Title: Request for Information on Scope of Civil Space Situational Awareness Services (Document Number (2023-01556)
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Executive Summary

Slingshot Aerospace (Slingshot) is grateful for the opportunity to provide input at this critical stage of transitioning space traffic management responsibility from the U.S. Department of Defense (DoD) to the U.S. Department of Commerce (DoC). Slingshot, driven by a vision of accelerating space sustainability to create a safer, more connected world, builds world-class space data, simulation, and analytics solutions. As a commercial space data and analytics provider, Slingshot is invested in the DoC's successful development and implementation of the Traffic Management System for Space (TraCSS). Slingshot offers these answers and suggestions to shape the path forward to creating the most accurate and relevant space traffic management solution for the entire space domain.

In our view, there is a balance between the needs of the U.S. Government and the commercial sector for our products, and the relationships required to provide a next-generation space safety solution for the burgeoning global satellite market. The growing community of satellite operators (O/Os) spans many cultures, territorial boundaries, and orbital regimes. To operate safely, O/Os require a solution that meets their basic space safety needs, enables global coordination, and scales with their business. To provide this service to the space community, the DoC will need to work with commercial space data and analytics providers, like Slingshot, to successfully define what basic services should be provided to O/Os on a free basis through TraCSS. In addition, commercial data will be needed to bridge the gap in creating a "robust" space catalog.

Basic Services

For the purposes of this response, Slingshot considers "Basic Services" as those services provided to satellite O/Os by the DoC through TraCSS. It is our understanding that to offer these services to O/Os, the DoC would pay for data/services provided by commercial data and analytics providers and offer them to the operators community for free. "Advanced Services" are considered to be services provided by the commercial industry through a paid relationship directly with satellite O/Os.

(1) Satellite Attributes, Capabilities, Status, and Point of Contact (Included). To maintain a database of primary (protected) assets, which contains basic satellite attributes (approximate dimensions, mass), indicates satellite trajectory change capabilities and current status, and includes 24/7/365 contact information to coordinate mitigation actions for conjunctions between active satellites.

Slingshot agrees that this should be a Basic Service and the DoC should leverage capabilities that are commercially-available today.

(2) 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.

Slingshot agrees that this should be a Basic Service and the DoC should leverage capabilities that are commercially-available today.

(3) 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.

Slingshot agrees that this should be a Basic Service and the DoC should leverage capabilities that are commercially-available today. To operate safely, O/Os require accurate and timely collision assessment (CA) screenings and Conjunction Data Messages (CDMs). Accuracy requires that the DoC maintain a robust catalog, which can be purchased from industry, that aggregates, validates, and verifies which positional data for the primary and secondary should be used for a given conjunction screening. Today, the U.S. Government provides collision assessment and CDMs to O/Os every 8 hours and this should continue in the free service.

(4) 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).

Slingshot agrees that the screening of submitted ephemerides should be a Basic Service within defined time periods and SLAs. Slingshot does <u>not</u> agree that the screening of special ephemerides, or maneuver plans, should be provided on an <u>on-demand basis</u>. The DoC should abide by set screening and data delivery windows so that operators know when to anticipate new screening results. The DoC should leverage commercially-available capabilities to meet this requirement.

(5) Data Quality Evaluation (Included). To perform a first-order evaluation of the orbit determination and propagation of the (usually secondary but in principle both) objects' state estimates and co-variances in order to determine whether these inputs are of sufficient quality to serve as a basis for a durable risk assessment calculation.

Slingshot agrees that this should be a Basic Service.

(6) 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.

Slingshot agrees that this should be a Basic Service. Unlike other services listed herein, the Launch COLA end users are typically launch providers, not O/Os. However, like other Basic Services, the DoC should leverage commercially-available capabilities to meet this requirement.

(7) 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).

Slingshot agrees that this should be a Basic Service. The DoC should leverage commercially-available capabilities to meet this requirement.

(8) Re-entry Management and Assessment (Included). To perform reentry 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.

Slingshot agrees that this should be a Basic Service. The DoC should leverage commercially-available capabilities to meet this requirement.

