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**REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND
THE COUNCIL**

**on the implementation of the Space Surveillance and Tracking (SST) support
framework (2014-2017)**

1. INTRODUCTION

Space assets and services have become indispensable to our economy and society, and their long-term availability is essential for Europe's safety and security. The number and criticality of European space assets has been increasing steadily, as have space hazards. Europe is set to have 40 Galileo and Copernicus satellites in space by 2020 and around 12% of the world's satellites. It therefore has a vital interest in ensuring that its space assets and services can be launched and operated safely. In 2008, the Council¹ underlined the need to develop a European capability for the monitoring and surveillance of European space infrastructure and of space debris.

The EU's initial response was to establish a European Union space surveillance and tracking (EU SST) capability by means of Decision No 541/2014/EU of the European Parliament and of the Council of 16 April 2014 establishing a framework for space surveillance and tracking support ('the SST Decision')². As required by its Article 11(2), this report sets out information on its implementation and achievements.

The SST Decision recognises that securing an acceptable degree of autonomy in SST activities could require the adoption of a basic act³ and that the mid-term review of the EU's 2014-2020 multiannual financial framework (MFF) should examine such a possibility. Consequently, the conclusions and recommendations of this report will contribute to the work foreseen in the Space Strategy for Europe⁴ on the EU SST.

2. BACKGROUND

The security of critical European space infrastructure is threatened by the risk of collision between spacecraft and between spacecraft and space debris. Also, the uncontrolled re-entry of spacecraft and debris to Earth represents a hazard for the security of the Earth's population. Before the framework was established, there was no Europe-wide SST service to respond to these hazards. Although some Member States had SST assets, these did not make up a European network. Neither did they provide operational SST services available to all satellite operators in Europe.

Against this background, the framework was established with the overall objective of helping to ensure the long-term sustainability of European and national space infrastructure, facilities and services, and the following specific objectives:

- a) to assess and reduce the risks of in-orbit operations involving European spacecraft and enable spacecraft operators to plan and carry out mitigation measures more efficiently;
- b) to reduce the risks to the launch of European spacecraft;

¹ Council Resolution of 26 September 2008 on *Taking forward the European space policy*, OJ C 268, 23.10.2008

² OJ L 158, 27.5.2014, p. 227.

³ Within the meaning of the Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002

⁴ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on *A space strategy for Europe* (the Space Strategy) (COM (2016) 705, 26.10.2016).

- c) to survey uncontrolled re-entries of spacecraft and debris into the Earth atmosphere and provide more accurate and efficient early warnings; and
- d) to seek to prevent the proliferation of space debris.⁵

More broadly, the SST Decision also envisages that the framework should foster synergies across all main areas of space situational awareness (SST, space weather and near-Earth objects) and complement relevant international initiatives on space debris and outer space activities.

To achieve the above objectives, the ambition of the framework is to establish a European SST capability with an appropriate degree of European autonomy. To this end, the SST Decision sets out three actions:

- a) establishing and operating a sensor function consisting of a network of Member States' ground- and space-based sensors to survey and track space objects, and to produce a database;
- b) establishing and operating a processing function to process and analyse SST data at national level to produce SST information and services for transmission to the SST service provision function; and
- c) setting up a function to provide civilian SST services to users for the assessment of risks of collision (CA) and of the re-entry of objects into the Earth's atmosphere (RE) and the detection of in-orbit fragmentation (FG).⁶

In view of the sensitivity of the field, the proposed framework was based on an innovative governance model: participating Member States, integrated in a consortium⁷, would implement the sensor, processing and service actions to deliver the SST services, and would act as the EU-level implementing body in cooperation with European Union Satellite Centre (SATCEN) in a role of a front desk. The Commission's role is primarily to managing the framework and ensuring its implementation, with powers to take relevant measures in support of the framework's objectives.

