastructure, and notably to protect it against the risk of collision;

– There is a political consensus among Member States that the setting up of a European SST service should be led by the EU, which has competence to coordinate the exploitation of space systems and has also the competence and the mechanisms in place to deal with the security dimension of such a service; Member States consider that ESA should support the EU in this endeavour (and is doing so through its SSA preparatory programme[3]) but, as an R&D organisation, does not have the competence and the mechanisms necessary to set up and run a European SST service on its own.

– There is a consensus among EU and ESA Member States and experts that a future European SST service should link and build on existing sensor capacity and develop it with new sensors; Member States possessing sensor capacity and those willing to develop it should play a key role in the setting up of the European SST service;

– There is a consensus that the development of a European SST service should be done in close cooperation with the United States of America;

– Public opinion is aware of and supports the need to protect space infrastructure.

These consultations are explained in detail below.

Consultations of national space agencies, ministries and industry representatives

In 2009, a series of bilateral meetings were held with national space agencies and ministries in charge of space matters in Member States more actively involved in space activities as well as with representatives of the European space industry. From these bilateral meetings the following conclusions could be drawn:

– The European Union has a very important role to play in space matters. Together with Member States and ESA, the EU is one of the three main players in the European space field, each of them having a specific and distinct role. The EU has a political role and a political responsibility and must aggregate and represent the interest of all, when deciding its involvement in space;

– Stakeholders agree that the most urgent priorities for the EU are the completion of the Galileo and Copernicus (new name for GMES) programmes (the latter including reinforced security and climate change dimensions), in order to start benefiting from the services they provide;

– The next priority for stakeholders, notably Member States, is the protection of our space infrastructure. Our economy and the well being of our citizens are increasingly dependent

[3] In the framework of its SSA preparatory programme launched in 2009 with a budget of around 55 M€, ESA conducts a number of technical studies to define SSA user requirements, system requirements as well as technical architecture options. This work provided useful indications concerning the assets needed in order to respond to civil user requirements. Furthermore, the programme included the development of 2 surveillance demonstrator radars.

on space-based applications and we need to acquire the capacity to protect them. Space Situational Awareness (SSA)[4] and notably SST is instrumental to ensuring such protection;

– There is also a consensus that the EU, ESA and their Member States need to work together on all of the above.

In addition, under the Spanish EU Presidency in 2009, a conference on space and security was held to contribute to defining the role of European institutions and centres in security programmes. In 2011, a conference on SSA under the Polish EU Presidency examined the current situation with regard to SSA in Europe and led to some first discussions on possible governance options.

Furthermore, the Communication "Towards a space strategy for the European Union that benefits the citizen"[5] aimed at triggering a debate amongst stakeholders on future EU action in space policy. The Council Conclusions adopted on 31 May 2011 in response to this Communication confirmed space and security as a priority for EU action after ensuring the implementation and sustainable exploitation of Galileo and Copernicus.

In 2010, relevant target stakeholders were interviewed by an external contractor[6], in the context of a study to support the preparation of the previous impact assessment accompanying the Communication the EU strategy for space adopted in April 2011. A further study was commissioned at the end of 2010 in support of the preparation of this current impact assessment[7]. It included a series of stakeholder interviews with ESA, national space agencies, national ministries responsible for space and industry representatives with the aim to get input on the potential implication of the EU in the setting up of a European SSA capability. The results of the study launched in 2010, in particular the risks related to space debris and the related estimated losses, have been presented to and discussed with Member States in late Spring 2011.

An ex-post evaluation of the European space policy is ongoing. However, its results will not have any impact on this impact assessment, as the EU did so far not take any action in the field of space surveillance and tracking apart from the prospective studies referred to below.

Finally, in general terms the policy options defined in chapter 5 of this impact assessment report have been discussed with Member States representatives on a number of occasions over the past two years. In these discussions, Member States expressed a clear preference for an approach to the setting up of European SST services along option 3 or an EU-led programme along options 4 or 5. Most recently, SST governance options have been discussed with Member States in the framework of the Enterprise and Industry DG led group of EU Member States space policy experts on 23 March 2012 where all Member States signalled readiness to support option 3. SSA data policy has been subject to discussion with the Council's space

4 Space Situational Awareness (SSA) refers to the protection of space infrastructure from collision with space objects (which would be a satellite or space debris) or asteroids or meteoroids (summarised as Near Earth Objects) and from solar radiation (the so called space weather). While these threats are often discussed together – and for this reason this report refers in some cases to SSA – the present impact assessment report concerns only the threats from space debris.

5 COM(2011) 152 final of 4.4.2011

6 “Study on the EU Space Programme 2014-2020”, Ecorys, Draft Final Report, 18 April 2010, contract n. SI2.541751.

7 Evaluation of options for an EU space programme 2014-2020, Booz & Company, Final report of 16 May 2011, contract no; 30-CE-036363/00-01

working party in autumn 2011 where Member States broadly agreed with the Commission's Staff Working Document setting out the key elements for the future SSA data policy[8].

Consultations of the broad public

As concerns the consultation of the broad public on space issues in general and SSA more specifically, two surveys have been carried out over the past three years:

- A Eurobarometer survey on the space activities of the European Union was conducted by Gallup in July 2009 in order to examine EU citizens' opinions and to assess: a) their awareness of space activities of Europe and the European Union, and b) their perception of these activities. The majority of European Union citizens regard European space activities as important from the perspective of the EU's future global role: one in five citizens considered such activities *very* important (20%) and a further 43% felt that space activities are important in this respect. In total, almost two-thirds of Europeans share the view that space activities are important for the future international position of the European Union[9]. Overall, 67% of the survey respondents consider it important to develop space based applications to improve citizens' security.

- A second public consultation was carried out via the Commission's Interactive Policy Making (IPM) tool from 3 January to 15 March 2011. The survey focused on the public's opinion on possible EU action in the domain of SSA and space exploration. In total, 608 contributions were received from 25 Member States. The majority of respondents (around 38 %) identified themselves as individuals. Around 14 % of the respondents were representatives of larger or smaller businesses or business associations. SME participation as well as the participation of public authorities (at European, national or regional level) amounted to around 8 % each. The consultation also prompted a number of separate position papers from industry provided in addition to questionnaire replies[10]. As concerns SSA, a **large majority of respondents (86%) were aware of and felt concerned by hazards caused by space debris**, space weather phenomena, or Near Earth Objects (NEOs) to a wide range of space-based and ground-based critical infrastructures and services. At the same time, 32% of the respondents indicated that they had no dealings with space or the space sector. **A large majority of respondents (83%) felt that the EU should have its own capacities to protect critical European satellites** either in order to complement third country capacities (57%) or to be autonomous from third country capacities (26%). 89% expressed the opinion that the EU should play a role in building a European SSA capability, which the EU should either set up alone or together with its Member States. Only 5% of the respondents expressed the opinion that the EU should not get involved in such capability building.

External expertise used

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8 Commission Staff Working Paper "Discussion note on space situational awareness data policy", SEC(2011) 1246 final of 12 October 2011. This document is currently discussed within the Council Security Committee and will serve the basis for the Committee's concrete recommendations for SST data policy.

9 http://ec.europa.eu/enterprise/newsroom/cf/itemlongdetail.cfm?lang=fr&item_id=3749.

10 http://ec.europa.eu/enterprise/newsroom/cf/itemdetail.cfm?item_id=5307&tpa=141&tk=&lang=en

Two studies carried out by external contractors in 2010 (Ecorys) and end 2010/beginning of 2011 (Booz & Company) provided input alongside other sources to the preparation of this impact assessment[11]. The Ecorys study underlined that EU action in space situational

[11] "Study on the EU Space Programme 2014-2020", Ecorys, Draft Final Report, 18 April 2010, contract n. SI2.541751.

awareness should be given priority to any future EU action in space going beyond Galileo and Copernicus. The Booz & Company study provided valuable qualitative and quantitative input to refine the problem definition related to the protection of European space infrastructure and critical ground infrastructure, and helped defining policy options and their impacts.

Furthermore, the definition of the various policy options and their effect relies also heavily on ESA expertise. In the framework of its ongoing SSA preparatory programme, ESA conducted a number of technical studies to define SSA system requirements which led to useful preliminary indications concerning the assets needed in order to respond to civil user requirements defined in 2010 in collaboration with potential SSA user communities and ESA Member States[12].

1.4. Scrutiny by the Commission Impact Assessment Board

The Impact Assessment Board of the European Commission assessed a draft version of the present impact assessment and issued its opinion on 20/04/2012. The Impact Assessment Board made several recommendations and, in the light of the latter, the final impact assessment report:

- Describes in a clearer way the problems that need to be addressed, the nature and scope of the initiative proposed to address these problems, the current situation with regard to space surveillance and tracking activities in Europe (including an overview of existing SST relevant assets owned by EU Member States) and elsewhere, and explains what other long-term mitigation measures exist at international or multilateral level.