(9) Precision Probability of Collision Calculation (Included). To include in each generated CDM a Probability of Collision (PC) calculation that uses more advanced approaches for determining the appropriate hard-body radius (HBR) and employs a calculation technique appropriate to the particular dynamics of the encounter.

Slingshot agrees that this should be a Basic Service. The DoC should leverage commercially-available capabilities to meet this requirement.

(10) Collision Consequence and Debris Production Potentials (Included). To calculate, using an appropriate model, an estimate of the number of trackable debris fragments that would be generated if a particular conjunction were to result in a collision.

Slingshot agrees that this should be a Basic Service. The DoC should leverage commercially-available capabilities to meet this requirement.

(11) Conjunction Object Solution Improvements with Additional Tracking (Included). To obtain additional tracking on the satellites involved in conjunctions of interest (typically the secondary objects), improve these objects' predicted states at the conjunction time of closest approach (TCA), and calculate higher-fidelity risk assessment metrics with this improved information.

Slingshot does <u>not</u> agree that this should be a Basic Service. If the DoC is successful in providing conjunction analysis, data (including CDMs), and alerts based on a "robust" catalog that is complete and routinely maintained, then O/Os should not require additional tasking and tracking of objects in the catalog for purposes of space safety. If O/Os require additional tracking services not offered by the DoC, they can purchase it directly from commercial data providers.

(12) 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.

Slingshot does <u>not</u> agree that this should be a Basic Service. If O/Os require additional tracking services not offered by the DoC, they can purchase it directly from commercial data providers.

(13) Risk Assessment Time History Plots (Included). To produce time history plots of conjunction risk assessment parameters of interest to allow assessment of conjunction event phasing and stability.

Slingshot agrees that this should be a Basic Service. The DoC should leverage commercially-available capabilities to meet this requirement.

(14) 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.

Slingshot agrees that this should be a Basic Service. The DoC should leverage commercially-available capabilities to meet this requirement.

(15) Fusion of CA Products (Not Included). To combine CA products, such as CDMs or predicted ephemerides, from multiple providers into a single, higher-fidelity product that can then be used to enable CA risk assessment.

Slingshot agrees that this should <u>not</u> be a Basic Service.

(16) PC Variability (Not Included). By considering bounding scale factors for the "true" size of the primary and secondary objects' covariances, to generate a matrix of possible PC values to allow risk assessors to assign a more conservative "high-water-mark" PC value.

Slingshot agrees that this should <u>not</u> be a Basic Service.

(17) 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.

Slingshot agrees that this should <u>not</u> be a Basic Service.

(18) 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.

Slingshot agrees that this should <u>not</u> be a Basic Service.

(19) 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.

Slingshot agrees that this should <u>not</u> be a Basic Service.

(20) Maneuver Trade Space (Not Included). To assemble a visual aid that identifies particular maneuver times and intensities (and, for some maneuver types, durations) to achieve the desired level of conjunction risk reduction (for both the main conjunction and any other conjunctions that the particular maneuver might introduce).

Slingshot agrees that this should <u>not</u> be a Basic Service.

(21) Optimized Maneuver Recommendations (Not Included). In addition to the parameters in service (20) above, to include satellite contact restrictions, spacecraft maneuverability limitations, and O/O optimality preferences to construct a recommended maneuver plan to mitigate the main conjunction and ensure against the creation of any serious derivative conjunctions.

Slingshot agrees that this should <u>not</u> be a Basic Service.

(22) Breakup Detection, Tracking, and Cataloguing (Not Included). To commission routine surveillance 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.

Slingshot recommends that this should be a Basic Service. To maintain a "robust" catalog, the DoC must detect, track, and catalog breakups and new debris as part of a basic space safety service. The DoC should leverage commercially-available capabilities to meet this requirement.

(23) 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.

Slingshot agrees that this should <u>not</u> be a Basic Service.

Impacts of Proposed Basic SSA Safety Services on Commercial SSA Providers

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- *Are any of the basic SSA safety services readily available from the current U.S. SSA industry? If so, is the service affordable to owners and operators of spacecraft?*

Slingshot currently offers a variety of SSA products to operators from LEO to GEO and beyond. Please see the table below which outlines our commercially-available capabilities. The DoC should leverage these capabilities to provide Basic Services to satellite operators.

