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Response to the Request for Information on Scope of Civil Space Situational Awareness Services

The U.S. Department of Commerce, via the Office of Space Commerce (OSC) in the National Oceanic and Atmospheric Administration (NOAA)

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Via Electronic Submission to space.commerce@noaa.gov

Richard DalBello

Director, Office of Space Commerce

National Ocean and Atmospheric Administration

U.S. Department of Commerce

RE: Maxar Mission Solutions Inc. Response to Request for Information (RFI) on Scope of Civil Space Situational Awareness Services.
FR Doc. 2023-01556 (Published January 26, 2023)

Dear Director Richard DalBello:

Maxar Mission Solutions Inc. ("Maxar") submits these comments on behalf of itself and its affiliates, regarding the Office of Space Commerce's planned scope of basic and advanced space safety services to be provided via the Traffic Management System for Space (TraCSS). Maxar appreciates this opportunity to give input on the wide spectrum of space safety topics presented in this RFI.

Maxar is responding to this RFI in two parts.

I. The first part addresses OSC's Traffic Management System for Space (TraCSS) development and implementation plan. Questions posed in RFI Section III. under categories A, B, C, and D are addressed. These categories cover scope of basic services, impacts to commercial Space Situational Awareness (SSA) providers, tenets of participation, and general feedback. Input is given on a phased, test-driven approach to provide basic and advanced SSA services through collaboration with commercial SSA service providers.

   This response is based on our owner/operator experience navigating a constellation of high-resolution imaging satellites in an increasingly crowded low earth orbit regime of debris and maneuvering satellites. Our experience is centered around collaboration between government and industry to improve space safety. We are sharing our insights to help reach our common goal with OSC to achieve a safe and sustainable space environment.

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II. The second part focuses on Maxar's commercial SSA capability. Maxar provides a toolset called BlueGround which allows better understanding and more precise visualization of the orbital environment. This leads to the better traffic management solutions and decisions.

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Part I. TraCSS Development and Implementation

Answers to: A. Scope of Proposed Basic SSA Safety Services

Introduction

The following outline addresses TraCSS development and implementation, by addressing questions under Part A. "Scope of Proposed Basic SSA Services".

This outline is presented in a suggested time order of services to be implemented. This presents a priority of starting with smaller basic services, building basic and advanced capability in pieces, and testing and delivering capability throughout the process.

Foundational basic services that are needed sooner are identified, to be built upon over time.

The objective is to achieve success in a stepwise fashion while accommodating improved technologies.

Improved technologies can best come from domestic commercial SSA data and service providers, only as their products can be demonstrated to augment or surpass current DoD system accuracy, completeness, robustness, and speed.

Suggested new services and capabilities are included in the outline below. Many are in addition to those listed under the RFI Supplementary Information given in Section II. "Description of Basic Safety SSA Services".

This outline answers OSC specific questions:

- **"What, if any, additional capabilities beyond those currently provided by the DoD should be included in the TraCSS?"**
- **"Are there 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?**
- **"Are there any matters not discussed above that OSC should or must consider before it provides basic SSA safety services through TraCSS?"**

Priority and level of necessity are included below, to answer these questions:

- **"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?"**
- **"What proposed basic safety SSA services are essential to your ongoing operations?"**
- **"If the U.S. Government were to prioritize the delivery of individual services as part of TraCSS, which ones should be provided soonest?"**

Progression of OSC TraCSS Development

TraCSS should initially leverage existing DoD sensors and processing capability as its baseline system. Improved commercial capabilities should be phased in as each new capability is demonstrated to be superior to the baseline system. Metrics for superiority should be well-defined and published first, as a foundational tool used to qualify orbit determination and prediction improvements over time.

Progression:

A. Initial Baseline System

Use existing DoD sensors, processing capability, products, and satellite owner/operator (O/O) facing portal (space-track.org). This is default system, currently in operations*

B. TraCSS Portal and Repository

Develop new O/O facing portal and data repository into TraCSS. Portal and data repository should be built for scalability and speed increases expected in the future with a growing space object population in low earth orbit.

i. Sufficient data connectivity from current DoD system is necessary.
Authoritative DoD catalog should be transferred to TraCSS, nominally 3x/day, for processing outlined below in item L. "Improved Space Object Tracking".
Other DoD products should be transferred for shadow operations comparisons, detailed below in item C. "Shadow operations".

ii. Standard published interfaces should be used for all incoming data and outgoing products, including intermediate data files. This is to allow products from new commercial vendors to plug in without new software development.

iii. An underlying database storage framework, as opposed to flat file storage, should be considered to lay the foundation to support an inevitably growing space object population.