- Strengthens the baseline scenario by describing in more detail how the situation is expected to evolve in absence of any EU initiative in the SST domain, including cooperation amongst Member States, and why the baseline scenario would leave the problems unchanged. It also clarifies the value-added of EU action in SST.

- Describes more clearly and in a more structured way the policy options proposed, their differences in terms of governance, data policy, the difference in performance of the services provided, the new SST assets needed to achieve the targeted service performance level, and the related funding needs. A new chapter has been added to explain the position and views of stakeholders on the options set out in the report. Two tables have been added to facilitate the comparison between the options.

- Assesses in more detail the impacts of the options, in particular the expected economic and social impacts (by looking in particular into impacts on citizen's health and security).

The Impact Assessment Board issued a second opinion on the re-submitted impact assessment report on 20 June 2012 (written procedure). In response, the report was further amended to take into account the last remaining recommendations:

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12 ESA SSA Mission Requirements Document (SS-MRD) Revision 3; final version as presented to the ESA SSA Programme Board in its meeting on 2 May 2011.

- The impact analysis chapter describes in more detail how the proposed governance of the European SST service will address concerns related to the relationship between Member States involved in the SST service provision and those benefiting from the service.

- As concerns funding aspects, the report better explains that the performance of the planned SST service is incremental and that risks related to budgetary constraints at EU and Member States level could be offset by down-scaling the system, for example in terms of sensors to be included in the sensor function of the system, or in terms of new sensors to be developed by Member States. Financial contributions from both the public and private sector in form of service fees could be envisaged at a later stage.

- The analysis of the safety impacts of all options has been strengthened. Option 3 has been identified as the preferred option in terms of effectiveness, efficiency and coherence with Member States' political will and with other EU policies.

2. CONTEXT

The Commission's Communication "Towards a space strategy for the European Union that benefits its citizens" adopted in April 2011 defines priorities for the future involvement of the EU in space and sets out options for EU action. With relevance to this impact assessment it underlines that:

(1) Space infrastructure is critical infrastructure on which services that are essential to the smooth running of our societies and economies as well as our citizens's security depend. The protection of this infrastructure was underlined as a major issue for the EU going beyond the individual interests of individual satellite owners;

(2) In view of ensuring such protection, it underlines that the Union should define the organisation and governance of a European Space Situational Awareness (SSA) system taking into account its dual nature and the need to ensure its sustainable exploitation as highlighted in the Industrial Policy Communication adopted in October 2010.[13]

The need for European action in the domain of SSA has been supported by Member States in several Council Resolutions and orientations on the European Space Policy (ESP) jointly adopted by the EU and the European Space Agency (ESA) at the 4th, 5th, 6th, 7th and 8th Space Council meetings held in 2007, 2008 and 2009, 2010 and 2011as well in EU Council conclusions adopted on 31 May 2011. These views are also shared by the European Parliament in its report on the space strategy for the EU adopted on 30 November 2011[14].

If the policy choice leads to EU intervention, this impact issessment (IA) will accompany a proposal establishing a space surveillance and tracking support programme supporting the

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[13] Commission Communication "An integrated industrial policy for the globalisation era – putting competitiveness and sustainability at centre stage", COM(2010) 614 final of 27.10.2010

[14] For references to the Space Council and EU Council (competitiveness) Resolutions and Conclusions see footnote 2. On 30 November 2011, the European Parliament adopted a report on the Commission's on a a space strategy for the European Union that benefits its citizens (2011/2148(INI)).

setting up and operation of a European service to prevent collisions in space and monitor uncontrolled re-entry of spacecraft or parts thereof, which could come into force during the next

EU Multiannual Financial Framework from 2014-2020. This service will provide alerts to satellite operators and public authorities to avoid collision during launch, in-orbit operations, and will also inform relevant authorities of any potential danger for citizens and ground infrastructure derived from uncontrolled re-entries of inactive spacecraft or their debris into the Earth's atmosphere.

This initiative builds on past achievements in space research under the R&D framework programmes. It is also closely linked to two other European space flagship projects (Galileo and Copernicus) and will benefit other EU policies such as security and defence, environment or health.

3. PROBLEM DEFINITION

3.1. The problems that require action

3.1.1. Security of critical European space infrastructure is not ensured

Space-based systems enable a wide spectrum of applications which play a fundamental role in our everyday reality (TV, Internet or GPS), are critical to key areas of the economy, and help ensuring our security[15].

Space infrastructures and derived services as well as space research have also become critical for the implementation of EU policies[16], such as transport, environment, climate change, maritime policies, development, agriculture, security related policies including the CFSP/CSDP, as well as the furthering of technical progress and industrial innovation and competitiveness.

With increasing dependance on space-based services, the ability to protect space assets and infrastructures has become essential to our society. Any shutdown of even a part of the space infrastructure could have significant consequences for citizens' safety and for the well-functioning of economic activities, and would impair the organisation of emergency services[17].

With Galileo and EGNOS, the EU itself has become owner of a growing fleet of satellites with related ground based infrastructure. Furthermore, the EU is responsible for the overall coordination of the ongoing GMES Initial Operations Programme including its satellite segment and can be expected to continue to have such role in the future. Thus, the EU will soon become one of the largest satellite operators in Europe.

However, space infrastructures are increasingly threatened by the risk of collision between sapcecraft and, more importantly, between spacecraft and space debris. Space debris has become the most serious threat to the sustainability of space activities.

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15 As regards space applications: GPS, Internet services routed by satellite, TV broadcast by satellite. For examples of spin-offs from Space R&D activities to applications used in everyday life, consult http://www.esa.int/esaCP/GGGIPLH3KCC_Improving_0.html http://www.sti.nasa.gov/tto/Spinoff2009/pdf/spinoff2009.pdf

16 Applications from Earth observation, navigation and telecommunication satellites are important for issues such as transport, agriculture, fishery, science, environment, health and security.

17 For example, communication systems, electrical power grids, and financial networks all rely on satellite timing for synchronisation. The provision of satellite-based rapid mapping services is indispensible for today's crisis management.

In order to mitigate the risk of collision it is necessary to indentify and monitor satellites and space debris, cataloguing their positions, and tracking their movements (trajectory) when a potential risk of collision has been identified so that satellite operators can be alerted to move their satellites. This activity is known as space surveillance and tracking (SST).

A SST service comprises three basic functions:

– Sensor function, which through a network of instruments such as radars and telescopes allows to identify and track spacecraft and debris;

– Processing function, through which the relative orbit of spacecraft and debris can be catalogued and analysed to determine the probability of collision or to determine the re-entry path of space objects;

– Front desk function, which is responsible for the actual provision of the SST services (such as collision or re-entry alerts) to satellite operators and relevant authorities. At the same time, the front desk will be the entry point for user requests for SST information which it relays to the processing and sensor function.

It should be noted that SST is a dual-use activity which can serve both civil and military user communities. Both civil and military sensors can be used to provide SST services that respond to both civil and military user needs[18] - which are to a large degree identical.

Surveillance and tracking information is highly security-sensitive. Uncontrolled dissemination of SST information (revealing for example the existance and position of a sensitive military satellite) could jeopardise national security interests. Cooperation amongst actors within Europe (Member States, ESA and EU entities) requires a data policy and a governance that takes into account these national security concerns. It was for this reason, that Member States through the Space Council turned to the EU with the request to play an active role in the development of an SSA capability at European level, and to define its governance scheme and its data policy.

The fact is that Europe has today no SST service: existing sensors do not have adequate capacity to identify and track objects in space, they are not linked so that they can be used as a network, there is no adequate processing capacity in place and there is no front desk function.

3.1.1.1. Current situation in Europe

The **current situation in Europe** with regard to surveillance and tracking can be described as follows:

Sensor function

– The **French** space agency CNES and the French Army own radars and telescopes that can survey/observe space objects in the low earth orbit region up to 2000 km used for Earth Observation satellites such as the future Copernicus/GMES sentinels (GRAVES system) as

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[18] Common civil and military SSA user requirements have been set out in the document "European Space Situational Awareness high-level civil-military user requirements" jointly prepared by the European Commission services and the European External Action Service (EEAS), SEC (2011) 1247 of 12.10.2011 and approved by the Council's Political and Security Committee (PSC) in its plenary meeting on 18 November 2011.

well as to survey higher orbits used mainly for navigation satellites such as Galileo or communication satellites (TAROT telescope). **UK**'s Chilbolton meteorological radar allows to survey space objects in low earth orbit; its Starbrook optical telescope is designed for surveying higher orbits. **Germany** owns radars that would allow to track and characterise specific space objects both in lower and higher orbits (TIRA and Effelsberg radiotelescope). **Spain's** optical observatory in La Sagra could support space surveillance activities. **Italy's** Croce del Nord radiotelescope and antenna could support tracking activities. In addition some R&D, design and pre-development activities have been carried out in the framework of the ESA "SSA preparatory programme"; these include the development of two demonstrator SST radars. **All of these existing sensors have significant shortcomings. Some were developed developed during the 1960s or 1970s for military purposes such as horizon monitoring in view of potential launches of ballistic missiles. Some were developped for research purposes. Most need substantial refurbishing and upgrading to become operational and others are too limited in operational availability despite potential high technical performance. None of them operate as a network and even if they would their combined capacity would not be sufficient to deliver a significant collision risk reduction.**

Processing function

– France and Germany have set up operational national centres for surveillance and tracking that allow for analysis of collision and re-entry risks. There is an early stage of European cooperation and sharing of data as exemplified by the Fanco-German cooperation in the operation of the French GRAVES surveillance radar and the German TIRA tracking radar, or the coordinated cooperation of the ESA optical surveillance telescope at Tenerife and the Swiss ZIMLAT telescope at Zimmerwald. These initiatives are the result of the discussion on future development of a European SST service. **However, no broader cooperation among Member States emerged from these bilateral cooperation arrangements. They also did not lead to the provision of operational SST services available to satellite operators in Europe**.