Slingshot Products	DoC RFI Requirements Met
Beacon Slingshot Beacon is a global space traffic coordination and data-sharing solution for satellite operators and is available today with over 75% of LEO commercial satellites on the platform. Beacon is a turnkey product that provides satellite operators with essential space safety services including conjunction analysis, visualizations and alerts, and the ability to coordinate and share data with other operators to avoid high risk collisions. Slingshot offers a free version of Beacon that provides operators with a basic set of space safety tools at no cost.	2, 3, 4, 9, 10, 13, 14
Vantage Slingshot Vantage generates space data products such as state vectors, ephemerides, and CDMs for satellite operators. Vantage leverages Slingshot's Global Sensor Network (GSN). The GSN combines the power of 150+ globally distributed electro-optical sensors – across 20 sites – with an automated Tasking, Collection, Processing, Exploitation, and Dissemination (TCPED) software pipeline to routinely generate high-quality tracking data on thousands of active satellites and debris from LEO to GEO and beyond.	3, 4, 6, 8, 22

Seradata

Slingshot's Seradata is the space industry's leading launch and satellite database and analysis solution with technical specifications of launch vehicles & satellites.

MFAST

Slingshot's Multiple Frame Assignment Space Tracker (MFAST) fuses multi-source, multi-sensor, multi-object tracking data to build and maintain high-quality orbital state estimates. MFAST is used operationally by 18th/19th SDS for uncorrelated track (UCT) processing, (i.e., initial orbit determination (IOD)), examples of which include breakup processing, Attention List processing, and Lost List processing. Slingshot's GSN Tasking, Collection, Processing, Exploitation, and Dissemination (TCPED) software pipeline also leverages MFAST for catalog maintenance and UCT processing, and the resulting data products are used operationally by both the US Government and commercial customers.

- *For commercial SSA service providers, does the current SSA capability offered by the DoD have any impacts on your current or future product offerings?*

No it does not. A large majority of the commercial LEO satellites are also on Slingshot Beacon and Space-track has not hindered its growth.

- *For commercial SSA service providers, do any of the basic SSA safety services identified for inclusion in TraCSS have any impacts or implications on your current or future product offerings? If so, which services proposed to be part of TraCSS would have an impact on your offerings and why?*

As long as the new TraCSS service is similar to what is offered today with Space-track.org, we do not see a tremendous impact to our business. Should anything additional be added to the list of Basic Services the DoC plans to offer, then this would significantly affect our ability to sell our advanced capabilities directly to O/Os.

- *Are there unique advantages to the government purchasing and redistributing certain commercial services rather than leaving these to the commercial marketplace?*

By purchasing and redistributing certain commercial services, the US Government will allow disadvantaged users to access the data if they choose to participate in TraCSS. Slingshot supports the government purchase of data for this end as it serves the same purpose as our offering of free Beacon. As the commercial space data market matures, there may be a need to move the offering of these services back to the commercial marketplace to allow the industry to continue to grow.

- *Which basic SSA safety services identified for inclusion in TraCSS should be made publicly available?*

    Even though Basic Services will be provided to O/Os, it is not appropriate to make all the underlying data used for those services available to the general public. The guidelines that are currently in place with the DoD model should be sufficient for public release.

- *What, if any, information should owners and operators of spacecraft be required to provide to OSC to participate in TraCSS?*

    The DoC should request that O/Os provide data from their space systems required to facilitate the creation of the decided upon Basic Services, including O/O ephemerides.

- *What, if any, actions should owners and operators agree to take to participate in TraCSS as part of the tenets of participation?*

    As part of the participation in TraCSS, O/Os should be asked to inform the DoC of maneuvers, updates to data formats, disruption of data (planned and unplanned), and activation/decommissioning of spacecraft.

- *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?*

    O/Os should be incentivized to participate in the DoC OSC TraCSS program and notified when a previously agreed upon piece of information is not provided.