3. METHODOLOGY

This report covers the first three years and eight months of the framework's activity (April 2014 to December 2017), which includes 18 months of actual operations. It was prepared on the basis of data and information collected from documentation, surveys and meetings with stakeholders, as follows:

- deliverables and documents produced by the SST Consortium between January 2016 and December 2017, including final reports on the closure of the 2015 SST grants and statistics on the activity of the EU SST service provision portal as of December 2017;

⁵ Article 3 of the SST Decision.

⁶ Article 4 of the SST Decision.

⁷ The participation of applicant Member States in the SST Consortium is subject to the compliance and security assessment by the Commission.

- feedback from Member States in 2017 through consultations on the implementation and evolution of the EU SST in the SST Committee⁸ and the SST Expert Group⁹, and technical meetings with the SST Consortium¹⁰.
- a user feedback campaign by SATCEN and the SST Consortium in May-June 2017 with EU SST registered users;
- public stakeholder consultation on the Space Strategy for Europe (April-June 2016), which contained specific questions on the SST¹¹.
- analysis by external and independent technical experts hired by the Commission to support the evaluation of the execution of the SST grants.

As required by Article 11(2) of the SST Decision, the report assesses the achievements of the framework objectives from the point of view of results and impacts, the effective use of resources and European added value. The report informs on the progress on activities, outputs and key performance indicators in the 2017-2020 coordination plan in the Commission's Implementing Decision of 2016¹².

4. IMPLEMENTATION OF THE SST SUPPORT FRAMEWORK

4.1 Preparatory phase

Several activities prepared the ground for the start of EU SST operations on 1 July 2016, those included:

- in March 2015, five Member States (France, Germany, Italy, Spain and the United Kingdom) were deemed compliant with the criteria for participation in the SST support framework laid down in the SST Decision and the Commission's Implementing Decision of 2014¹³ and designated national entities to make up the SST Consortium¹⁴;
- on 16 June 2015, the participating Member States signed the SST Agreement, which formally established the SST Consortium.
- on 14 September 2015, the SST Consortium and SATCEN signed the SST Implementing Arrangement, which formally established the SST Cooperation; and
- the first grants under the EU programmes (2015 budget) were launched on 1 January 2016 to finance the establishment and operations of the EUSST.

⁸ On 17 January, 1 March, 30 March, 18 May, 12 June and 11 December 2017.

⁹ On 2 March and 27 November 2017.

¹⁰ On 5-6 July, 20 September, 13 November and 12 December 2017.

¹¹ Synopsis report on the public consultation accompanying the Commission's *Space Strategy for Europe* Communication.

¹² Commission Implementing Decision of 19 December 2016 on a coordination plan for the space surveillance and tracking support framework and on the procedure for the participation of Member States, (C(2016) 8482).

¹³ Commission Implementing Decision of 12 September 2014 on the procedure for the participation of the Member States in the space surveillance and tracking support framework (C(2014) 6342 final).

¹⁴ Agenzia Spaziale Italiana (ASI), Centro para el Desarrollo Tecnológico Industrial (CDTI), Centre National d'Etudes Spatiales (CNES), Deutsches Zentrum für Luft- und Raumfahrt (DLR), UK Space Agency (UKSA).

SST Decision adopted (April 2014)	SST Decision in force (June 2014)	SST Consortium created (June 2015)	SST Cooperation created (September 2015)	Initial SST service delivered (July 2016)	Evolution of Initial SST service (since July 2016)
Preparatory phase (April 2014 - June 2016)				Operational phase (since July 2016)	

4.2 Operational phase

Sensor function

Under the SST Decision, each Member State retains control of and operates its own SST sensors, networked to its national operations centre (NOC). The national SST sensors generate data on space objects in orbit, which are an essential input for the data and information processing function.

The type, capability and geographical distribution of EU SST sensors determine the orbital coverage and number of space objects of a given minimum size that can be observed, and ultimately the EU SST's autonomy and capability.