iv. Add O/O directory to provide:
    a. contact information for 24/7 operational communication to each O/O*
    b. list of satellites and on-orbit assets per O/O, including supplementary information indexed to each object:
        i. satellite dimensions, including appendages, average hard body radius (HBR), and mass
        ii. image of satellite if available

* Existing DoD capability

iii. O/O option to provide time-varying HBR time series, based on their satellite orientation
iv. status: alive or dead*
v. status: maneuverable using propulsion or non-maneuverable[1]
vi. status: whether operator intentionally adjusts drag profile to affect orbital period adjustments (differential drag).
vii. cross-index, using underlying database, of each satellite catalog ID to conjunction data messages (CDMs), so user can bring up O/O and satellite supplementary information from a CDM list.
viii. time series of historical maneuvers as graphical plot and data table for each maneuverable space object.

This is **RFI Section II (1) "Satellite Attributes, Capabilities, Status, and Point of Contact (Included)".**

v. Baseline DoD products can be incorporated into repository first, feeding in from DoD system for distribution out to O/Os.

For example:

a. Conjunction Data Messages (CDMs)
b. then O/O predicted ephemerides made available for download
c. then receipt of O/O predicted ephemerides in from O/O, and sent to DoD system for screenings, and eventually used by TraCSS for screenings (in item L. below).
d. O/O maneuver data files. These data are sent in from O/O given in CCSDS Orbit Parameter Message (OPM) format.

This is **RFI Section II (2) "Receipt and Sharing of O/O Predicted Ephemerides (Included)".**

vi. Portal and repository can be tested non-operationally, and proven out first with limited number of beta users.

vii. TraCSS portal and repository can be built and maintained by commercial vendors, but all incoming data and outgoing products should follow established public Interface Control Documents (ICDs) and be agnostic of data source or product destination, with no proprietary formats, and not tied to any specific commercial vendors.

C. Shadow Operations.

Include shadow operations data storage capability to be used for continuous comparisons of new system components versus default baseline system output products.

* Existing DoD capability

i. Initial baseline system data will be imported from current DoD system. For example, these data sets are determined Special Perturbations (SP) ephemerides, predicted SP ephemerides, each with associated covariance, and CDMs.

ii. Products from new commercial sources will use this shadow ops capability for verification.

iii. In general, this repository and portal should be developed, tested, and brought on-line in stages at logical break points, using continuous shadow operations of new capabilities against default system for verification.

D. Demonstration Area

Include capability for separate demonstration area that is fed with actual real-time data, for example, sensor observations and O/O predicted ephemerides.

i. This demonstration area should allow parallel test versions of processing and product generation that can be demonstrated and verified against shadow operations data.

ii. Standard set of metrics given below, in item E, will be gauge for success of new capabilities.

E. Metrics

Concurrently, develop standard metrics to gauge product superiority.

i. Metrics should be well-defined and published.

ii. For TraCSS data transfer and services that interface with O/Os, metrics are:

- accessibility
- scalability
- transparency
- clarity
- completeness
- reduction of O/O collision risk
- speed of upload and download
- ease of user manual or API (Application Programming Interface) automated operation
- security of uploaded products through industry-standard encryption

iii. For internal space object orbit determination and prediction products, metrics are:

- accuracy of predicted ephemeris
- realism of associated covariance throughout predicted ephemeris span

- speed of updating cataloged predicted ephemerides given new observations of space objects or new O/O predicted ephemerides
- catalog completeness

iv. Metric results of accuracy and covariance realism for catalog objects should be published on TraCSS in an easily grasped graphical format. This is so commercial SSA providers can gauge their system's capabilities against a robust authoritative catalog. Catalog objects can be characterized in bins with logically similar objects.

v. OSC should own and manage the operational metrics. This is to allow objective judgements to be made across multiple vendor and government agency products. In other words, contractors should not monitor and manage the metrics.

vi. Using underlying database, each primary satellite catalog ID is cross-indexed to the most recent predicted ephemeris accuracy and covariance realism metrics, so user can bring up metrics from CDM list.

F. Sensor Tasking

Concurrently to above, the first new added capability within TraCSS should be the addition of sensor tasking capability and tasking feedback to O/Os. This capability is applied to secondary objects involved in conjunctions with maneuverable satellites. This is the highest priority new service for O/Os to improve collision risk with sparsely tracked debris.

This is **RFI Section II. (11) "Conjunction Object Solution Improvements with Additional Tracking (Included)".**

As a starting step, provide notification to O/O of status, including date/time when existing DoD-based secondary object tasking has increased for upcoming conjunction. This information can potentially be included in CDM.

Improve on DoD sensor tasking criteria so that covariance on secondary object is reduced through increased observations.