Front desk function

– There is no SST front desk function.

3.1.1.2. Situation at international level

The overall situation of SST services at international level is the following:

– While all major space faring nations have their own SSA systems to some extent, there is currently **no operational global system for space surveillance and tracking**. However, the USA has today the most extended sensor network, processing capacity and provides alerts (front desk). The US SST system is owned and operated by the US Air Force. **Most public and commercial satellite operators in Europe depend today on collision alerts provided by the US SST. However, these alerts often require verification and refinement through further analysis by the spacecraft operator to avoid risky or unnecessary mitigation measures** (collision avoidance manoeuvres). **US SST information is not accurate enough and it could not prevent a major catastrophe in**

terms of debris creation which was the collision between two satellites in 2009[19]. In view of this and given that not all Member States and satellite operators have the capacity to carry out the verification of US SST alerts, unnecessary anticollision maneuvers are often required as a precaution.

– The US system which has been operational since the 1960's is aging. Therefore, in its space policy issued in June 2010[20], the US recognised that its system requires updating and refurbishing to address the increasing need for SST information. As this requires substantial investments, **the US signalled openness to stengthen international cooperation in this domain with actors that can actively contribute to improve the quality of SST information**. **The setting up of a European SST capability would allow the EU to collaborate with and influence developments in the US as an equal partner with a view to mutually enhancing SST performance**.

– Russia, China, Japan and India have surveillance systems with limited geographical coverage and undisclosed performance capacity. Russia and China are known to work on strengthening their capacities. However, none of these systems are today open to cooperation with other space-faring nations[21].

3.1.1.3. Other actions to mitigate collision risks

In addition to avoidance manoeuvers there are other complementary measures that can be undertaken to mitigate the increasing risk of collision or the consequences of collisions:

– **Protecting satellites**: Satellites can be hardened or shielded against the impact of space debris. Research activities in this domain are ongoing. However, even the most state of the art hardening or shielding technologies cannot prevent satellites from being damaged from space debris;

– **Removal of space debris**: Research and development efforts also focus on technologies to remove space debris. However, work in this domain is at a very early stage, and it is generally accepted that debris removal can only be an effective solution in decades to come and cannot be expected to resolve the problem at hand;

– **Prevent the creation of space debris**: The international community widely recognises the proliferation of space debris as the current biggest threat to the sustainability of space activities. There are several initiatives seeking to ensure the commitment of space-faring nations to reducing the production of space debris when conducting space activities through international instruments (see annex IV). The International Space Code of Conduct proposed by the EU currently under negotiation has received so far wide international support. However, important as these instruments may be if their provisions are

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19 Since the 2009 Cosmos-Iridium, satellite collision which the US system did not detect in time, there has been an increased push in the U.S. to strengthen its capability for conjunction analysis — e.g. the ability to accurately predict high-speed collisions between two orbiting objects. A new Space Fence, currently under development, is expected to cost more than 1 billion US$ to design and procure. The system, with a target completion date of 2015, will likely include a series of S-band radars in at least three separate locations; Space Security 2011Report (complement reference)

20 United States of America, National Space Policy, 28 June 2010

21 This analysis relies on the study carried out by Booz & Company which provides a broad overview of SSA systems in space faring nations.

implemented, they will not eliminate the problem that existing and future debris pose, they will just reduce the exponential growth of space debris in the future[22].

Therefore the most viable way for spacecraft operators to mitigate collision risks is today to undertake collision avoidance manoeuvres.

3.1.2. Increased collision risks due to space debris

During the past half century objects have been launched into space regularly, reaching a peak of 140 items per year during the Cold War. Every time a launch vehicle boosts a satellite into space, some debris is produced. Examples of space debris are: discarded rocket bodies, fuel tanks, satellite components, non-functional satellites and debris from collisions and explosions[23]. This material, orbiting the Earth at very high speed and in an uncontrolled manner, poses an ever increasing potential risk for the launch of spacecrafts and of their exploitation due to collision with other debris or other spacecrafts in orbit.

As a result of the current limitations of space surveillance systems, a large proportion of the overall population of the debris population is neither tracked or catalogued and is estimated by using mathematical models with different results. According to latest estimates, there are 16 000 objects orbiting Earth larger than 10 cm, which are catalogued and between 300 000 and 600 000 objects larger than 1 cm, not catalogued. According to ESA, the population of objects larger than 1 cm will continue to grow, and will reach a total of approximately 1 million debris in 2020. Furthermore, it is estimated that there are more than 300 million objects larger than 1 mm[24].

The vast majority of these space objects are not in deep space, but in the commercially most exploitable areas of the outer space region. These include the Geostationary Earth Orbit (GEO) at 36 000 km altitude which is mainly used for satellite telecommunications (and EGNOS), the Medium Earth Orbit (MEO) at around 20 000 km altitude where all satellite navigation constellations orbit including the Galileo satellites, and the Low Earth Orbit (LEO) (from around 600 to more than 2 000 km altitude) that is mostly used for Earth Observation satellites such as the future European Copernicus/GMES satellites.

At a speed of 10 km/s, space objects can cause serious harm to operational spacecraft, from total destruction (which would inevitably be the consequence of a collision with a space object larger than 10 cm) to permanent damage to sub-systems or instruments on-board spacecraft (which will be the minimum impact of a collision with a space object larger than 1 cm).

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22 According to UN and NASA research, space debris will continue to grow, even if all activities in space would be stopped. Source: Ecorys study which quotes NASA researcher Donald Kessler: "The future debris environment will be dominated by fragments resulting from random collisions between objects in orbit, and that environment will continue to increase, even if we do not launch any new objects into orbit."

23 On February 11 2009 about 800 pieces of debris were generated by a collision between a US and a defunct Russian satellite. A similar number of debris was generated by a Chinese anti-satellite test in 2007. Such 'accidents' can generate a chain reaction that would destroy most satellites in a given orbit, knowing that the speed of a satellite and debris is 10 km/second.

24 “Study on the EU Space Programme 2014-2020”, Ecorys, Draft Final Report, 18 April 2010, contract n. SI2.541751 and Study "evaluation of options for a space programme in 2014-2020", Booz & Company., Final report, 16 May 2011, contract n. ENTR/2009/050 lot 1.

The table below provides a synthesis of NASA, ESA and Booz & Company estimates on debris and possible damage to satellites.

Category	Definition	Estimated population	Potential risk to satellites
Traceable	Greater than 10 cm in diameter	16,000 catalogued; 20,000 in total	Complete destruction
Potentially Traceable	Greater than 1 cm in diameter	up to 600,000	Complete to partial destruction
Untraceable	Between 1 mm and 1 cm	More than 300 million	Degradation, loss of certain sensors or subsystems

Table 1 – NASA, ESA and Booz & Company estimates on debris and possible damage to satellites[25].

According to data analysed by Booz & Company, approximtely 950 active satellites were orbiting the Earth in January 2011 as well as a handful of additional spacecrafts such the International Space Station (ISS) or vehicles to ferry to and from the space station. More than 19 % of the active satellites are of European origin.

A particular and increasing source of concern is the LEO region where the satellites of the European Copernicus programme will be. For this region, NASA modelling estimates a risk of 8-9 collisions between catalogued objects over the next 40 years (that means one collision every 5 years). Approximately 50% of these collisions are predicted to lead to the complete distruction of the satellite[26]. This view is commonly accepted and shared by UK analyses as well as by experts of the French space agency CNES [27].

The collision risk with partially traceable space debris (between 1 cm and 10 cm), is estimated at 1 every 3 years[28]. Collision with space debris of this size is likely to lead to a complete or partial loss of the satellite.

In addition, taking into account debris smaller than 1 cm and under the same assumptions made above, the risk of collision with a satellite could rise drastically up to 500 every 3 years (i.e. around 170 per year). This kind of collisions may lead just to minor failures which, nonetheless, can have the effect of shortening the lifetime of a satellite[29].

Booz & Company, taking the lowest risk assumption of 1 collision every 3 years for partically catalogued debris globally in LEO as a basis, estimated Europe's economic risk in the LEO region at a minimum indicative of 2.5 M€ per year over the next decade[30]. This estimte takes

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25 http://www.esa.int/esaMI/Space_Debris/SEM2D7WX3RF_0.html.

