IAC-24-E9-IP.14

Comparison of European Union Space Surveillance and Tracking and TraCSS

Mariel Borowitz[a]*, Cristina Pérez Hernández[b], Matthew Hejduk[c], Aurélie Gillet[d], Monique Moury[e], Pascal Faucher[f]

[a] *Office of Space Commerce, National Oceanic and Atmospheric Administration (NOAA), United States. Department of Commerce, mariel.borowitz@noaa.gov*
[b] *Spanish Space Agency (AEE), Spain*
[c] *Aerospace Corporation*
[d] *European Union Space Surveillance and Tracking Partnership*
[e] *Centre National d'Etudes Spatiales (CNES), France*
[f] *Centre National d'Etudes Spatiales (CNES), France*
* Corresponding Author

Abstract

This study, jointly carried out by members of the United States Traffic Coordination System for Space (TraCSS) program and the European Union Space Surveillance and Tracking (EUSST) program, defines and compares the full set of services that each program intends to provide free of charge to end users in support of spaceflight safety and sustainability of the space environment. The functional definitions of each proposed service are systematically compared to identify areas of alignment and non-alignment between the two programs, and to highlight any differences in terminology. The study also discusses the rationale behind the provision of these services. Both the United States and Europe recognize the need to provide a free public space situational awareness and space traffic coordination service to support spaceflight safety and sustainability of the space environment. The United States and Europe also agree on the value of encouraging the continued growth of a robust global commercial space situational awareness market. Clear identification of the services that will be provided free of charge by government programs allows current and future spacecraft owners and operators to have confidence that products and services essential to spaceflight safety will continue to be available free of charge, even as space becomes increasingly congested and the global SSA sector continues to evolve. This information is also critical for the global commercial SSA sector, which aims to augment government-provided services with additional commercial SSA products and services to meet the growing demand of spacecraft owners and operators around the world. The results of this study will provide important insight into two of the largest public space situational awareness programs in the world, bring greater clarity to the broader space community regarding the future of space safety services, and facilitate international discussion regarding the future of space safety and sustainability and commercial space activity.

Keywords: Space situational awareness, spaceflight safety, space surveillance

Table 1. EU SST & TraCSS Services Comparison Summary Table (as of August 2024)*

		EU SST	TraCSS
1. SSA information as a service			
1. Contact information		No	Yes
2. Satellite attributes		No	Yes
3. O/O ephemerides with planned maneuvers		No	Yes
4. Catalog of space objects		Potential Future	Yes
2. In-Orbit Collision Avoidance service:			
1. Routine catalog and O/O ephemerides screening and CDM production		Yes	Yes
2. Risk Assessment† and Detection and Notification of High Interest Events/Emergency Events		Yes	Yes
3. Additional tracking on the secondary and/or primary objects		Yes	Yes
4. Basic CAM Options for selection by O/O‡		Yes	Yes
5. Candidate CAM Screening		Yes	Yes
6. For selected HIE/ Emergency Events, dialogue with O/O		Yes	Yes
3. Candidate Maneuver Screening		No	Yes
4. Spacecraft Anomaly Reporting		No	Yes
5. Reentry Monitoring Service		Yes	Future Phase
6. Fragmentation Notification and Analysis Service:		Yes	Yes (Notification only)
7. Potential Future Services Under Consideration			
1. Launch Collision Avoidance service		TBD	Future Phase
2. Improved O/O Ephemerides		TBD	TBD
3. Space Weather Information and Atmospheric Drag Model		No	TBD
4. Traffic Coordination Platform as a Service		TBD	TBD

* Reproduced with permission.

† Additional risk assessment tools are provided, such as Risk Assessment Evolution Plots, Sensitivity Analysis Plots and Space Weather Sensitivity Plots.

‡ The Collision Avoidance Maneuver options consist of a trade-space plot of possible collision avoidance maneuvers that is based on basic assumptions about the maneuver capabilities of the spacecraft and not tailored to individual spacecraft capabilities, missions, or preferences. The determination and selection of the maneuver is made only by the owner/ operator.