An example of improved tasking criteria is to consider Probability of Collision (PC) dilution, where secondary object covariance can be reduced in size through additional tracking. This allows more accurate PC calculation and assessment of conjunction.

DoD-based secondary object sensor tasking should consider tasking commercial sensors.

Benefits of sensor tasking to reduce collision risk can be measured and optimized. Metrics above in item E. can quantify space object orbit determination and prediction accuracy improvements through smaller covariance, and its positive effect on producing actionable risk assessment data to O/O.

G. This service will immediately add accuracy and reduce collision risk in O/O conjunction assessment.Expected Tracking Metrics

The second added capability within this new portal and repository should be the addition of expected tracking determination.

i. This is **RFI Section II. (12) "Expected Tracking Determination (Included)".**

ii. Developing in small steps, providing pass schedule and probabilities of detection for upcoming commercial tracking will be valuable. Although, value is limited in LEO until commercial observations can lead to higher prediction ephemeris accuracy for sparsely-tracked debris compared to default DoD system.

H. Risk Assessment Graphics

The third added capability of a new portal and repository should be the addition of risk assessment time history plots.

i. This is **RFI Section II. (13) "Risk Assessment Time History Plots (Included)".**

ii. These will be immediately valuable to O/O by improving their conjunction assessment.

iii. Implementation will be relatively straightforward based upon database driven design of TraCSS data storage.

I. Orbit Determination and Prediction Quality Evaluation

The fourth added capability should be orbit determination and prediction quality metric evaluation.

i. This is **RFI Section II. (5) "Data Quality Evaluation (Included)"**.

ii. These will be immediately valuable to O/O by improving their conjunction assessment.

iii. This capability should be combined with above "Risk Assessment Time History Plots", as assessment of both datasets will be done together by O/O.

J. Commercial Vendor Access

Commercial vendors should be given access to demonstrate their products in the demonstration area outlined in D. above.

i. For example, the added capabilities in F, G, H and I above [RFI Section II. Services (11),(12),(13) and (5)] can be provided by commercial vendors, after demonstrating quality of their products. Multiple vendors can compete, with metrics in E. serving as quality gauge for selection by OSC.

ii. Using this demonstration system, new commercial products can be run to demonstrate their improvements, allowing OSC to move out underperforming vendors and adopt best products and services available. Cost versus value of improvements should be considered. Competition between one or more commercial vendors should be facilitated, to allow competition to keep cost acceptable.

K. Improved Space Object Tracking

i. Transfer and synchronize DoD authoritative catalog (predicted ephemerides and associated covariance) into TraCSS from DoD system on a continual basis. This is nominally 3x/day coinciding with DoD catalog update cadence.

ii. Accuracy metrics (item E above) are to be applied to gauge accuracy and covariance realism for all objects in authoritative DoD catalog.

iii. Add capability to swap in and use new estimates of space object trajectories that have more accuracy and realistic covariance than authoritative catalog trajectories, based on standard accuracy metrics (above in item E). Consider accuracy metrics that are sustained for a period of time before swapping out, to verify stability of accuracy improvements. Maintain accounting of source of cataloged predicted ephemerides. This accounting allows on-going comparisons of all "best estimate" ephemerides versus estimates from DoD if applicable and other commercial sources.

iv. These new trajectories should come from commercial SSA data providers, based on their own tracking.

v. This aligns with Space Policy Directive-3 to catalog improved trajectories of space debris. [SPD-3 Sec. (5) Guidelines, (a)(i) Improving SSA coverage and accuracy].

vi. This is permanent on-going activity, as improving authoritative space object catalog entries requires on-going effort towards accuracy and completeness.

vii. For new estimates of space object trajectories from outside the DoD system, i.e. from commercial sources, the orbit determination and prediction should be run following receipt of new valid tracking observations.

viii. The DoC should fund commercial data providers at a base level, and then pay additional fees based on number of objects' ephemeris estimates that exceed quality metrics of current authoritative catalog ephemeris. This escalating pay structure is to incentivize

commercial innovation in sensor development, orbit determination and prediction algorithm accuracy.

ix. As long as commercially-produced predicted ephemerides do not meet or exceed DoD ephemerides accuracy, combining (also known as fusing) DoD and commercial sensor observations should be pursued.

a. Combining tracking data in the orbit determination filter allows observations to be weighted based on known sensor quality and leads to a satellite position and velocity estimate optimized for accuracy.

b. Resulting predicted ephemeris, used for conjunction assessment, will have higher accuracy compared to predicted ephemerides stemming from disparate sets of tracking observations.