26 NASA Orbital Debris, Quarterly News, Vol. 14, issue of January 2010.

27 http://www.parliament.uk/documents/documents/upload/postpn355.pdf.

28 2011 Study of Booz & Co.

29 The satellite Jason 1 was hit twice by untracked small debris (2002 and 2005) leading to minor failures. CNES, Presentation "French Policy for Space Sustainability" at the ISU Symposium, 21st February 2012

30 The Booz & Company estimates are based on the following assumptions (see also annex V): Average satellite manufacturing costs are around 99 Million €; a launch to LEO costs indicatively 8 Million €

per satellite; the satellite loss will occur in the middle of its lifetime; economic damage due to service outage has been calculated on the assumption that the replacement of the satellite could lead to 3 month service outage (rather conservative scenario) and data available concerning the global market for Earth observation data sales and mobile satellite services which can be considered to be the most common satellites in LEO.

into account the satellite's destruction and the income shortfall generated by a 3 month service outage following the destruction.

Nonetheless, these estimates - already defined as conservative by their authors - do not take into account the consequences over the long term of collisions with debris smaller than 1 cm.

Geographical scope	**Satellites in LEO**	**Satellite Loss probability (years)**	**Potential Satellite Losses (10 years)**	**Indicative economic damage (10 years in Mln Euro)**		**Annualized Economic damage (Mln Euro)**
				Asset	**Service Outage**	
Global	470	~1 every 3 years	3 satellites	~ 150 to 180	~ 5 to 6	~ 15 Million Euro
Europe	68[31]	~1 every 20 years	0.5 satellite	~ 25	~ 1	~ 2.5 Million Euro

Table 2: European and global economic risk of debris in LEO; source: Booz & Company

3.1.3. Collision avoidance manoeuvres shorten the lifetime of satellites

As collision risks for potentially traceable or untraceable debris is difficult to predict, satellite operators tend to carry out avoidance manoeuvres on the basis of alerts of close approaches of space debris. Modelling work at global level has suggested that close approaches will rise from 13,000 a week in 2009 to 20,000 by 2019 and more than 50,000 by 2059, meaning satellite operators will have to make four times as many avoidance manoeuvres in 2059 as in 2019.

As stated above, space agencies in Europe as well as ESA rely on automated conjunction assessments and alerts from the US SST system. On this basis the French space agency CNES, for example, perfoms its own estimates and analysis, where necessary complemented by measures from its own surveillance and tracking system GRAVES, and performs a collision avoidance manoeuvre in case of elevated risks.

For the year 2010, CNES, operating a fleet of 17 satellites in LEO, reports almost 1 conjunction assessment risk per day, and 1 collision alert on average every 4 days. To mitigate collision risks it had to perform more than 1 collision avoidance manouvre per month.

Similar evidence is given by ESA sources and the German space agency DLR. In 2010, ESA had on average 16 conjunction risks per satellite[32] and performed on average 3 collision

[31] 68 European satellites out of a total of 470 globally in LEO. Being the number of European satellites one seventh of the total number, the probability of an impact for them is considered as seven times less than the total.

[32] Using the ESA operated Envisat, ERS-1 and ERS-2 satellites as a reference

avoidance manoeuvres per satellite. DLR reports more than 2 conjuction asessment risks per satellite and performed 1 collision avoidance manoeuvre per satellite a year[33].

Combined data from CNES, the German space agency DLR and ESA suggest 1.5 collision avoidance manoeuvres per satellite per year in LEO. Considering that around 14% of the 470 satellites in LEO are European, this would imply around 100 collision avoidance manoeuvres per year in LEO perfomed by European satellite operators or EU Member States space agencies.

Collision risk avoidance manoeuvres are also a problem in the GEO region, not necessarily related to the need to avoid collision with debris, but due to the quantity of satellites in this very confined area of outer space. Stakeholder interviews carried out by Booz & Company revealed that an average GEO satellite operator with a fleet of 20 satellites performs up to 50 collision avoidance manoeuvres per year.

Each avoidance manoeuvre requires fuel, which shortens the active life of satellites, or requires additional fuel to be carried into orbit thus increasing the cost of launch[34]. Furthermore, due to the inaccuracy of data related to the position of the objects in question, it can be assumed that a good number of manoeuvres may not be indispensible but have to be made as a precaution generating extra costs.

The table below shows the estimated annualised costs of collision avoidance manoeuvres which result in the shortening of satellites' lifetime. The table also indicates the costs linked to the interruption of Earth observation data collection and distribution which occurs during avoidance maneouvers of Earth observation satellites in LEO[35] [36]:

Europe	**Collision Avoidance (yearly)**	**Impact over time (10 years)**	**Indicative economic effect (10 years)**	**Annualized economic effect**
Total 68 satellites in LEO	~ 90[37]	Life time shortening ~ 2900 weeks	~ 1.2 billion Euro	~ 120 Million Euro
32 satellites in LEO are Earth Observation satellite	~ 45	Days of EO loss of data ~ 450 days	~ 8 Million Euro	~ 0,8 Million Euro
~ 120 satellites in GEO	~ 25[38]	Life time shortening ~ 700-750 weeks	~ 150 – 200 million Euro	~ 15-20 Million Euro

Table 3 – Annualised costs of collision avoidance manoeuvres in LEO and GEO[39].

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33 Using the DLR operated TerraSAR-X, TanDEM-X, GRACE 1 and GRACE 2 as a reference.

34 http://www.parliament.uk/documents/documents/upload/postpn355.pdf.

35 In general, there is no interruption of services during avoidance manoeuvres for satellites in GEO.

36 Detailed rationale and calculations can be found in the annex V "Calculation methodology" or at page 123 to 125 of the Booz & C. report

37 Not all (but 90 % of) avoidance manoeuvres in LEO lead to a significant consumption of propellant. Therefore, Booz & Company calculated the annualised economic effects of collision avoidance manoeuvres on the basis of 90 manoeuvres per year instead of 100.

38 Only 10 % of the avoidance manoeuvres in GEO lead to a significant consumption of propellant (e.g. only in case of large fly-bys). Therefore, Booz & Company calculated the annualised economic effects of collision avoidance manoeuvres on the basis of 25 manoeuvres per year instead of 250.

39 Source: Booz & Company

Accurate, timely and complete space surveillance and tracking information is instrumental for the protection of critical European infrastructures in space and for the secure and safe operation of space-based services, as well as for the protection of the population in case of re-entry events[40].

3.1.4. Re-entry of debris or uncontrolled spacecraft to Earth threaten the security of EU citizens

Re-entries of spacecraft and debris to Earth form an increasing hazard for the security of the Earth population. Whilst active spacecraft re-entries into the dense layers of the atmosphere are controlled (e.g. the US space shuttle, the Russian Soyuz, and the European Automated Transfer Vehicle), inactive satellites and debris regularly re-enter the atmosphere in an uncontrolled manner. These uncontrolled re-entries account for more than 90% of all re-entries[41].

According to the Aerospace Corporation Center for Orbital Debris studies, since the beginning of space activities in 1957, more than 20,000 catalogued objects re-entered the atmosphere, equivalent to more than one object per day on average[42]. However, most debris have hit the Earth far from inhabited areas due to the fact that 75% of the Earth surface is covered with water and only 25% of the Earth's land mass is inhabited.

Nevertheless, the ability to predit the trajectory of an object (which is highly dependant on the survey and tracking capability of a space surveillance system) is essential to mitigate risks related to re-entries. In controlled re-entry situations, this may include the evacuation of a certain area of the ocean by stopping air and sea traffic or boosting a spacecraft to remain on trajectory to a defined impact footprint. In uncontrolled re-entry situations, trajectory information is vital to alert local authorities of the impact assessment, or to take in extreme cases measures such as the US shooting of a missile in February 2008 to destroy their own military satellite.

According to Booz & Company a total of 27 space debris have been found on the ground and identified. Except for a few lightweight debris, the mass of these identified debris vary from 10 kg to a maximum of 270 kg. Debris are estimated to hit the ground at a speed of 30 km/h for lightweight debris and up to 300 km/h for the heaviest ones. Fortunately, in the last 20 years the damages to property caused by debris hitting the Earth have been marginal and no casualties have occurred.

However, uncontrolled re-entries can become a particularly serious hazard to citizens' security and health when they involve nuclear powered satellites. The most dangerous un-controlled re-entry in the history of space missions in terms of the actual damages caused on Earth occurred in January 1978, when the former USSR military nuclear powered satellite Cosmos 954 hit the Canadian territory. When impacting with the denser layers of the atmosphere the satellite broke up and a large number of radioactive debris crashed on the Canadian regions of Northwest Territories, Alberta and Saskatchewan. Almost all debris found of the ground were radioactive, some of it proved to be of lethal radioactivity. The Canadian authorities in charge

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[40] There could be significant negative economic, environmental and social impact generated if debris from spacecraft fall on the surface of the Earth, notably if the spacecraft are powered by nuclear fuel, as is the case with a small number of them today.

