UNITED NATIONS
Office for Outer Space Affairs

Promoting Space Sustainability

Safety of Operations

EU SST

19/02/2021

Implementation of the Guidelines for the Long-term Sustainability (LTS) of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space

Operational Case Studies

I. Short description of the outer space activity

It is internationally acknowledged that the increased number of (artificial/man-made) space objects has become a serious threat to the security, safety and sustainability of space activities. This in turn could have a serious impact in the safety and security of economies, societies and citizens. More than one million space debris objects larger than 1 cm are travelling in Earth's orbit uncontrolled, and this puts at risk space infrastructure and space-based applications critical for our daily lives, such as communication, navigation and Earth observation.

In this context, the European Parliament and the Council of the European Union (EU) in 2014 decided to establish a Framework for Space Surveillance and Tracking Support.[1] This Decision served as the legal basis for the creation of European Space Surveillance and Tracking (EU SST), which will evolve from a framework into a fully-fledged programme as part of the SSA component of the EU Space Regulation.[2] EU SST is the European Union's operational capability for ensuring the long-term availability of European and national space infrastructure, facilities and services, which are essential for the safety and security of economies, societies and citizens in Europe. The specific objectives of EU SST are currently set out in the Decision and comprise reducing the risks to in-orbit operations relating to collisions; reducing the risks to the launch of European spacecraft; surveying uncontrolled re-entries; and preventing the proliferation of space debris.

Under the umbrella of EU SST, seven EU Member States (France, Germany, Italy, Poland, Portugal, Romania and Spain), represented by their respective national entities, networked their capabilities across sensor, data processing, and service functions and built an SST system that provides free, operational Collision Avoidance (CA), Re-entry Analysis (RE) and Fragmentation Analysis (FG) services[3] to owners and operators of space assets, civil protection authorities and other European entities. These services are generated based on own measurements shared through a dedicated European platform, the EU SST Database, as well as on external data. The services are offered to European users through a Front Desk hosted and managed by the EU Satellite Centre (SatCen).

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[1] 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

[2] Regulation (EU) 2021/696 of the European Parliament and of the Council of 28 April 2021 establishing the Union Space Programme and the European Union Agency for the Space Programme and repealing Regulations (EU) No 912/2010, (EU) No 1285/2013 and (EU) No 377/2014 and Decision No 541/2014/EU, OJ L 170, 12.5.2021, p. 69–148

3 EU SST Service Portfolio can be downloaded under Services – EUSST

Additionally, being the safety, security, and sustainability of the outer space a global concern, it is foreseen that under the new EU Space Regulation, where SST is one of the sub-components, the CA, RE and FG services will become available to users from non-European countries too, thereby supporting a range of additional users in conducting safe and sustainable space activities.

The following figure shows the service provision model of EU SST:

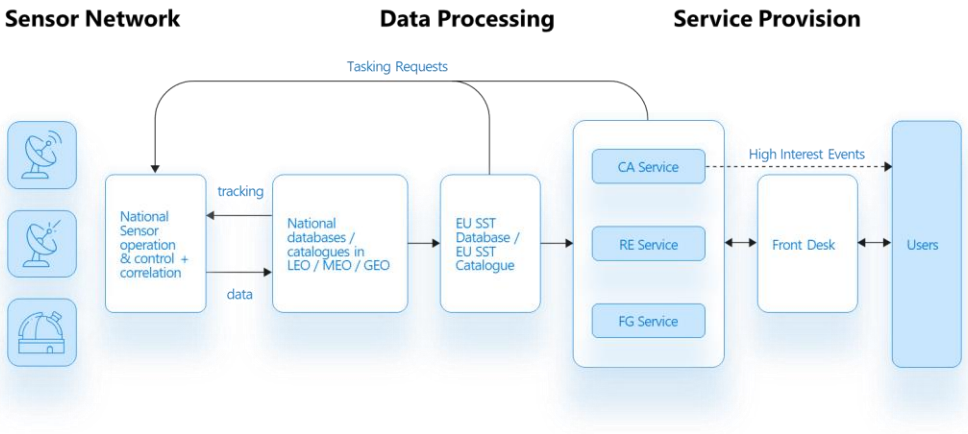

Figure 1 EU SST Service Provision Model

Currently, there are more than 50 sensors contributing to EU SST, which are distributed worldwide, as shown in the following map:

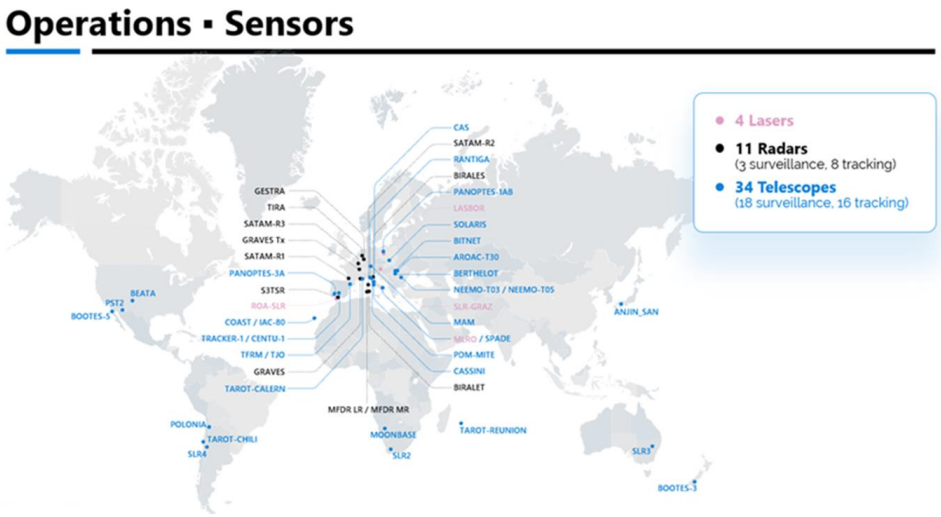

Figure 2 Map of sensors contributing to EU SST

During 2020, in average more than 105,000 measurements were shared through the EU SST Database, corresponding in total to more than 10,000 different objects distributed in all orbital regimes. On the service side, the next plots show the total number of events and the autonomous products (CDM, RE and FG messages) generated using data from sensors contributing to the EU SST, break down per service and orbital regime:

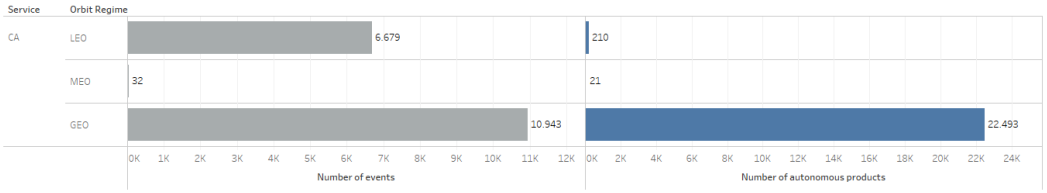

Figure 3 Total number of CA Events and associated autonomous CDMs during 2020

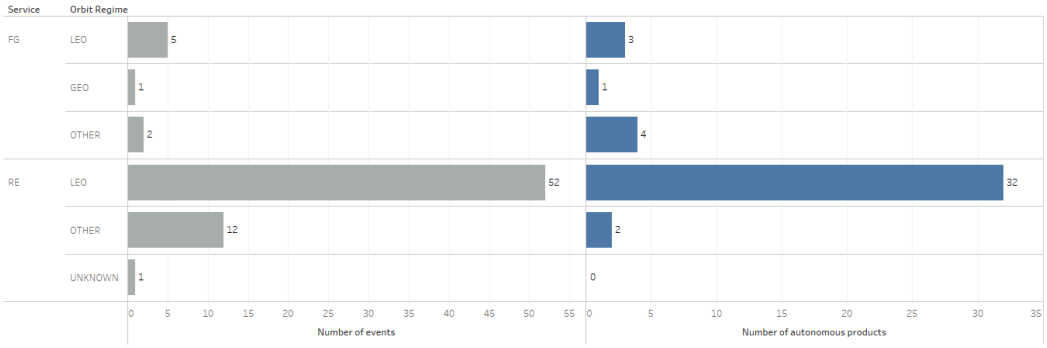

Figure 4 Total number of FG and RE Events and associated autonomous products during 2020

At present, more than 100 organisations receive SST services: more than 25 are registered for the CA service, protecting in total more than 200 satellites, and more than 80 organisations for RE and FG respectively.

EU SST strives for excellence; therefore, it is committed to a continuous improvement of the system and the services. With this philosophy, Architecture and System Design studies are run to define an optimized SST system and identify existing gaps. These studies determine the evolutions to be implemented in the short, medium, and long term in the following areas:

a) Sensor Layer: Exploration of the use or the evolution of existing technologies into the SST domain, or the development of new technologies to increase the space surveillance and tracking capabilities of Europe.

b) Processing Layer: Exploration and development of novel approaches of data processing algorithms, multi-source data fusion techniques and methods, allowing improving both the service and the cataloguing functions.

c) Service Layer: Development of new services, complementing the current added-value ones, to progress towards the improvement of safety, security and sustainability of space operations. Many of the envisaged new services, which answer to stakeholder and operator needs and expectations, do not exist at commercial or governmental level. This work, aligned with the European ambition to develop mitigation and remediation services in this domain, will allow defining a clear path towards the provision of additional added-value safety of flight services in the short- and medium-term, enhancing the European capability to coordinate the space traffic.

