Space Traffic Coordination for Safety & Sustainability

Office of Space Commerce

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National Oceanic and Atmospheric Administration

U.S. Department of Commerce

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Visualizing the Problem

Growth of Human Artifacts in Space

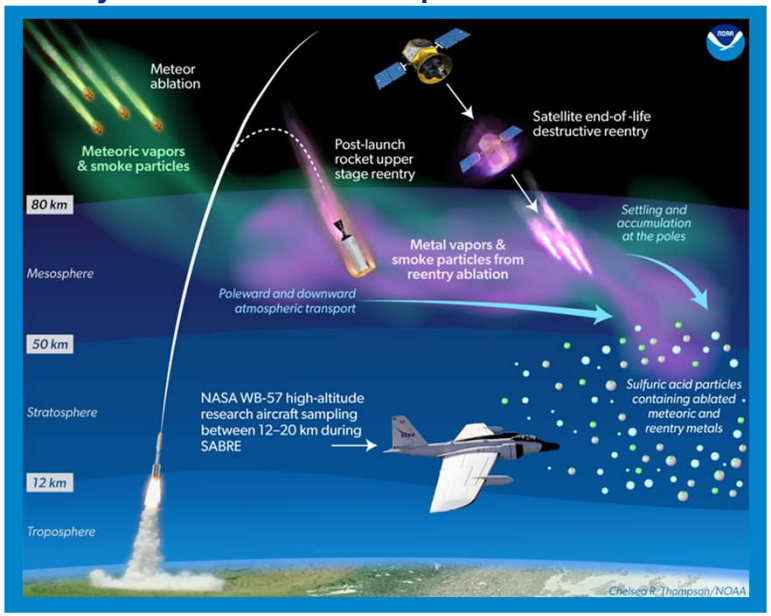
1957
2

1990
~9000

2024
~500,000
(> 1cm)

Sustainability is More than Space Debris

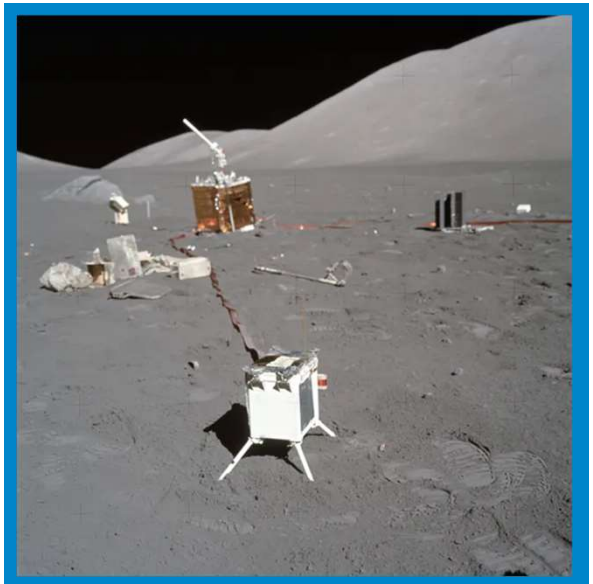
Reentry Materials into Stratospheric Particles



Dark and Quiet Skies

Credit: ESO

Lunar Debris



Credit: NASA

Orbital Loading Challenges

Structure increases capacity, but limits individual freedom

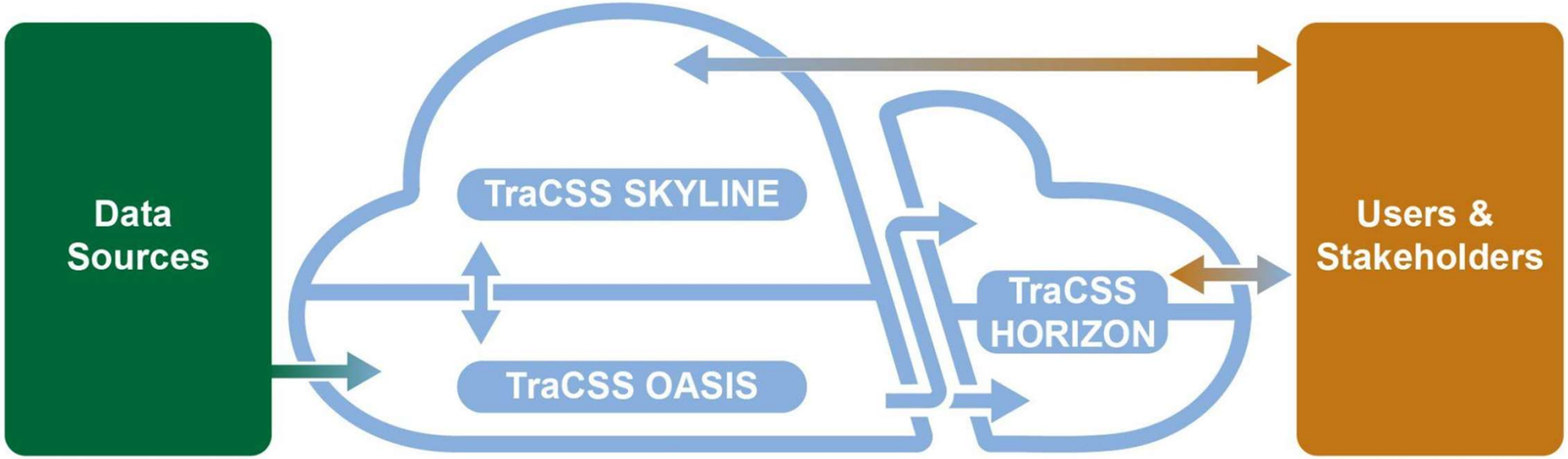
- Who gets to park in what spaces?
- Who, if anyone, enforces the rules?