[41] Aerospace Corporation, Center for Orbital Debris Studies

[42] US Stratcom Fact Sheet Re-entry Assessment, February 2008

of locating, recovering and cleaning-up the affected areas performed these activities in two phases over 8 months. The total cost of these activities incurred by various Canadian departments and agencies was reported at $ 13.970.000 (at 1978 economic conditions). A few dozens of nuclear powered satellites of similar design remain in orbit.[43]

Examples of unctrolled re-entries over the past 15 years compiled by Booz & Company[44] illustrate the risks. Three of the cases shown concern debris from European origin:

Date	Debris and event characteristics	Source of debris	Country of origin
Jan 1997	A lightweight fragment of a debris (10 x 13 cm) grazed the shoulder of Mrs. L. Williams, whilst walking in Turley, Oklahoma, USA	Probably originating from a 2nd stage of a Delta II launcher	USA
April 2000	A 270 Kg debris was found 20 km from the nuclear power plant of Koeberg, South Africa	2nd stage of Delta II launcher	USA
Jan 2001	A 70 kg debris was found 1km from the motorway linking Riyadh to the city of Taef in Saudi Arabia	Rocket motor of Delta II launcher	USA
March 2002	A 49 kg debris landed in a house in Kasambya, Uganda	3rd stage of Ariane 3 launcher	Europe
August 2002	A 10 Kg debris landed near the village of Manzau, Angola	3rd stage of Ariane 4 launcher	Europe
March 2008	A 10 kg debris landed on a farm in Montividiu, Brazil	Probably from Atlas V launcher	USA
Sept 2011	The UARS (Upper Atmosphere Research Satellite) breaks apart and lands in the Pacific Ocean far off the U.S. coast. Twenty-six satellite components, weighing a total of about 1,200 pounds, could have survived the re-entry and reach the surface of Earth.	The US NASA owned UARS (about 12 by 5 meters) was among the largest spacecraft to re-enter Earth's atmosphere and make an uncontrolled descent.	USA
October 2011	Satellite weighing 1.7 tons re-enters the atmosphere over the Bay of Bengal; not clear whether space debris reached the Earth's surface and no damage to property has been reported.	German DLR owned X-Ray Observatory satellite ROSAT	Europe
December 2011	Re-entry with fireball observed above Belgium, the Netherlands, France and Germany; no damage reported;	Third stage of the Soyuz rocket that transported the Dutch astronaut André Kuipers to the ISS.	Russia
January 2012	The Russian Marsian probe Phobos-Grunt threatens to re-enter the Earth's atmosphere over Europe;	Satellite experiencing failure during the launch phase	Russia

Table 4: Examples of debris hitting land in dangerous circumstances; source: Booz & Company

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43 Booz and Company and HTTP://WWW.SPACE4PEACE.ORG/IANUS/NPSM3.HTM

44 The non-comprehensive list of examples provided by Booz and Company were updated with recent re-entry examples; sources include: www.dlr.de; http://earthsky.org/space/where-will-nasas-uars-satellite-land; http://news.discovery.com/space/santa-soyuz-reentry-europe-sighting-111226.html

With increasing population of satellites in orbit, the number of uncontrolled re-entry events can be assumed to increase over the coming years. Over the past 12 months, over fourty satellites and upper stages of launchers have re-entered the atmosphere[45] and in the last 6

45 Aerospace Corporation, Centre for Orbital Debris Studies, http://reentrynews.aero.org/past.html

months the US STRATCOM system issued three re-entry alerts: one for the US satellite UARS, another for the German ROSAT satellite and the third for the Russian Mars mission Phobos-Grunt. The three "threatening" probes eventually fell safely in the seas.

While there is no doubt about the serious risks posed by uncontrolled re-entries, it is not possible to estimate the annualised losses that they may cause. This is because, among other considerations, it is not possible to establish a statistic risk of uncontrolled re-entry and it is also not possible to predict whether the re-entry, if it happens, will cause or not damage on the ground.

3.1.5. Overview of estimated annualised losses due to hazards from space debris:

Section 3.1.2 estimates the annaulised economic impact for Europe resulting from collision risks due to space debris. Section 3.1.3 estimates the annalised economic impact of collision avoidance manoeuvres. The table below brings together these figures[46].

The table also includes an estimation of the possible annualised economic loss in light of the future evolution of satellite market growth. According to Euroconsult[47], the satellite industry launched an average of 76 satellites per year over the last ten years, ranging between 60 and 90 units per year. Since the market is expected to grow by 50% in the coming decade, with a total of 1,145 satellites to be built for launch over 2011-2020, the launch rate for satellites will increase approximately at the same level.

The table below gives only a non-exhaustive overview of quantifiable estimated losses[48]. As indicated above, it is not possible to estimate the annualised losses provoked by un-controlled re-entries.

Loss type	**Annualised loss**	
	Actual	**Actual + growth forecast (+50 %)**
Direct loss of satellite due to collision	~€ 2.5 Million	~€ 3,75 Million
Life-time shortening of satellites in LEO due to collision avoidance	~€ 120 Million	~€ 180 Million
Loss of Earth Observation data in LEO due to collision avoidance manouevres	~€ 0.8 Million	~€ 1,2 Million
Life time shortening in GEO due to collision avoidance manouevres	~€ 15-20 Million	~€ 22,5 -30 Million
Total minimum annualised loss	**~€ 140 Million**	**~€ 210 Million**

Table 5 – Estimated loss due to space debris.

46 The calculation is explained in detail in annex V and is based on the estimated annual revenue of Earth Observation Satellites and the risk of destruction of a European EO satellite.

47 Satellites to be Built & Launched by 2020

48 Detailed explanation in the annex "Calculation Methodology".

These costs are almost certainly just a small fraction of possible non-quantified costs and, to some extent, the non-quantifiable consequences that may result from the absence of a European space surveillance and tracking capability. For example the loss of a satellite may result in the loss of critical satellite communication capacity in an emergency situation resulting in loss of life. Destruction or complete failure of a satellite can result in serious disruption of economic activity (banking relies increasingly on satellite communications) and could have an impact on client business through loss of service. The loss of Earth observation capacity could also have serious consequences in emergency and non-emergency situations.

3.2. Underlying policy considerations regarding the problem and the design of the solutions

From discussions with stakeholders over the past years, it became clear that the setting up of operational European SST services will require the intervention of the EU.

3.2.1. SST development must be led by the EU

There is a consensus among EU and ESA Ministers responsible for space that the development of this service is to be led by the EU and not by the European Space Agency. This consensus is reflected in several Space Council Resolutions mentioned in the impact assessment. In particular, Member States asked the EU to define the governance and data policy for a European SST service, to play an active role in the setting up of the European service, and to make best use of sensors and expertise that already exists at national and European level. Member States were also very explicit as to how security concerns should be taken into account: SST sensors need to remain under national control. Confidentiality of SST information was defined as the key principle for the SST data policy (e.g. all information is to be classified, to be declassified on a case by case basis only).

The reason for such position is not formally recorded but emerged in numerous discussions: European SST service has a security dimension (it allows gathering intelligence on States' civil and military space infrastructure and operations) which the EU, unlike ESA, has competence and is equipped to deal with. The TFEU grants the EU competence to coordinate the exploitation of space activities and the TEU confers the EU competence over security issues such as those that arise in the context of SST. The EU has the necessary legislative capacity to put in place governance mechanisms and a data policy for SST.

ESA, on the other hand, is a world-class R&D agency designed to define and implement scientific, technology and space application development programmes. ESA is neither conceived to do the sort of complex policy and legislative work necessary to set up an SST system where assets are largely in the hands of the military, nor has it been designed to operate space-based services (a fact which ESA itself underlines in its policy documents).

Arguably, Member States could set up a new organisation to deal with SSA. Such organisation would have to have many of the features that the EU already has. Therefore such new organisation would generate duplications and inefficiency. In addition, some Member States have expressed concerns that any solution outside the EU framework may be dominated by those Member States that already possess today some sensor capacity preventing others from developping their own in the framework of a truly European service.

3.2.2. Future SST must build on exisitng assets and completed with new ones

There is a consensus among Member States and experts that any SST development should capitalise and build on existing assets which should be linked and operated as a network. There is also convergence regarding the fact that current assets are insufficient to ensure a minimum desirable level of performance. To reach this minimum desirable level of performance new assets need to be built and integrated in an SST system. These assets are primarily sensors such as tracking and surveillance radars and telescopes.

3.2.3. Governance: assets must remain under the control of Member States

Over the years-long discussion regarding the setting up of a European SST service, Member States possessing assets have insisted on one crucial governance aspect: due to security concerns the sensor and processing functions must, in any scenario, remain under the control of the national competent authories (i.e. military authorities). The majority of Member States possesing assets support the idea of that, for the purpose of setting up a European SST service could form a consortium to run, Member States possessing existing or new assets should form consortium to run, as a network, both sensor and processing functions.