The number of operational sensors has increased gradually since the start of operations in July 2016. By December 2017, 33 sensors under national control (3 surveillance radars, 8 tracking radars, 18 telescopes and 4 laser-ranging stations) had contributed to EU SST operations, used for tracking or/and surveillance. Between them, they cover all orbits (LEO, MEO, HEO and GEO)¹⁵, but the number of objects they cover is limited, due to:

- the insufficient availability of some sensors for the EU SST;
- the geographical location of existing SST sensors; and
- the non-detection of objects below certain size.

Overcoming those shortcomings requires an upgrade of existing and deployment of new SST sensors. A simulation in 2017 estimated the following level of coverage for various sizes of object according to different orbit regimes, and compared the performance of the initial architecture in 2017 with that expected in 2021 after the upgrades:

¹⁵ LEO – low earth orbit; MEO – medium earth orbit; HEO – high elliptical orbit; GEO – geostationary orbit.

	2017 (initial architecture)		2021 (expected architecture)	
MS architecture (orbit and object size)	Total observed (%)*	Total well observed (% of the total) **	Total observed (%)*	Total well observed (% of the total)**
LEO (> 7 cm)	19%	14%	35%	19%
LEO (> 50 cm)	79%	72%	95%	80%
LEO (> 1 m)	96%	95%	98%	97%
MEO (> 40 cm)	18%	7%	62%	7%
GEO (> 50 cm)	40%	30%	66%	42%

* *Observed objects are objects that were observed at least once during the 14-day period of the simulation.*

** *Well-observed objects are those observed objects that were observed every day in LEO and every three days in MEO/GEO*

As regards sensor function, the SST Consortium work performed mainly involves:

- networking of SST sensors in national SST systems

Most sensors already had the necessary links with their NOC at the start of operations and the links have now been established for the remainder. Further work has been ongoing to adapt the use of the sensors to the EU SST needs;

- mapping European sensors and architecture studies

The mapping of European sensors potentially suitable for EU SST was completed in 2017. The resulting European sensor almanac formed a basis for architecture studies and facilitated enlargement of the EU SST sensors. It gathers data from 133 potential sensors from nine Member States (the SST Consortium countries, plus Austria, Poland, Portugal and Romania). Continuous updates, including extension of country coverage, will be necessary. Studies on the initial EU SST architecture and its performance were completed in 2017 and detailed assessment of future architecture options for EU SST is expected in 2018;

- upgrade of sensors

On the basis of the results of the initial studies on European sensors, an upgrade of 18 sensors from all SST Consortium countries started in 2016 (co-financed by the EU). No development of new EU SST assets is planned in the EU programmes for 2015-2020.

Processing function

The processing function is performed by NOCs, which are operated by Member States under the SST Consortium's coordination. Each NOC feeds data and information from internal and external sources into its national database, which it then processes and analyses to provide SST services. Each NOC is independent and uses different data and information formats, data processing software and algorithms.

Compared with the US catalogue, the national databases contain a limited number of objects and as yet there is no common European database of space objects; as a result, the process is almost entirely reliant on US data. The quality and updates frequency of US data varies according to the orbit and depends on bilateral agreements with the US at national level. It often requires further analysis, verifications and refinement. The table below presents the share of conjunction data messages (CDM)¹⁶ generated by using data from EU SST sensors to the total number of CDM uploaded to the EU SST portal.

Orbit: CDM source:	LEO	MEO/GEO
EU SST	3%	22%
Partially from US ¹⁷	97%	78%

The EU SST is composed of five NOCs: ISOC (Italy), S3TOC (Spain), COO (France), GSSAC (Germany) and UKSpOC (the United Kingdom). Communication links between NOCs have been established and NOCs are in regular contact with each other to exchange knowledge and information. Data- and information-sharing policy is being prepared to facilitate future cross-Consortium collaboration. Initial studies on the status of each NOC's processes (data and information formats, algorithms, databases, external data use, etc.) have been completed. On this basis, it will be possible to establish the formats and procedures for data and information exchange that are a prerequisite for improved networking, data interoperability, cross-Consortium sensor-tasking and the compilation of a common European database.

