

February 27, 2023

VIA ELECTRONIC MAIL

Richard DalBello Director Office of Space Commerce National Oceanic and Atmospheric Administration U.S. Department of Commerce

<u>Re: SpaceX Comment—Office of Space Commerce, National Oceanic and Atmospheric</u> <u>Administration, Department of Commerce, Request for Information (RFI) on Scope of Civil</u> <u>Space Situational Awareness Services (88 FR 4970)</u>

Dear Director DalBello:

Space Exploration Technologies Corp. ("SpaceX") is pleased to submit these comments regarding the planned scope of basic safety services to be provided via the Traffic Management System for Space (TraCSS) program. SpaceX appreciates the opportunity to highlight a few key areas to focus on as the Office of Space Commerce ("OSC") continues to investigate how to establish a reliable space situational awareness ("SSA") database and services via the TraCSS program.

With the Starlink network, SpaceX is bringing high-speed, low-latency broadband to unserved and underserved communities around the globe, and is leading the world in responsible space operations that ensure continued and sustainable orbital access. SpaceX is committed to ensuring space is sustainable and safe. We request that the Office of Space Commerce consider our comments based on our direct and extensive operational experience and engagement with U.S. SPACECOM, NASA/Conjunction Assessment Risk Analysis ("CARA") industry partners and other satellite Owner/Operators ("O/O"). The OSC model should embrace radical transparency and engender a collaborative environment when developing and employing TraCSS, which has begun with this RFI. Transparency and collaboration among all stakeholders is crucial to building a sustainable foundation for safe space operations and practices.

The development of TraCSS is an important step in ensuring space remains safe and sustainable. SpaceX's top recommendations include the following:

- OSC must focus on designing a process for low-latency, high-frequency collision avoidance screening ephemerides, for *both* owner/operator ephemerides and for cataloged objects. This is an absolutely critical requirement for any modern space domain awareness system.
- OSC, consistent with Congressional direction, should be the lead agency overseeing the licensing aspects for space safety and orbital debris standards, including working with industry and technical authorities to establish best practices.
- The process for launch licensing and collision avoidance analysis should be centralized, modernized, and made more efficient in order to reduce the manual work and redundant inputs for multiple government agencies currently involved in this process. This will improve space safety and ensure processes aren't the constraint to increasing the cadence of launch operations.
- Satellite operators authorized or licensed in the United States should be required to maintain current, publicly available contact information on TraCCSS. They should also be required to publish validated ephemerides and realistic covariance. This information should be mandatory to improve SSA and ensure effective coordination between owner/operators.

- The TraCSS program should include as basic services at least the services that are currently available via space-track.org.
- The TraCSS program and OSC efforts on SSA generally should seek to bring in owners/operators who do not launch from the United States and are not seeking licenses to operate in the United States into the system in order to provide for and engender global coordination for safe space operations.

Beyond these points, SpaceX would like to provide specific comments to several basic and advanced services questions raised in the RFI. Those comments are provided in the appendix to this letter.

Conclusion

The proposed updates are an important step to ensuring responsible space operations. OSC should take an approach that works to preserve space sustainability, while ensuring that the space-based services provided to Americans and the U.S. Government by the U.S. commercial space industry continue to expand. Ultimately, space sustainability is a technical challenge that can be effectively managed with the appropriate assessment of risk, the timely exchange of information, and the proper implementation of technology and operational controls. SpaceX appreciates the opportunity to provide comments and looks forward to continuing our work with the Office of Space Commerce on this important topic.

Respectfully submitted,

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David Goldstein, Principal Engineer SpaceX

Appendix: detailed SpaceX comments

Service Number	OSC States	Attribute	SpaceX Comments
2	Included	Receipt and Sharing of Predictions O/Os Ephemerides (Included). To receive predicted ephemerides from O/Os, store them in a manner that makes them available for download by other interested O/Os, and use them as the representation of the primary object for collision assessments (CA) screenings, risk assessment, and (when appropriate) mitigation planning.	Recommend a screening frequency >= 6 times per day.
3	Included	Routine Collision Assessment (CA) Screening and Conjunction Data Message (CDM) Production (Included). To screen primary objects against a robust satellite catalog, both routinely and on demand; and to generate CDMs for objects that violate the particular physical volumes used for the screening activity.	Recommend these screenings include owner/operators' ephemerides and be conducted with low-latency, < 15 min.
4	Included	Special CA Screening and CDM Production (Included). To perform an on- demand screening against a robust satellite catalog for a particular submitted ephemeris or set of ephemerides (usually for a confirmatory or speculative screening as part of maneuver planning).	Recommend there be an option to share special/on-demand screening results with secondary object owner/operators.
6	Included	Launch Collision Avoidance (COLA) Screenings (Included). To perform timely screenings of a set of launch nominals against a robust satellite catalog in order to identify specific launch times during a launch window that would create unacceptably high collision risk and therefore, should not be used.	Recommend launch COLA screening be done against both observation- based ephemerides and owner/operators' ephemerides. Also, recommend including considerations for eliminating the known "COLA Gap", e.g., the time between when launch COLA screen concludes and when objects are cataloged.
7	Included	O/O Ephemeris Generation and Curation with Covariance (Included). To use O/O telemetry and on-board global positioning system state information, as well as potentially other commercial tracking information, to generate a reliable predicted O/O ephemeris that includes covariance at each ephemeris point and incorporates planned maneuvers (and maneuver execution error).	Recommend making this an advanced service.