Member States are of the view that the fornt desk funcion should be run either by the consortium itself or by another body with adequate security credentials, such as the European Union Satellite Center[49].

3.2.4. Data policy: SST information is classified

Under any scenario, SST data policy must upheld the principle that information is by definition classified and it should only be declassified on a case by case basis when the need arises.

3.2.5. Funding

Member States are willing to make their assets available for the setting up of the European SST service. They are of the view that, in return, the development of the SST should involve EU funding and should, as a minimum, cover operations directly linked to the setting up of the European SST service. In addition to making their assets available, Member States are open to contributing to it financially.

Although the overall benefits from the proposed initiative are estimated to exceed the costs, SST services are mainly of a public and precautionary nature which do not lend themselves to commercial activity. While the introduction of a fee for both public and private/commercial SST service users could be considered at a later stage to cover operational costs, SST is not likely to be an activity to be started of through private/commercial actors. Furthermore, those Member States owning assets, for reasons of national security, would not collaborate with a commercial actor in this sensitive domain.

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[49] The European Union Satellite Center (EUSC) is an agency of the EU Council that currently provides geospatial imagery information services and products with various levels of classification to a variety of users, both civil and military, at the EU Council, the Commission and in EU Member States. EUSC services are based on data stemming from existing national public satellite systems, private/commercial systems, or systems owned by third countries or international organisations.

3.3. Who is affected, in what ways and to what extent?

The most affected groups include:

- **The EU, and more precisely the European Commission**, which is about to become a significant European operator of space-based infrastructure;

- **Public/government entities and administrations** with legal and policy responsibilities related to the management of public space activities and those responsible for space security issues;

- **Public (national, European) and private/commercial satellite operators** having the legal responsibility and effective control over operational or experimental satellites;

- **Launch companies** share the same concerns as the satellite operators for the launch of satellites or other spacecraft;

- Space **insurance companies** will need space surveillance data to improve their risk analysis and propose better tailored products;

- Public authorities and private/commercial entities **responsible for the operations of ground based infrastructures with a satellite or space-based infrastructure component** (such as financial transaction networks, telecom networks or energy supply networks);

- Public/governmental entities and administrations with legal and policy responsibilities for **civil protection** early warning, mitigation and response actions for situations where the re-entry of space objects into the Earth's atmosphere threatens the property and life of citizens or the security of critical ground infrastructure.

While the primary concern in setting up a European SST service lies with the categories outlined above, the service may also help international partners that do not possess such service. It has already been mentioned earlier how the development of a European SST system can be carried out in collaboration with the US.

3.4. Foreseen evolution of the problem

As previously described (section 3.1.5), the number of active satellites in orbit is deemed to increase by 50% in the next ten years. This would imply a simple raise of 50% of satellites in orbit only if the current operational satellites that will have reached their end-of-life in that laps of time will be discarded (de-orbited or re-orbited following debris mitigation guidelines). Taking into account the fact that this assumption seems quite optimistic and that, for example, additional launcher upper stages may be left in orbit after the launch of a satellite, it is clear that the orbits' crowding will keep growing, raising further the level of risks assessed in the previous sections.

Moreover, the number of tracked and catalogued objects in orbit has increased by 100 % over the last 20 years (from 8,000 to 16,000 in 2012). As there is no visible sign for this trend to be reduced, with current capabilities, the number of tracked and catalogued objects can be estimated to be around 32,000 by 2032. The level of risk can be expected to increase accordingly. The 2011 space security report states that although there were no major fragmentations (events creating space debris) in 2010, the number of catalogued objects increased by 800, mostly due to continued discovery and cataloguing of debris from major fragmentation events in 2007 and 2009. A significant number of debris will not reenter the Earth's athmosphere and disintregrate in a relatively short period of time due to the athmospheric drag and will remain a threat for decades and even centuries to operational satellites and thus to the long-term sustainability of space activities.[50]

3.5. EU right to act

Article 189 TFEU introduces a right for the EU to act in drawing up a European Space Policy, while building on past achievements at the level of ESA and Member States, and gives the European Commission a clear mandate to exercise its right of initiative. Space policy is defined as a shared competence between the EU and its Member States.

Under section 3.2 there is a detailed explanation of the reasons why the EU is asked to exercise its comptence in the specific domain of SST.

The EU does not seek to replace initiatives taken by Member States individually or in the framework of ESA. It seeks to complement actions taken at their level and reinforce coordination where such coordination is necessary to achieve common objectives.

The EU involvement would be necessary to aggregate the investment required to fund certain space projects, set in place governance arrangements, define a data policy and ensure that existing and future capacities are broguht to work in a coordianted and efficient manner ensuring a robust and interoperable system benefiting all relevant European stakeholders.

Furthermore, the proposed EU action does not seek to replace or duplicate existing mitigation measures at international or multi-lateral level, such as the UN guidelines for space debris mitigation or the EU proposal for an international Code of Conduct on outer space activities. These measures will not solve the problem at hand, but will reduce the growth of space debris in the long-term (see the detailed description of this measures in annex IV).

4. OBJECTIVES

4.1. General policy objectives

The general objective of the proposed initiative is to safeguard the long-term availability and security of European and national space infrastructures and services essential for the smooth running of Europe’s economies and societies and for European citizens’ security.

4.2. Specific policy objectives

More specifically, the initiative aims at increasing the EU’s capacity to:

– Reduce the risks related to the launch of European spacecrafts;

– Assess and reduce the risks to in-orbit operations of European spacecrafts in terms of collisions, and to enable spacecraft operators to more efficiently plan and carry out

[50] Space Security Report 2011

mitigation measures (e.g. more accurate collision avoidance manoeuvres; avoidance of unnecessary manoeuvres which are risky in itself and reduce a satellite's lifetime);

– Survey uncontrolled re-entries of spacecraft or their debris into the Earth's atmosphere and provide more accurate and efficient early warnings to national security and civil protection/disaster management administrations with the aim to reduce the potential risks to the security and health of European citizens and mitigate potential damage to critical terrestrial infrastructure.

4.3. Operational objectives

In order to realise the specific objectives, the continuous and sustainable provision of SST information to European and national public and private/commercial users needs to be ensured through:

– The setting up of an operational space surveillance and tracking capability at European level building on existing European and national assets and capable of intregrating future new assets as well as the implementation of an appropriate governance structure;

– The definition and implementation of data policy principles for the handling of SST information through the European SST capability;

– The definition and delivery of SST services open to all European and national public and private/commercial actors who need SST information; the services should respond to defined and agreed user requirements.

– Ensuring the necessary quality of SST services and their efficient and sustainable operational provision:

– Supervising the implementation and efficient functioning of the proposed operational SST capability and the operational SST services and by ensuring a sustainable EU funding contribution;

4.4. Consistency with other policies and objectives

The objectives are coherent with Member States political will expressed in Council conclusions as well as the objectives of the ongoing (and planned future) European GNSS programmes and the GMES initial operations programme which aim at ensuring the sustainable provision of European satellite navigation services or services for environment monitoring or in support of security related activities. They are also coherent with the objectives of space research activities carried under the current EU framework programme for research and development (FP7) as well as the planned Horizon 2020 programme. Furthermore, the proposed initiative's objectives are consistent with the objectives set in the EU's policy related to the protection of European critical infrastructure and the European Civil Protection Mechanism.

As concerns activities beyond the EU framework, the objectives of the proposed initiative are complementary with the ongoing ESA SSA preparatory programme as well as national SSA activities.

5. POLICY OPTIONS

This impact assessment identifies five options which - apart from the baseline scenario – seek to deliver the same output: establishing a European service to avoid collisions in space and monitor uncontrolled re-entries. However, they differ in terms of governance, funding and the degree of performance that the service can deliver.

The selection of the options is based on the following **considerations some of which have been outlined in previous sections and which can be summarised as follows**:

(1) European SST services should build on existing European and national assets and competences and would entail the development of additional ones;

(2) **SST capacity is incremental:** SST is an activity that can be developed in an incremental and modular way. New sensors or assets added to a European SST network can improve the system's overall performance and the quality of the data and information it provides**;**

(3) Without prejudice of on-going budgetary discussions**, funding for a European SST service would** come from redeployment of budget from existing programmes foreseen for the next MFF provided that such redeployment is compatible with the legal base of the proposed programmes[51];

(4) **No risk of cost-overruns:** SST performance is incremental and improvement of performance can be achieved with relatively (compared with other space programmes) modest investments. Any unlikely cost-overruns would be offset by down-scaling the system (for example with regard to number of sensors included in SST sensors function or new sensors to be developed by Member States), which can still guarantee enhanced performance compared with the current situation. In addition, to safeguard EU budget, EU funding provided under any of the options would take the form of fixed contributions;

(5) **Strengthened cooperation with US on SSA**: The US SST technology and architecture is old (with assets dating back to the 60ies) and needs modernising. As part of its space policy, the US has publicly stated its desire to collaborate internationally in this domain. Collaboration between the US and the EU could improve the accuracy and quality of SST overall and generate efficiency and savings. This two-way collaboration is obviously only possible in so far as the EU develops SST capacity of its own.