Service function

Delivery of three initial SST services started on 1 July 2016:

- conjunction analysis and warning (CA)
- re-entry analysis and information (RE)
- fragmentation analysis (FG)

NOCs provide the services according to the EU SST service portfolio, which is made of:

- the 'common guaranteed baseline' (CGB, i.e. minimum EU SST services provided by all NOCs); complemented by
- added value services (based on the existing capacities of NOC concerned and to be progressively included in the CGB).

Currently, for collision avoidance, user requests are allocated to one or more NOCs case by case, which may include joint or shared handling of a fleet of spacecraft. There is a monthly rotation of NOCs to deliver fragmentation and re-entry services, based on handover procedures.

¹⁶ CDM contain space objects orbital information used to analyse potential conjunctions.

¹⁷ Includes information received from US for the secondary object.

SATCEN operates the EU SST portal and the EU SST helpdesk. Products are usually delivered to registered EU SST users through the EU SST portal. For collision avoidance, the NOC in question can provide its assigned users with information directly where appropriate.

As of 1 December 2017, the following registrations had been approved since the start of EU SST operations: 27 for CA, 30 for FG and 36 for RE. Those represent 27 organisations from 12 Member States¹⁸ and, for collision avoidance, 79 spacecraft, of which 35 in LEO, 18 in MEO and 26 in GEO. The EU Galileo and Copernicus satellites are registered to the EU SST services.

Between the start of operations in July 2016 and December 2017, over a million events and products have been handled or reported, with reports provided through the EU SST portal. Annex provides statistics on the products delivered.

It is expected that the user interaction mechanism will be established in 2018. The first user feedback campaign was carried out in May-June 2017. Respondents to the questionnaire were generally satisfied with the initial SST services, but the response rate was only 26%. They suggested improvements to the harmonisation and timing of product delivery and more information on the object and event. SATCEN and the SST Consortium identified user needs and a preliminary list of potential users.

SST grants management

EU grants have financed EU SST activities in three main areas:

- EU SST service provision (1SST);
- the networking of assets and coordination of actions (2SST); and
- the upgrade of existing, and development of new, SST assets (3SST).

A total of EUR 167.5 million has been allocated for 2015-2020 through various grants under the Copernicus, Galileo and Horizon 2020 programmes, out of which around EUR 70.5 million to implement the actions of the SST Decision (1SST and 2SST grants) and EUR 97 million for the sensors' upgrades (3SST).

The activities described in this report were co-financed by the 2015 grants, which were subject to administrative closure in December 2017. The 2016-2017 grants signed in December 2017 should ensure the continuity of the activities and the transition to more comprehensive and effective EU SST services. The topics of Horizon 2020 calls for grants in 2018-2020 were published in 2017.¹⁹

The EU funding arrangements for the first SST projects proved to be complex and administratively burdensome. In 2015-2017, this led to the simultaneous management of several grants of a relatively short duration (18 months) under different financial rules. Some efforts were made to simplify the grant management arrangements.²⁰

¹⁸ Belgium, Bulgaria, Czech Republic, France, Germany, Greece, Italy, Netherlands, Romania, Slovakia, Spain and the United Kingdom.

¹⁹ Copernicus and Galileo work programmes are adopted on an annual basis.

²⁰ Namely, 2SST and 3SST were merged for the 2016-2017 budget.

Governance

The SST Decision recognises the sensitive nature of SST and leaves the implementation and management of the EU SST capability to the participating Member States, with assets owned at national level. The Commission's involvement in 2014-2017 was mostly related to monitoring the procedure for Member States' participation, executing grants, interacting informally with the SST Consortium and drawing up the 2017-2020 coordination plan.