L. Screening Capability

Add screening capability to produce CDMs.

i. As any new O/O predicted ephemeris is received, it should be automatically screened versus current catalog, and CDMs immediately sent out. This supports maneuvering satellites, including constellations with automated on-board collision avoidance systems. This capability replaces manual "Special" screenings.

ii. It is still sufficient to run nominal primary satellite (SP estimate of primary satellite) screenings versus catalog 3x/day.*

iii. Add new capability: expose time of last observation.
O/O enters catalog number of space object into portal, and time of last observation is returned. Make available through API connection.

iv. Add new capability: automated 1-versus-1 screening.
O/O inputs primary and secondary catalog numbers and desired screening volume into portal. Make this input available through API connection.
Each objects' orbit determination and prediction are automatically updated if new observations have been received since the previous update.
Resulting CDMs are posted for download.
If manual intervention is needed due to an anomalous orbit determination, then message to that effect is sent with reason for orbit determination failure.

* Existing DoD capability

This is **RFI Section II. (3) "Routine Collision Assessment (CA) Screening and Conjunction Data Message (CDM) Production (Included)"** combined with **RFI Section II. (4) "Special CA Screening and CDM Production (Included)"**.

M. Improved Orbit Determination and Prediction Algorithms

i. Several of proposed services in the RFI Section II are temporary gap filler capabilities, developed because these improved capabilities could not, or have not yet, been added to baseline DoD algorithms.

ii. Each of these services increases accuracy and completeness of TraCSS output data, leading to increased space safety for O/O and thus should be available to all O/O as basic services. They should be included in TraCSS, not added-on as separate service.

iii. They are from **RFI Section II:**

(9) "Precision Probability of Collision (PC) Calculation (Included)"

a. More accurate Hard-Body Radius (HBR) calculation, to account for encounter dynamics, should be included in standard TraCSS PC calculation that is reported in CDM.

b. More accurate HBR calculation that incorporates satellite orientation should be performed when O/O has provided satellite orientation time series (above B.iv.b.ii.).

(10) "Collision Consequence and Debris Production Potential (Included)"

a. Agree, this metric should be included in TraCSS as a standard output in CDM along with Probability of Collision (PC).

b. However, it should be clear to O/O that goal of TraCCS is to prevent generation of any new debris by minimizing PC for each conjunction.

(14) "Space Weather Sensitivity (Included)"

a. NOAA Space Weather Prediction Center (SWPC) Product Subscription Service should be leveraged to provide warnings. No need to duplicate in TraCSS.

Corresponding changes to atmospheric density should be incorporated into atmospheric model used in orbit determination and orbit prediction. Uncertainties in upcoming atmospheric density should be included predicted ephemeris covariance. This is so predicted ephemerides used in conjunction assessment include drag effects and

uncertainty of upcoming space weather events. Accuracy of atmospheric model used should be gauged by predicted ephemerides metrics in E.

(15) "Fusion of CA products (Included)"

a. Fusion of conjunction assessment (CA) products leads to difficulties in interpretation, as quality of original products may not be conveyed and understood by users.

b. Better solution is to put effort into fusing CA data at the tracking observation level, where observations can be weighted based on known sensor quality. This is listed above under K. "Improved space object tracking", item ix.

c. Resulting CA products (CDMs) will reflect that optimized accuracy of better orbit determination based on combined, or fused, observations.

(16) "PC Variability (Included)"

a. As an add-on, this service is making up for a lack of covariance realism is current O/O and catalog predicted ephemerides.

b. Better solution is to automatically apply covariance realism metrics, given under E. above, to O/O predicted ephemerides and cataloged ephemerides. Realistic covariance scaling can be derived based on these metrics. Resulting PC calculation in TraCCS will incorporate realistic covariance size, and PC scaling will not be needed.

(22) "Breakup Detection, Cataloging, and Tracking (Not Included)"

a. This service is essential to space safety and should be included as a basic TraCSS service.

b. Space safety requires that new space debris be tracked and cataloged accurately as soon as possible for CDM production.

(23) "Maneuver Detection and Processing (Not Included)"

a. This service is essential to space safety and should be included as a basic TraCSS service.

b. Detection of a maneuvering space object should be standard.

c. Maneuvers should be accounted for and solved for in orbit determination. Currently DoD uses Orbit Parameter Message (OPM) formatted files for O/O maneuver data. If O/O maneuver data exists for current orbit determination span, it can be used to aid delta-V solution.

d. Resulting predicted ephemeris should be marked accordingly in CDM if recent maneuver occurred, especially for low-thrust maneuver running past end of orbit determination span. O/O would be alerted to use CDM based on O/O predicted ephemeris, which should include modeled burn in future.

e. Using historical ephemerides, TraCSS should detect past maneuvers for all active and maneuverable satellites and make this maneuver time series available publicly. O/O should access it as part of standard data available, indexed per catalog ID (as all satellite data given in B. iv. "O/O directory" above). O/O can use this time series to gauge possibilities of upcoming maneuvers in their conjunction assessment that involve this satellite as a secondary object.