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[51] The Commission's proposal for the future EU budget under the **next Multiannual Financial Framework (MFF) 2014-2020 does not foresee a specific budget support to the setting up of operational European SST services**. As the protection of space infrastructure during launch and in-orbit operations is to be considered an integral part of the operator's responsibilities, the Commission's proposal for a Regulation on the implementation and exploitation of European satellite navigation systems (COM(2011) 814 final of 30.11.2011) includes provisions for a limited funding contribution to the proposed activity. Redeployment of budget under other possible future EU financing instruments could be examined. Taking into account this constraint, the EU funding contribution to a European SST activity would have to be limited.

(6) The performance of the service allows reducing the risk of collision by a certain factor; the potential economic loss caused by collision will be reduced by the same

factor. As options 2, 3 and 4 are variations of the same option and based on expert advice, the performance of the service proposed in these options **suggests a risk reduction by a factor of 3 to 5. Option 5 which proposes a more performing service suggests a risk reduction by a factor of 10**.

(7) Any enhancement of SST capacity will result in improved ability to predict and monitor uncontrolled re-entries but we can not establish a target for this. Therefore, the options are designed considering only the target reduction of collision risk.

FROM PROBLEM DEFINITION TO OPTIONS			
1. PROBLEM DEFINITION	**2. SOLUTION**	**3. POLICY CONSIDERATIONS AFFECTING THE DESIGN OF THE SOLUTION**	**4. THE DESIGN Of THE SOLUTION: THE OPTIONS**
Increasing number of sapcecraft and debris generate an increasing risk of collision. Collision can destroy or damage satellites. There is direct economic loss due to destruction or damage. There is indirect loss of revenue. There is unquantified indirect damage due to disruption of satellite service. Incraesing risk of uncontrolled re-entries that may cause damage on the ground. In Europe there is at present no adequate capacity to survey and track space objects and to alert stellite operators of the risk of collision. The capacity that exists allows to survey and track limited number of objects. The alerts given are inaccurate and often demand unecessary avoidance maneouvres that shorten the life of satellite. There is also no adequate capacity to monitor uncontrolled re-entries.	The baseline scenario would not make the problem go away, on the contrary it can only get worse. The problem cannot be solved through debris mitigation measures which can only prevent the problem from becoming exponentially worse. The solution to the problem is to have the means to survey and track space objects to determine the risk of collision and provide alerts when such risk arises. These means will also serve to better predict and monitor the uncontrolled re-entry of space objects in order to alert if necessary public authorities of any potential danger that these re-entries may generate. These means is what the report refers to as Surveillance and Tracking Service which consists of three functions: – Sensor function, which through a network of instruments such as radars and telescopes allows to identify and track spacecraft and debris; – Processing function, through which the relative orbit of spacecraft and debris can be catalogued and analysed to determine the probability of collision or to determine the re-entry path of space objects; – Front desk function, which is responsible for the actual provision of the SST services (such as collision or re-entry alerts) to satellite operators and relevant authorities. At the same time, the front desk will be the entry point for user requests for SST information which it relays to the processing and sensor function.	Discussions on the potential development of SST have revealed that Member States have converging strong views on the fact that SST must be developed in the framework of the EU and on the following issues: **Architecture:** A SST service must be developed building on existing assets owned by Member States and by adding new assets. **Governance**: The European SST service has a highly sensitive security dimension as it allows gathering intelligence on States' civil and military space infrastructure and operations. Member States have made clear that due to security concerns the sensor and processing functions must, in any scenario, remain under the control of the national competent authories (i.e. military authorities). Given such security concerns, front desk function must be entrusted to an entity that has solid security credentials. **Data policy:** There is a consensus among Member States that SST information is by definition classified and can only be declassified on a case by case basis where the need arises. **Funding:** Member States are of the view that the development of the SST should involve the EU funding, but they are open to contributing to it financially.	There are basically two broad options: status quo and the developing of a European SST service. There are however possible variations on the latter. In column number 3, a number of policy considerations are idenitfied. In this light, any of the options will build on the combination of existing and new assets and will have identical governance and data policy. Against this backdrop, the design of the options is guided by the degree of performance that they seek, i.e. the quantifiable reduction of collistion risk, and the way the funding contributions necessary for the setting up and operations of the European SST service are shared between the EU and the Member States. Following expert advice, for the purpose of this report two targets have been identified: – a reduction by a factor of 3 to 5 (options 2, 3 and 4) and – a reduction of 10 (option 5). Achiving these targets requires the addition of new assets to the existing ones and a certain investment: 60 M€ to achieve the factor 3 to 5 target, and 120 M€ to achieve the factor 10 target. Options 2 and 3 propose EU funding as an incentive for Member States to invest in the new European SST service. Options 4 and 5 propose EU funding for all costs linked to the setting up and operation of the European SST service.

5.1. Option 1: Baseline scenario: No EU financial involvement in SST

Under the baseline scenario the EU would not engage in any action or provide any support (legal or financial) to the setting up and operational provision of European SST services.

The reasons underlying the need for EU intervention have been outlined under Section 3.2 of this impact assessment.

Without the preparation of an organisational framework setting out how the provision of operational SSA services would be organised and without an agreed data policy that would ensure the EU Member States that information related to sensitive satellites or their existing sensors is handled with the necessary level of confidentiality, there are no indications that EU Member States on their own initiative would come to a broader cooperation on SST outside the EU framework.

The fact that the need for setting up of European SSA services was highlighted in Space Council Resolutions since 2007, but no initiative was taken by EU Member States so far underpins the likelihood of this scenario.

Existing sensors and expertise at Member States level, such as radars and telescopes or SST data centres, that could form building blocks for a European SST system, will remain fragmented and not inter-connected. Bilateral cooperation as described in the problem definition may continue, but there are no indications today that this may lead to more formal cooperation arrangements apart from the cooperation between France and Germany which announced to interconnect their existing sensors and data centres (GRAVES, TIRA), but which is still not an operational reality.

Cooperation in the SSA domain between a number of EU Member States (in their capacity of ESA Member States) in the framework of ESA may continue. However, such cooperation emerged in the context of a several year-long policy discussion for the setting up of a European SST that is supposed to be led by the EU. If the EU does not take action, the continued cooperation on SST amongst EU Member States in the ESA framework is highly unlikely.

So far ESA has carried out a number of preparatory studies to define civil SSA user requirements, SSA system requirements, architecture options, and to develop two demonstrator radars. The proposal for actions in 2013-2015 currently under discussion indicates that the focus will be on space weather and NEO monitoring, which are typical R&D activities and have no significant security dimension. As concerns space surveillance and tracking, the current draft programme proposal suggests continuing the development, testing and validation of SST sensors (the already launched development of two demonstrator radars as well as three telescopes), the development of a secured network between existing sensors and the testing of pre-cursor SST services. These activities must be seen as technical support within the overall framework of an EU-led development of a European SST service to which assets developed through ESA will also contribute.

Taking into account the fact that Member States do not see the development of a European SST service as a mission to be entrusted to ESA as explained in section 3.2, the setting up of operational SST services at European level under the baseline scenario cannot be expected.

Cooperation between EU Member States and third countries is expected to remain at the current status: The US are expected to remain the only space-faring nation that shares SST information with public and private/commercial European satellite operators on an individual basis. However, as set out in the problem definition chapter of this report, the information provided by the US is not accurate enough to efficiently plan and carry out collision avoidance manoeuvres. Operators that do not have the means to refine such information, or cannot get help in time from Member States that do possess such means, are forced to carry out sometimes unnecessary avoidance manoeuvres as a precaution.

The EU in its role as owner and operator of the EGNOS and Galileo would have to rely on the US SST and make arrangements with those Member States that have SST assets to ensure refined assessments of collision risks and to accompany collision avoidance manoeuvres.

Even in the absence of EU intervention, the US is likely to improve its SST capacity. However, it is not possible to predict whether, on what basis and with which degree of accuracy the US will continue to provide SST information to third parties. It is certain that the US will take such decision as a function, first and foremost, of US own national interests.

As concerns other mitigation measures to reduce collision risks for satellites, a number of actions may be taken including action at international level with the objective to limit the growth of space debris as illustrated under chapter 3.1.1.3.

These international mitigation measures seek to prevent the exponential growth of debris and may only be effective in the long-term, if indeed they are implemented. However, these actions cannot replace short-term mitigation measures such as collision avoidance manoeuvres.

5.2. Option 2: Partnership approach – EU funding for the European SST front desk function

This option would seek a reduction of the collition risk by a factor of 3 to 5 and therefore a reduction of economic loss due to satellite failure or destructions by the same factor. There is convergence among experts that in order to achieve such reduction the sensor function must be developped linking and operating as a netwok existing assets and adding to this network 1 tracking radar, 1 surveillance radar and 8 telescopes. These assets should be linked by secured lines. The processing function must be set up including in particular a robust data center. A front desk must also be set up.