8	Included	Re-entry Management and Assessment (Included). To perform re-entry forecasting and event pacing assistance for primary objects undergoing either natural decays or managed deorbits in order to assist the DoD in orchestrating the overall decay and decataloguing process.	Recommend removing limitations on the number of objects that an owner/operator can deorbit per day.
12	Included	Expected Tracking Determination (Included). To generate a pass schedule and probabilities of detection for obtaining additional commercial tracking for conjunction-related objects, so that O/Os can infer the potential benefit of additional tracking and be able to schedule mitigation action decision points appropriately.	Recommend making this an advanced service.
14	Included	Space Weather Sensitivity (Included). To provide warnings about space weather perturbative events and to assess the effects the perturbation-induced atmospheric density uncertainty will have on conjunction risk assessment parameters.	Recommend focusing on improving drag modeling and provision of the models to everyone publicly so all owner/operators can use high fidelity models.
17	Not Included	Additional Concierge Services (Not Included). To provide on-call, personalized telephone support at all times by CA subject matter experts to assist O/Os with the interpretation of conjunction screening and risk assessment products.	Recommend making this an advanced service.
18	Not Included	Anomaly Resolution (Not Included). To arrange for the obtaining and interpretation of anomaly resolution SSA products, such as point signatures (radar cross-section and/or photometry), time- series satellite signatures, and radar and optical imaging.	Very valuable and helpful to get an assessment of whether a satellite is stable or tumbling.
19	Not Included	Design-time Assistance for Improved CA (Not Included). During the satellite construction and mission design phase, to assist O/Os in the prudent selection of mission orbits, satellite construction decisions to produce favorable light pollution properties, and the proper build-out of effective O/O ephemeris construction and CA software and procedures.	Recommend keeping this as an advanced service.

		tracking to detect satellite break-ups; and upon the detection of a break-up, to increase supplementary surveillance tracking to collect break-up uncorrelated tracks (UCT), perform UCT processing, obtain dedicated tracking on new candidate objects, and suggest/perform cataloging actions for stable candidates for which the country of origin can be established.	owners/operators of the objects that break up. Rapid cataloging of collision debris or breakup debris is critically important to ensure objects are screened as quickly as possible post- event.
23	Not Included	Maneuver Detection and Processing (Not Included). To commission heightened surveillance tracking on maneuverable objects; execute maneuver detection algorithms against the tracking obtained from such heightened surveillance; and for objects for which maneuvers are detected, perform appropriate maneuver processing to create a durable post- maneuver state estimate.	This doesn't seem like a service that would be sought by owners and operators, but could potentially be of use to governments.

Section A:

Section A	Does the proposed basic safety SSA service provide sufficient data to allow ongoing operations of orbital assets at a level equal to or beyond that currently provided by the DoD?	Yes, if latencies are improved and O/O ephemerides are screened for Launch COLA, recurring CA screenings and on-demand/special screenings and the results can be shared with both parties.
Section A	What proposed basic safety SSA services are essential to your ongoing operations?	 Launch COLA screening against the catalog and 0/0 ephemerides Recurring CA screening with < 15 min latency 6-12 times per day with all generated CDMs shared between relevant parties On-demand CA screening against the catalog and 0/0 ephemerides with < 15 min latency with the ability to allow the results to be shared with the secondary's 0/0 Maneuverability flags on a shared database updated / accessible via api
Section A	If the U.S. Government were to prioritize the delivery of individual services as part of TraCSS, which ones should be provided soonest?	 Launch COLA screening against the catalog and O/O ephemerides Recurring CA screening with < 15 min latency 6-12 times per day with all generated CDMs shared between relevant parties