N. Advanced Services

Advanced services, available on a fee-based subscription basis, are not included in TraCSS basic services.

These are suggested advanced services from **RFI Section II:**

(7) "Ephemeris Generation and Curation with Covariance (Included)"

i. This service can be separate from TraCSS. There are no TraCCS datasets or processes that are required to accomplish this task. TraCSS can recommend commercial vendors to O/O for this service, but it should not be included as a basic free service in TraCSS.

ii. O/O should be responsible for completing this task, either in-house or through commercial vendor.

iii. If O/O satellites have on-board Global Navigation Satellite System (GNSS) capability and can download GNSS telemetry, the O/O should have resources to perform orbit determination, orbit predictions that include future maneuvers, and realistic covariance calculation. If O/O does not have technical expertise for any of these functions, appropriate commercial vendors should be contracted by O/O to perform the tasks. The O/O should allocate resources for this task at the outset of their mission.

iv. If this was a free service provided by TraCSS, O/Os would potentially plan to take unfair advantage of this service to save cost in the case that predicted ephemerides are required to execute their mission.

The following services extend beyond the basic space safety services of providing accurate predicted ephemerides in an authoritative catalog and associated metrics for conjunction assessment.

Commercial vendors should be required to follow established best practices in performing these services, i.e. the Space Safety Coalition Best Practices for Sustainable Space Operations (https://spacesafety.org/best-practices/).

O/O should be charged a fee for these advanced services:

(17) "Additional Concierge Services (Not Included)"
(18) "Anomaly Resolution (Not Included)"
(19) "Design-Time Assistance for Improved CA (Not Included)"
(20) "Maneuver Trade Space (Not Included)"
(21) "Optimized Maneuver Recommendations (Not Included)"

O. Launch and Reentry Standard Services*

(6) "Launch Collision Avoidance (COLA) and Screenings (Included)"
(8) "Re-entry Management and Assessment (Included)"

These should each continue to be available as free basic services to support space safety.

Answers to B. "Impacts of Proposed Basic SSA Safety Services on Commercial SSA Providers"

Addressing these questions:

1. **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?**

   Yes. Time history analysis of conjunction assessment parameters is available. Data quality time history plots are available. Screenings of O/O predicted ephemerides against each other are available. Screenings versus a commercially-derived catalog are available.

   No comment on affordability to O/Os.

2. **For O/Os, are any of the basic SSA safety services identified for inclusion in TraCSS duplicative of what O/Os of spacecraft are already responsible for obtaining or providing?**

* Existing DoD capability

Yes. However, O/Os perform these services only to the best of their ability, given constraints on limited SSA data available to them in CDMs.

Aside from **(7) "O/O Ephemeris Generation and Curation with Covariance (Included)"**, all of these services can be more accurate and complete if performed in TraCSS, using tracking and covariance parameters that are not available to the O/O.

These are duplicative services:

(4) "Special CA Screening and CDM Production (Included)"

O/Os can screen their predicted trajectories against a catalog built from prior CDM secondary objects, to save time requesting a special screening from the DoD. The drawback is that their O/O internal catalog, based on only their prior CDMs, is incomplete.

(5) "Data Quality and Evaluation (Included)"

O/Os perform data quality and evaluation, but do not have access to number and distribution of tracking sensors to help evaluate secondary object ephemeris quality.

(7) "O/O Ephemeris Generation and Curation with Covariance (Included)"

O/Os routinely perform this task.

(13) "Risk Assessment Time History Plots (Included)"

O/Os can make time histories for only CDM parameters. Time histories can be made more complete for conjunction assessment with a wider array of parameters in the orbit determination and prediction process.

(14) "Space Weather Sensitivity (Included)"

O/Os incorporate predicted space weather events into their predicted ephemerides calculations using solar atmospheric and geomagnetic predictions available from NOAA and the U.S. Air Force. For example, see https://www.swpc.noaa.gov/products/usaf-45-day-ap-and-f107cm-flux-forecast . O/Os have limited insight into uncertainty in secondary object SP predicted ephemerides due to upcoming solar events.

(16) "PC Variability (Included)"

O/Os compute Max PC and use other methods to inflate PC based on time series of CDM parameters, to attempt to calculate a more accurate PC.

(23) "Maneuver Detection and Processing (Not Included)"

Maneuverability status of other satellites can be done by O/Os, by analyzing a time series of historical Two-Line Element sets (TLEs) to detect propulsive energy added to an orbit. It is

better done through maneuver detection in tracking data within the orbit determination data arc.