This would require an overall investement, coming from EU and Member States, of some 60 M€ per annum (for details see annex V on the calculation method). According to the most conservative estimate the current anualised estimated loss of 140 M€ would be reduced to between 28 to 46 M€.

In this option, operational European SST services would be set up in partnership with EU Member States owning relevant assets. The EU would define the legal framework for the setting up and operations of European SST services on the basis of existing sensors and capacities as well as those Member States may decide to develop (for instance in the follow-up programme to the ongoing ESA SSA preparatory programme to be decided at the ESA Ministerial Council in November 2012).

This option is based on the so-called small option in the study carried out by Booz & Company. Further discussions and verifications with experts from ESA and national space agencies led to converging views on the new infrastructure elements needed to reach the targeted performance levels of the European SST service indicated above and the cost estimates.

5.2.1. Governance

The EU, through an appropriate legal instrument, would define the roles and responsibilities of each actor in the implementation and operation of the proposed European SST capability which comprises of three functions:

– the **sensor function** (consisting of a network of existing and new SST sensors connected amongst each other and with the SST data processing centres),

– the **processing function** (consisting of a combination of existing SST data centres and analytical expertise to process the data captured by the SST sensors, merge it with US SST data, build a European catalogue of space objects, analyse collision risks and re-entry risks etc), and

– a **front desk function** (handles the dissemination of SST information, e. g.collision risk alerts during launch and in-orbit operations and re-entry early warning alerts, to European users through defined SST services).

The governance framework would also define the services to be provided in accordance with defined user requirements, set out data policy principles, and define coordination and monitoring mechanisms to ensure the overall functioning of the European SST service, the implementation of the services and the agreed data policy, as well as the contacts with service users.

As explained under section 3.2, Member States have made clear that the sensor and processing function must remain under the control of competent national authorities (i.e. military authorities). Therefore, **a consortium set up by competent authorities of Member States would be responsible for the sensor and the processing functions** of the European SST capability. The consortium should be open to all EU Member States and European actors that are ready to contribute SST sensors or other relevant capacities or expertise. The consortium members will retain the full control over their assets, and will be responsible for their operation, maintenance and upgrading/further development. The consortium will also be responsible for the implementation and the operation of the secured network interconnecting sensors and the processing function. The processing function will consist of centres at Member States level (both France and Germany have set up such "precursor" national centres) and a central data center. In line with the role of the processing function explained above, the consortium would build and operate a European catalogue of space objects and provide analytical support to the front desk function. The interior organisation of the consortium would be the responsibility of the Member States constituting it on the basis of broad terms of reference to be provided by the European Commission. France and Germany declared readiness to form the nucleus for such a consortium on the basis of their existing assets.

The **front desk function** would be entrusted to an existing operational entity/agency with suitable security credentials and a proven capacity to handle SST information in a secured environment (for example the EU Satellite Centre provided that it will be given an appropriate mandate by its Member States[52]). The front desk ensures the provision of SST services open to all European and national public and private/commercial users.

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[52] Recent discussions within EUSC Board reveal openness to go in this direction.

The **European Commission** would not engage in any day to day operational activity, but would ensure the **overall coordination of the SST functional elements**. To this end, it would set up and chair a board consisting of the members of the Consortium and the European SST front desk.

5.2.2. Service provision

The services to be provided would be defined by the European Commission based on the civil-military SSA user requirements approved by Member States in October 2011(see footnote 18):

SST service groups	Users
Collision avoidance: Services related to the risk assessment of a collision between spacecraft or between spacecraft and space debris and the generation of collision avoidance alerts;	• Operators of public/governmental, scientific and commercial spacecraft within the EU and third countries; • Military spacecraft operators; • Launch service providers; • Government services that have legal and policy responsibilities related to the management of public space activities; • Space insurance companies and banks that provide financing for space actors; • ESA, EU
Detection and characterisation of on-orbit fragmentations: Services to detect and assess the risks of on-orbit fragmentation events (explosions or break-ups that lead to the creation of space debris) or collisions, and to issue alerts where required;	• Public (civil or military) and commercial spacecraft operators and launch service providers; • Government services that have legal and policy responsibilities related to the management of public space activities; • Space insurance companies and banks that provide financing for space actors; • International scientific community interested in orbital debris population; • Defence/governmental community in case such collisions could have an intentional nature (such as so called anti-satellite (ASAT) tests which aim at intentionally destroy a satellite); • ESA, EU
Re-entry predictions for hazardous space objects: Services to assess risky re-entries of space objects into the Earth's atmosphere, predict the time and location of impact, and initiate alert procedures to predefined points of contact	• Public (civil or military) and commercial spacecraft operators and launch service providers; • Government services that have legal and policy responsibilities related to the management of public space activities; • Space insurance companies and banks that provide financing for space actors; • Governmental civil protection services • ESA, EU

5.2.3. Data policy

The Commission in cooperation with EEAS and Member States is already working on principles for the SST data security policy. The SST data security policy will define the framework for the acquisition, handling, processing and distribution of SST data derived from the observation of space objects, information related to the SSA systems and its various components (functioning, availability, precision etc) as well as information related to the users.

The most stringent requirements on confidentiality of SST information are imposed by the defence community[53] in order to protect sensitive governmental space assets of Member States and allies. Uncontrolled disclosure of information related to these assets (including information concerning their existence, orbital parameters, space manoeuvres in view of military or intelligence operations), as well as information revealing interest expressed for specific assets or systems or information related to the characteristics of military SST sensors, could jeopardise national security.

In accordance with these needs, SST related information concerning objects detected through the SST sensors will be considered classified by default. Information about an object may only be declassified if it is cleary identified as a non-sensitive object. At any time, when there is a risk of collision or a hazardous re-entry involving a classified object, an ad-hoc decision shall be taken on the risk of declassification. The processing function of the proposed European SST system will be reponsible for taking such decisions based on the agreed data policy. No declassification decision will be taken without involving the actor responsible for the object.

5.2.4. Funding

The overall costs of the setting up and operation of the European SST capability would be co-funded **by the Member States constituting the consortium and the EU in the manner describe below**.

The **Member States participating in the consortium** would provide funding for:

– all capital investments related to the setting up of the sensor function including the development of new assets and its full operation;

– the capital investment for the setting up of the processing function;

– the secured network to inter-connect sensors and the processing function

– The maintenance and operational costs of the sensors and processing functions necessary for the Europan SST service;

The costs for the acquisition of new assets (1 surveillance radar, 1 tracking radar and 8 telescopes, the required equipment to network existing assets and the processing function and a data center) necessary to guarantee the targeted collision risk reduction factor of 3 to 5 is estimated at 50 M€ per annum. Costs for the operations of sensors and processing functions can be estimated at 8 M€ per annum[54].

The total contribution of Member States participating in the consortium would be around 58 M€.

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53 See footnote 18 on the common civil-military SSA user requirements approved by Member States in 2011.

54 See details in annex V.

The **EU** would provide funding for:

– the setting up and operation of the front desk function, namely the staff required to run such service (estimated at 6 FTE) the acquisition of the necessary hardware and software, the maintenance of such equipement and overheads[55].

Funding of the SST front desk function can be estimated at an average of 2 M€ per year. Therefore, the total contribution of the EU would be 2 M€.

As explained on page 24, the provision of SSA services is not likely to be an activity to be started through private or commercial actors. Member States owning relevant SST assets are not willing to collaborate with a commercial actor in this sensitive domain as commercial actors do not meet the security requirements identified to protect national security interests. However, similar to ongoing US STRATCOM reflections, the generation of revenues through the introduction of service fees for both public SST service users (who are not part of the consortium) and private/commercial users could be envisaged in the longer run – once the planned European SST services have reached a stable operational stage and the necessary quality level. The introduction of service fees could be examined in the context of the evaluation of the initative's implemementation.

5.3. Option 3: Partnership approach – EU funding for networking and operation of sensor, processing and front desk functions

This option is identical to option 2 in all respects except as regards the distribution of funding provided by the consortium of Member States and the EU.

Under this option **Member States** participating in the consortium would fund:

– the capital investments related to the setting up of the sensor function including the development of new assets and its full operation;

– the capital investment for the setting up of the processing function;

– The capital investments for the secured network to inter-connect sensors and the processing function;

As in option 2, the acquisition of new assets (1 surveillance radar, 1 tracking radar and 8 telescopes, the required equipment to network existing assets and a data centre) necessary to guarantee the targeted collision risk reduction factor of 3 to 5 is estimated at 50 M€ per annum.

The total contribution from Member States in the consortium would be some 50 M€ per annuum(see also annex V on the calculation method).

The **EU** would fund:

– The operational costs of the sensors and processing functions necessary for the Europan SST service;

[55] Operational costs the EU front desk function have been estimated on the basis of current EUSC man/hour costs for Earth Observation imagery analysts and the assumption that 6 analysists would be required to man the front desk. .