		• On-demand CA screening against the catalog and O/O ephemerides with < 15 min latency with the ability to allow the results to be shared with the secondary's O/O
		 Maneuverability flags on a snared database updated / accessible via api
Section A	What, if any, additional capabilities beyond those currently provided by the DoD should be included in	Exposing a user-settable acknowledgement of maneuver responsibility on a per-conjunction basis
	the TraCSS?	Ongoing monitoring of O/O ephemeris covariance realism and notification to O/Os and secondary object when ephemeris is lacking realism
		Centralize manual inputs for every launchand reentry • Assignment and acknowledgement of
		 temporary ids, i.e. 799xxxyyy numbers Provision of Launch Notification Unload of Launch "caliner" files for Launch
		 COLA screening Email notice of intent to "tumble for roontry"
		Object tracking
		 Track all objects with sufficient revisit time to enable effective collision avoidance with focus on providing the best covariance for the debris objects with the most conjunction risk
		 Also use tracking resources to increase revisit time and reduce propagation covariance for objects that have high risk and frequent conjunctions and that maneuver but don't provide propagated enhemoris and covariance with maneuvers
		included
		Provision of states and/or propagated ephemeris and covariance of all objects in the catalog to afford O/O the opportunity to do their own screening
		 Enhanced O/O directory / satellite status database Require all O/Os to maintain up to date contact information
		 Provide more granularity for maneuverability Full Propulsive Partial Propulsive Attitude Only Non-maneuverable Autonomous decisions
		 Timeline for CA maneuver decisions
		 For those owner/operators that don't provide informationprovide best estimate

		of maneuverability based on open-source intel and tracking data Make this service updateable and able to be queried via API Tool and Processes with Increased Transparency Propagation models Drag model Gravity model Solar radiation pressure Maneuver estimation Coordinate transformations Attitude prediction models Brightness prediction models
		Flexible CDM format whereby o/o can provide information to be included in customizable comment fields
		 Standardization of models and tools Covariance realism PC calculations Propagation Coordinate transformations Drag estimation
		Use of better machine-readable formats for ephemeris/covariance, maneuver and attitude predicationsi.e. JSON or other format rather than space delimited text files that require a parser
		API tools like https://oraas.orekit.space/oraas- tools.html
		GitHub for algorithms in Python and other languages
Section A	Are there any additional capabilities not listed that should be included in the basic SSA safety service to provide a baseline level of safety for owners and operators?	Unsure if this is not currently provided but to ensure completeness: Sharable, low latency (< 15 min), high frequency (up to 24 times per day) collision avoidance screening against catalog AND owner/operator ephemerides for launch COLA, recurring/operational and on- demand/special
Section A	Where applicable, at what level or how often should the service be performed? For example, comments may address how often routine collision assessments should be conducted as part of the basic SSA safety service. DoD currently provides these assessments three times a day.	For collision avoidance screening, low latency CDM provision (<15 min) and high frequency (up to 24 times per day)

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	How often should OSC's basic safety SSA service provide these assessments?		
Section C	Which basic SSA safety services identified for inclusion in TraCSS should be made publicly available?	Provision of TLEs for all cataloged objects and option for O/Os to expose their propagated ephemeris and covariance publicly	
Section C	What, if any, information should owners and operators of spacecraft be required to provide to OSC to participate in TraCSS?	 Contact information Regularly updated active / maneuver status via API Maneuver plansseparate from inclusion in propagated ephemeris Propagated ephemeris as soon as possible post deployment with realistic covariance Additional data that would be helpful for space sustainability but not necessarily required of satellite O/Os Truth / as flown ephemeris Brightness / Reflection BRDF models 	
Section C	What, if any, actions should owners and operators agree to take to participate in TraCSS as part of the tenets of participation?	O/Os should have to demonstrate compliance with their operating license, register and provide contact information, demonstrate or show evidence of their efforts to validate their ephemeris generation and covariance estimation and to fully describe their CONOPs for how they are going to plan and execute maneuvers, deorbit safely and perform collision avoidance	
Section C	What should happen when owners or operators fail to provide the relevant information to OSC or fail to take actions consistent with the tenets of participation?	If the Department of Commerce is also going to lead space safety regulatory approval and compliance monitoring for systems licensed in the U.S., then O/O that do not comply should be warned and OSC should implement a dialogue to resolve non-compliance; If an O/O continues to fail, OSC should consider a process of license suspension or working with other federal licensing agencies to consider withholding launch license approval until conditions are met. However, the space safety aspects of the TraCSS services should continue to be performed.	
Section D	For example, are there any matters not discussed above that OSC should or must consider before it provides basic SSA safety services through TraCSS?		