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

   Yes, for basic SSA services (listed above in items A through O). These are required to accomplish space safety and need to be included in a centralized and coordinated TraCSS system to utilize the robust authoritative catalog and associated metrics.

   For advanced services, no, there is not an advantage to the government purchasing and redistributing these services. They should be left to the commercial marketplace. These suggested services are listed above in N. "Advanced Services".

Answers to C. "Tenets of Participation and Receipt of Basic SSA Safety Services"

Addressing these questions:

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

   i. It is in the best interest of the government and all O/Os to prevent collisions and generation of new space debris, through collaboration and access to all basic space safety services.

   ii. Goals of OSC should be to:

      a. provide the most accurate and timely conjunction assessment (CA) data possible in TraCSS
      b. reach 100% participation and uptake in TraCSS services from all global O/Os.

      To this end, there should be no barriers for participation and all basic services should be provided publicly free of charge.

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

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

   i. Space safety for all global O/Os will increase proportionally to the number of O/Os that use TraCSS data and services.

ii. To reach the highest level of space safety possible, O/Os should be incentivized to fully participate in TraCSS. Access to TraCSS should be freely available to all O/Os, and not doled out based on behavior, capabilities, or political affiliation.

iii. There should no potential excuse or reasoning available for a satellite owner/operator to decline participation in TraCSS. If suppling predicted ephemerides is a requirement to participate, that could be spun into an excuse to justify opting out of participation.

iv. Conversely, OSC should intentionally reach out to encourage and guide inclusion from O/Os who are apathetic, ambivalent, underfunded, insecure in their technical expertise, or strategically misaligned with the U.S. government.

v. Denying TraCSS services would foster exclusion, just the opposite desired effect for space safety. Minimal participation, i.e. simply unilaterally responding to CDMs, is better than exclusion, which would lead to a space actor becoming worse.

vi. Instead, OSC should highlight top performing O/Os in TraCSS.

   a. Ranking can be made based on accuracy of O/O predicted trajectories and associated covariance realism, and completeness of O/O directory information, i.e. up-to-date status of satellite maneuverability.

   b. This ranking can be publicized with prominent easy-to-grasp graphical results.

   c. This should incentivize good behavior by each O/O as a source of national pride and foster competition to improve their technology. Space has been an arena for national pride in technology expertise since the launch of Sputnik in 1957.

Answers to D. General Feedback

OSC welcomes feedback about any other related topics. For example, are there any matters not discussed above that OSC should or must consider before it provides basic SSA safety services through TraCSS?

Feedback on suggested TraCSS priorities, foundational metrics, a development and testing framework, and new capabilities are given above in section A.

Part II. Commercial SSA Capability

Answers to B. Impacts of Proposed Basic SSA Safety Services on Commercial SSA Providers

As a Commercial SSA provider, Maxar provides the following input to the questions posed in part B of the RFI.

1. 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?

Maxar provides exquisite space system Modeling and Simulation (MODSIM) and Mission Management capabilities and has been a recognized and respected provider of those products for over 15 years starting with former RadiantBlue Technologies. Maxar's capabilities support responsive, quantifiable assessment and effective deployment and operation of ISR payloads, systems, and mission architectures enabling Force Design to Execution. One of our products, the BlueGround Feasibility Tool (BFT), uses our physics-based mission planning tool suite as its core engine. Since both our MODSIM and Mission Management capabilities are built off the same libraries and services, this enables a true "Train like you Fight" software tool suite. BlueGround applications have been developed and deployed in over a dozen instances, from MODSIM to prototype to operations.

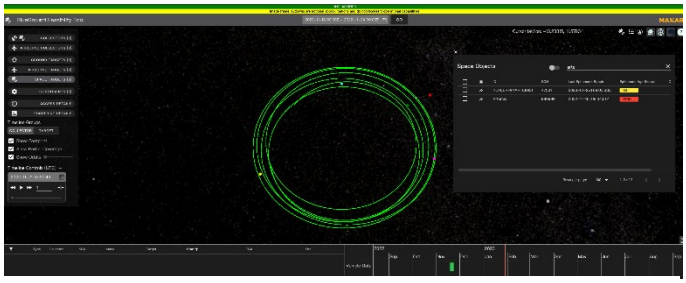

Figure 1 Orbit Modeling and Simulation Example

The BFT utilizes high fidelity force models to provide SSA for O/Os with a focus in access analysis for ground to space, space to ground, and space to space accesses. The feasibility tool utilizes the mature and validated BlueGround toolset and spacecraft ephemerides feeds to perform spacecraft propagation, including spacecraft covariance. Access analysis informs O/Os of access duration, start and end time of access, Time of Closest Approach (TCA), Ground Sample Distance (GSD) during access, as well as additional useful access properties. The tool can be leveraged for custody identification, tracking determination, future feasibility prediction for along-track imaging, and collection planning. It is proposed that the tool be offered as a concierge service in TraCSS for interested parties concerned with tasking collection and imagery.