The SST Consortium governance structure involves work in steering, technical, and security committees and project and financial coordination, with decisions being taken by unanimity. Most decisions, including those concerning the programme management, are taken in the steering committee, where the Commission is an observer since 2017. The coordination committee is responsible for the governance of the SST Cooperation (SST Consortium and SATCEN).

With the adoption of the second Implementing Decision in 2016, the Commission launched the second round of Member State applications to join the SST Consortium. Three Member States (Poland, Romania and Portugal) submitted formal applications to join the SST Consortium by the 19 August 2017 deadline and the procedure should be completed in 2018. The participation of new Member States can help to increase the performance of EU SST.

Eight other Member States (Austria, Croatia, Finland, the Czech Republic, Greece, Latvia, Slovakia and Sweden) expressed their intention to collaborate with the SST Consortium as participating entities in the implementation of the future grants. Private sector contributes to the EU SST, mainly as technology and data provider, and does not participate in the EU SST governance.

5. ASSESSMENT

5.1 Results and impacts

The framework delivered results as regards the establishment and operation of EU SST functions and actions. However, given the relatively short timeframe of the EU SST operations, it is not yet possible to identify socio-economic impacts.

The main achievements of the framework can be summarised as follows:

- **availability of the EU SST services** – the SST Consortium has provided services under the EU SST logo since 1 July 2016, through the EU SST portal. The collision avoidance, in-orbit fragmentation and re-entry services are provided to all European institutional users and spacecraft owners and operators free of charge and on a 24/7 basis. The number of users has risen steadily;
- **outreach to users** – potential users were identified and their needs documented. While limited, feedback from users is promising. The EU SST helped to enhance stakeholders' awareness of space risks and the need to protect space infrastructure;
- **cooperation and collection of shared know-how** – regular communication has been established between NOCs. National experts share knowledge and working

practices through working groups implementing the SST grants. Each NOC's systems, processes and procedures have been assessed;

- **mapping and pooling of European assets** – overall, 33 sensors contributed to the initial EU SST operations, covering all orbits. Their initial architecture and performance have been assessed. European sensors potentially suitable for EU SST have been identified and upgrades of national sensors have started;
- **outreach to other Member States** – the EU SST attracted interest and led new Member States to collaborate with or to join the SST Consortium.

5.2 Effectiveness

The framework facilitated setting up the initial EU SST capability toward the general objective of ensuring the long-term sustainability of European space infrastructure and services. All three services were established and operational as foreseen in the SST Decision. Since EU SST operations began, NOCs have provided collision warnings and there have been no catastrophic incidents involving registered spacecraft, including EU satellites. Re-entry events have been monitored and reported. The enlargement of the SST Consortium and execution of SST grants as of end 2017 was on track. The framework has been implemented at an appropriate pace according to the coordination plan, given the complexity and sensitivity of the domain. The innovative EU SST governance model facilitated progress in this highly sensitive domain.

Despite these achievements, the EU SST has yet to improve its performance and autonomy. The EU SST functions as a sum of national capabilities, with different national databases and varying service level, and economies of scale and avoiding unnecessary duplications have yet to realise. To this end, the preparatory work has been carried for NOCs' networking and exchange of SST data and information with an aim of developing a common European database and optimising the EU SST operations. In addition, as demonstrated by the initial architecture studies carried out under the SST grants, further progress toward the European SST autonomy depends on substantial investments in existing and new sensors for surveillance and tracking of space objects. To this end, guidance at the EU level is needed on the long-term vision and strategic objectives.

The EU SST services does not cover space hazards over the entire life-cycle of spacecraft missions from launch to disposal, which however threaten the long-term sustainability of European space infrastructure and services. Moreover, the framework does not define actions or provide means to facilitate exploring potential synergies with other segments of space situational awareness (space weather and near-Earth objects) and has yet to create leverage on the international scene as the capability develops.