Acronyms/Abbreviations

CAM collision avoidance maneuver
CDM Conjunction data message
DOC Department of Commerce
DOD Department of Defense
EU European Union
EU SST European Union Space Surveillance and Tracking
HIE High Interest Event
O/O Owner/ operators
OSC Office of Space Commerce
SSA Space Situational Awareness
TLE Two-line element set
TraCSS Traffic Coordination System for Space
U.S. United States

1. Introduction

As the number of objects in space continues to grow rapidly, providing many useful services to people on Earth, more effort is needed to support spaceflight safety and space sustainability. Space situational awareness (SSA) services have a key role to play in this area. SSA involves monitoring the current location of objects in space and predicting their future location, with the goal of identifying and avoiding potential collisions.

Both the European Union and the United States maintain programs that offer SSA services free of charge to spacecraft operators around the world. In the European Union, this is done through the European Union Space Surveillance and Tracking system. <More on EU SST>. In the United States, the Office of Space Commerce is establishing the Traffic Coordination System for Space (TraCSS), with an initial operations date of September 30, 2024. <More on TraCSS>

International coordination is a key element of ensuring spaceflight safety. Recognizing this, officials at EU SST and TraCSS have been working in partnership to build mutual understanding between the two systems. As one component of this partnership, EU SST and TraCSS conducted a systematic comparison of the products and services offered by each of the programs. This effort included technical discussion of similarities and differences in the use of key terms and the elements of key processes as well as the underlying motivations and purpose behind the provision of key services.

In addition to improving mutual understanding between the programs, it was recognized that sharing the results of this study would also be valuable for the broader space community. In particular, spacecraft operators can benefit from having a clear understanding of the services made available by these two systems. The study also provides other national and regional SSA providers with useful information as they develop or grow their own systems. Commercial SSA providers can use this study to better understand how they might best contribute to government efforts and to determine how to best differentiate their own commercial offerings from those offered free of charge.

The full technical analysis was presented at the Advanced Maui Optical and Space Surveillance Technologies Conference in September 2024 [1]. This paper summarizes some of the key findings from the technical analysis and discusses potential next steps for international cooperation in this area. Table 1 provides a high-level overview of the results of the comparison. It shows that there is a significant amount of commonality among the two programs, particularly when it comes to the core area of in-orbit collision. The following section briefly describes the similarities and differences across the two programs.

It is important to note that this study was completed in August 2024, and the product and service descriptions represent the activities and plans of the programs as of that time. Both programs intend to continue to evolve to meet the space safety needs of the dynamic space environment

2. Comparison of SSA Services in the European Union and the United States

The first service listed in Table 1 is SSA information as a service. This is something that the TraCSS program will provide, as it seeks to emphasize transparency and information sharing in its program. Although EU SST doesn't currently offer SSA information as a services, the program is considering sharing a portion of its catalog of space objects in the future.

The second service is the in-orbit collision avoidance service. Both programs align closely in their provision of this service. Both conduct routine screening of a spacecraft catalog and owner/ operator ephemerides to generate conjunction data messages (CDMs) with probability of collision. Both programs conduct risk assessment and detection of conjunction events of particular concern – those that rise above a risk threshold defined by each program. In EU SST, these are referred to as High Interest Events, while TraCSS calls these Emergency Events. Both systems are capable of seeking additional tracking information, when necessary. EU SST and TraCSS both provide basic collision avoidance maneuver (CAM) options for consideration by the owner/ operator. While these are not tailored to the individual spacecraft capabilities, missions or preferences, they can assist operators in

identifying opportunities for collision avoidance maneuvers. It is ultimately the spacecraft operator that must determine whether and how to maneuver. Once a maneuver plan is developed, both programs offer the ability to screen that candidate collision avoidance maneuver. Finally, in the event of high interest events/ emergency events, both programs have the ability to enter into dialogue with the owner/ operator if the program determines such engagement is warranted.