Such coordinated research and development approach allows to inflect key improvements on each of the constituting functions of the SST system, while keeping European knowledge on the SST domain at the leading edge.

II. Connection with the LTS Guidelines

As stated in the previous section, EU SST is conceived as the European contribution to the safety of operations in outer space (**LTS B.**), being as well, an excellent example of international cooperation in support of the long-term sustainability of outer space activities (**LTS C.1**), involving public, private and academic sectors, with special emphasis in the system improvement, in particular through research and development activities (**LTS D.1**).

As part of the services provided, EU SST is contributing to guidelines **A.3**, **B.4** and **B.9**:

- EU SST computes the risk of collision for more than 200 European Satellites and gives support to the computation of Collision Avoidance Manoeuvres (CAM). Moreover, as services continuous enhancement, the support is being expanded to all phases of controlled flight.
- EU SST screens potential hazardous (mass greater than 2,000 kg or radar cross-section larger than 1m^2 and rocket bodies) re-entry of objects.[4]

Critical events and important EU SST technology and capacity developments are often communicated in social media to increase general public awareness on space activities (**LTS C.4**)

EU SST relies on a strong and coordinated collaboration among the partners. Measurements of space objects from a network of sensors distributed worldwide are shared daily in standardized formats to ensure interoperability (LTS **B.1 5**) through the EU SST Database (routinely and for specific risky events after dedicated request on sensor tasking), promoting guideline **B.3**. Data sharing ensures that the best possible orbital accuracy is achieved, as per guideline **B.2**. EU SST contributes to **B.1**, facilitating the coordination and sharing of information in case of events between two active satellites.

Being a joint multilateral effort, the international cooperation and sharing of experience and the exchange of information is paramount for the success of the activity (guidelines **C.1** & **C.2**). Recurrent challenges for multilateral SSA data sharing – such as distinct nomenclatures and data formats – are addressed, and agreements on joint definitions of relevant terms and concepts were reached. To ensure an efficient cooperation, the service provision model chain relies on commonly agreed procedures for the data sharing, the requests for tasking of sensors, the interaction with the users, etc. Additionally, to guarantee the highest quality and reliability of the outputs, in key areas a thorough cross-check of results using different methodologies applied by the various partners is done. Furthermore, due to the dual dimension of the SST domain, and since information of different sensitive levels need to be managed, Security is of the outmost importance, a dedicated Security Committee works to ensure that the Data and Information Policy suits the needs of the activity and guarantees the constrains from the involved stakeholders.

On the sensors part, guideline **B.10** is also regarded in the operation of lasers contributing to the EU SST.

Last, but not least, the research and development activities done under the scope of the EU SST promote guidelines **D.1** & **D.2** by enhancing the current sensor and processing functions and added-value service and provide new ones that support the mitigation and remediation activities.

[4] The EUSST Consortium has been particularly active during the follow-up of the re-entry of the core stage of the rocket that launched Tianhe https://www.eusst.eu/newsroom/eu-sst-monitors-reentry-cz5brb/

III. Lessons learned

EU SST, as a network of European assets and capabilities, has been implemented through a bottom-up approach. On one hand, this has allowed setting up a reliable SST system, providing high added-value SST services, in a record time. On the other hand, to ensure that an appropriate level of redundancy while avoiding unnecessary duplications an effort was needed. By a transparent and truthful cooperation, the highest added value of various solutions was identified for each element, progressing towards a specialisation of partners, with clear interfaces and common procedures, which grant an efficient use of the available resources.

A thorough procedure to evaluate the Key Performance Indicators in all system components (sensors, data sharing, service provision, users) has also been established. In case of deviation from the expected performances, corrective actions are taken.

To ensure the added-value of the services, the EU SST establishes a close interaction with the users, to ensure the added-value of the services. The Collision Avoidance service is tailored to the needs of the spacecraft operator in terms of the acceptable level of risk and communication procedures. For all the services, feedback campaigns and workshops are organised, with the aim of gathering the user needs and make sure the services are evolved according to them. In line with these campaigns, new services such as the anticipation and characterisation of non-physical interferences, the support in case of in-orbit contingency or anomaly, or the communication platform among users, are being developed.

Finally, for building an adequate level of autonomy a worldwide sensor network, capable of monitoring any space activity in all orbital regimes is needed. This network is crucial to build a European Catalogue of orbits from objects orbiting Earth and to provide best quality services. This network is complemented with on-going efforts to ensure an effective data sharing that guarantees the integrity and security thereof.