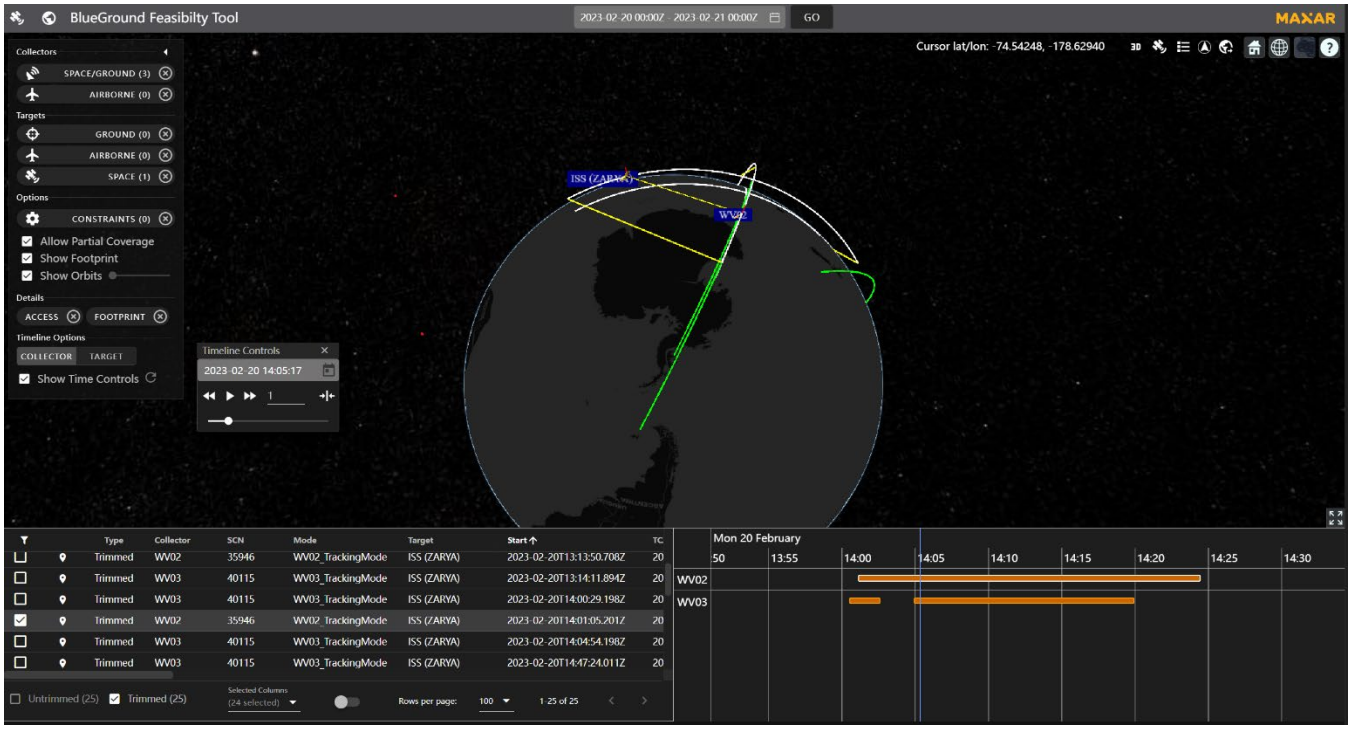

Figure 2 Space-to-Space Visualization

A key strength of this tool is the ability to tell customers when the next tracking will occur and provide an understanding of whether better data will be available before they have to make a maneuver decision.