5.3 European added value

The SST support framework has given Member States an incentive to cooperate in this nationally sensitive area and has helped to increase transparency and build confidence.

SST services accessible to European users and fostering excellence

The EU SST service is available free of charge to all European users concerned, which have been especially important for European public and private satellite owners and operators who may not have their own high-quality collision avoidance capability.

Requests to access the EU SST services have been received from non-EU countries; specific criteria should be developed to address such requests.

The framework created a platform for learning and knowledge-sharing between NOCs, which is conducive to the improvement of added-value services, including to the benefit of users previously served by the national SST.

Overcoming fragmentation of national SST capabilities and enhancing European autonomy

The initial European sensor mapping and architecture studies provide strategic input that should enable the future development of the EU SST capability in a more coordinated and cost-efficient manner. As a result, it should be possible to optimise, upgrade and develop sensors in Europe.

Europe is heavily reliant on data from the US, those data is of varied quality and accessibility. The creation of the EU SST provides the basis for, and the first step towards, the future development of certain level of European autonomy in SST. Due to the high costs associated with setting up high-performance SST capability, no Member State would afford to invest on its own. The EU SST has shown readiness to cooperate at the EU level toward this aim.

6. CONCLUSIONS AND RECOMMENDATIONS

Considering the relatively short period of the framework implementation, the activities are on track to achieving the results planned for 2014-2020 in the coordination plan. The EU SST delivered results for all actions and three services foreseen in the SST Decision and created EU added value. However, implementation needs to be stepped up in the next phase and the EU SST needs to evolve to improve its effectiveness.

The following operational milestones would facilitate achievement of the overall objective of helping to ensure the long-term sustainability of European space infrastructure and services:

- **defining an effective future EU SST architecture and suitable arrangements for service delivery** – this is critical to optimisation and European added value. Future development needs to ensure that the EU SST builds on complementarity between national assets and optimizes the EU SST architecture while avoiding unnecessary duplication across the functions. Investments in existing and new sensors, on the basis of the architecture studies, are necessary to improve the EU SST's capacities and service. To this end, the next steps must include establishing a sound development plan leading to the future EU SST architecture.
- **a common EU database of orbital objects, building on national data** – this is indispensable for Europe's future SST autonomy. To this end, progress is needed in the near future on the networking between NOCs and the exchange of SST data and information. In parallel, the EU should decide on the level of ambition to guide the strategic development of the EU SST. It should determine an appropriate, acceptable and achievable degree of autonomy and consider possible strategies for ensuring complementarity with key partner countries;

- **outreach to, and active engagement with, potential users, supported by further development of EU SST services** – the EU SST has helped to attract users for its services and raise awareness of space threats, but a large pool of potential users has yet to be reached. To this end, the quality and efficiency of EU SST services needs to be improved according to the needs of users, including in terms of added value and operational handling of the fleet. This should be supported by: intensified outreach campaigns; further development of the user feedback mechanism and common EU SST operational procedures and standards for service provision; and inclusion of added value services to the common guaranteed baseline;
- **consideration of the needs for, and possible means of realising, synergies** with other segments of space situational awareness and the need for SST services covering space hazards over the life-cycle of entire spacecraft missions;
- **formulation of a long-term vision, strategic objectives and general guidelines at the EU level** – these should be supported by implementation roadmaps and multi-annual plans, and taking account of the preparatory work carried out so far;
- **further simplification of the EU SST grant management scheme** – this is needed to address the challenges linked to the complex and administrative burdensome EU funding arrangements and provide predictability and stability for future EU SST development; and
- **governance changes to ensure the cost-effective management** – this is crucial to accommodate possible broader Member State participation and EU SST development. The Commission's involvement in EU SST should be stepped up to enable providing more guidance and monitoring at the strategic, policy and organisational levels. The role of SATCEN in facilitating the provision of EU SST services should be further explored.