The TraCSS program will screen candidate maneuvers for owner/ operators for routine maneuvers. This is a service the EU SST doesn't provide. Similarly, TraCSS will encourage spacecraft owner/ operators to report anomalies experience on orbit, while the EU SST does not include this element. The EU SST does offer re-entry services, while TraCSS does not. The TraCSS program intends to offer re-entry services in the future, as phase three of the program.

The EU SST offers a fragmentation notification and analysis service. This includes notification of the initial fragmentation, as well as a prediction of the future location of the debris fragments in the medium and long-term, during the period before they are added to the space object catalog. TraCSS will providing only the initial notification of the fragmentation event, mirroring the notifications generated by the U.S. Department of Defense.

The final category in the table focuses on potential future services. These are services that one or both of the programs recognize as an area in which future services may be needed, or where some development is underway, but the service is not yet fully defined. The first example in this category is launch collision avoidance services. TraCSS plans to provide these services in phase two of the program and is currently working with the U.S. Department of Defense and the U.S. Federal Aviation Administration to define the services in this area. EU SST may also consider launch collision avoidance services. As present, these services are provided at the national level by France.

The next item in this category is improved owner/ operator ephemerides. Both EU SST and TraCSS recognize the critical role that reliable, high-quality owner/ operator ephemerides play in spaceflight safety. However, both have noted that some owner/ operators have difficulty reliably producing ephemerides with adequate quality. TraCSS initiated a pathfinder study in September 2024 to examining approaches to generating improved owner/ operator ephemerides. The program is also interested in exploring a wide array of potential solutions to this challenge. EU SST is also interested in these possibilities.

Space weather can be a source of significant uncertainty when seeking to predict conditions in the space environment. TraCSS is funding a study with the aim of developing a new space weather atmospheric drag model that could be used both by the TraCSS system and by individual owner/ operators as they generate their spacecraft ephemerides.

Lastly, both programs recognize that coordination between spacecraft operators in the event of a conjunction is a critical element of spaceflight safety. EU SST currently includes a collaboration platform for its registered users, while TraCSS does not have any service in this area. However, both programs recognize that the need for improved methods for coordination on a global level and are interested in options to support this need.

3. Discussion and Conclusion

This study helped to build mutual understanding between EU SST and TraCSS, and we believe it can be a first step toward broader coordination across SSA systems around the world. We believe the results will also be useful to spacecraft owner/ operators, to help them better understand the offerings available. Commercial SSA providers may find this analysis useful as they consider how they can best contribute to government services and also differentiate the services they provide to spacecraft operators from those provided free of charge from the government.

This study also helped to illuminate many additional opportunities for future research and collaboration. First, while this study focused on the services provided by each system, we believe that a future study that goes deeper to compare architectures, processes, and algorithms could be beneficial. This could focus on specific elements, such as the determination of hard body radius, a key variable in determining the probability of collision associated with a conjunction event. Similarly, examining in detail the similarities and differences in the approach to high interest events and emergency events, including the thresholds used to define these events, would be useful. Future research could also focus on a comparison of data and information changes between the programs, to better understand what data will be exchanged and how this will be accomplished.

Both programs have also been focused on the importance of global coordination among independent national and regional SSA providers, particularly to ensure that owner/ operators do not receive conflicting information. Future research could focus on comparing the outputs from the two systems to understand how

often they agree or disagree and to begin to develop mechanisms for routine coordination on this issue. Such an effort could be an important first step in exploring technical approaches to international coordination on SSA.

Finally, the paper identified potential future services, such as improved owner/ operator ephemerides and efforts to support coordination among owner/ operators. Future research could focus on working together to identify the range of approaches to addressing these challenges.

Space safety and space sustainability are becoming increasingly important as the global space sector continues to grow, and as people on Earth continue to rely on these space assets for applications and services in their everyday life. Studies such as this one, that bring together national and regional SSA providers to coordinate and work together demonstrate a commitment to these issues and a determination to ensure space remains safe today and sustainable for future generations.

Acknowledgements

The EU SST activities are co-funded by the European Union. This paper reflects only the SST Cooperation's actions and the European Commission and the European Health and Digital Executive Agency are not responsible for any use that may be made of the information it contains.