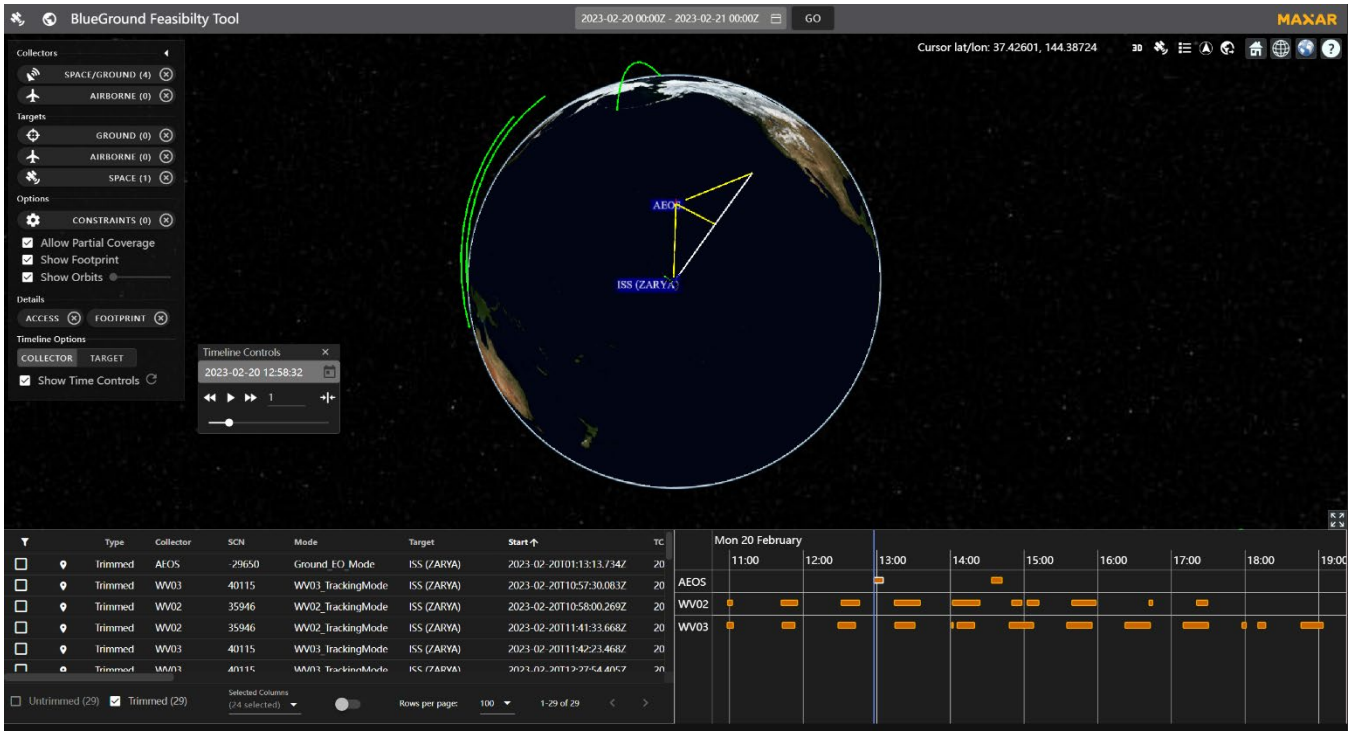

Figure 3 Ground-to-Space Visualization

The BFT provides O/Os with ongoing contact/custody analysis using constantly updating spacecraft ephemerides and the Maxar BlueGround system. The built-in high-fidelity force model allows O/Os to perform future propagation and feasibility analysis of ground to space, space to ground, and space to space access assessments in order to plan and carry out collections. The tool allows O/Os to constrain access time frames and sort returned accesses bypass time, start/end of access, TCA, GSD, and additional access properties. In addition to access analysis, the BlueGround system provides ongoing covariance propagation. These services are currently available to several government customers and could be made available in an affordable manner to commercial customers via direct sale or as part of a government service offering.

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

Maxar envisions a product offering portfolio as an augmentation to the current capabilities offered by the DoD and future offerings from OSC. As the BFT has been delivered and utilized by government customers and it is validated for contact location and collection planning, we see a market for some SSA services beyond the current basic capability. We'll continue to look for ways to augment and

improve SSA capabilities understanding that the needs of the market and the capabilities provided by the government will continue to progress.

3. **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?**

No, it is understood that a certain level of basic safety services must be provided for the benefit of all satellite providers. Our capabilities augment these basic services and can be employed to gain a better understanding of the orbital environment.

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

As detailed in the response above, there are unique advantages for basic SSA services. These are required to accomplish space safety and need to be included in a centralized and coordinated TraCSS system to utilize the robust authoritative catalog and associated metrics.

For advanced services, no, there is not an advantage to the government purchasing and redistributing these services. They should be left to the commercial marketplace. The BFT is envisioned as an offering to O/Os as a concierge service to TraCSS. Not all O/Os will utilize the tool, but certain O/Os may find it a useful resource for certain planning and tasking activities. This service can be provided most effectively through a service level agreement (SLA) with guaranteed support levels at certain price points. This allows for a consistency of service availability and an understanding of the ability of the product to meet the needs and requirements of the O/Os and the government.

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Thank you for the opportunity to express Maxar's comments with respect to this issue. This matter is of significant importance to Maxar. Please direct any questions or follow up from these comments to:

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