Current SSA Limitations

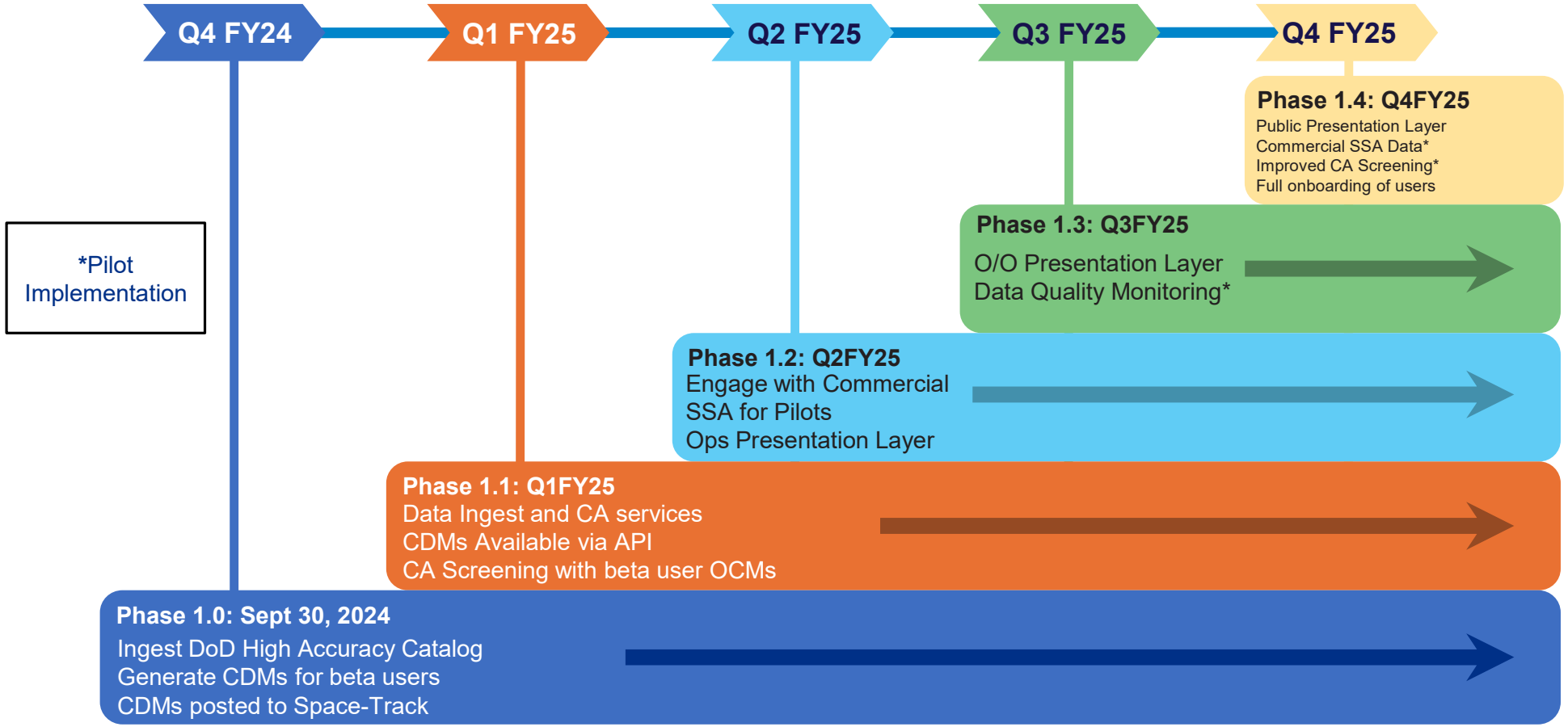
- Traditional SSA approaches have several known limitations:
  - Limited sensors and field of view
  - Ephemeris updates can occur at a slow cadence
  - Ephemeris calculations may include errors- sometimes 100 meters or more
  - Challenges keeping up with a dynamic environment, i.e. constantly maneuvering satellites

- Owner/Operator Ephemeris can contribute to safety, but there are still concerns:
  - Wide range of quality, particularly between established and new operators
  - Limited insight into how ephemeris is generated
  - Limited insight into maneuver planning and changes

The TraCSS Architecture



Phase 1 Capability Roll-Out Plan: Phased Delivery of Commercial Functionality



TraCSS' Safety Services

TraCSS will provide access to selected SSA data and information to spacecraft operators and governments, including:

- SSA data and information
- Conjunction screening every 4 hours using catalog and o/o ephemerides
- Risk assessment support information
- Detection and notification of emergency events
- Candidate maneuver screening
- Anomaly reporting

EUSST & TraCSS Services Comparison Summary (as of Aug 2024)

Service	EU SST	TraCSS
1. SSA Information As a Service		
1.1 Contact information	No	Yes
1.2 Satellite attributes	No	Yes
1.3 O/O ephemerides with planned maneuvers	No	Yes
1.4 Catalog of space objects	Future Phase	Yes
2. In-Orbit Collision Avoidance Service		
2.1 Routine catalog and O/O ephemerides screening and CDM production	Yes	Yes
2.2 Risk Assessment[1] and Detection and Notification of High Interest Events/Emergency Events	Yes	Yes
2.3 Additional tracking on the secondary and/or primary objects	Yes	Yes
2.4 Basic CAM Options for selection by O/O[2]	Yes	Yes
2.5 Candidate CAM Screening	Yes	Yes
2.6 For selected HIE/Emergency Events, dialogue with O/O[2]	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		
7.1 Launch Collision Avoidance service	TBD	Future Phase
7.2 Improved O/O Ephemerides	TBD	TBD
7.3 Space Weather Information and Atmospheric Drag Model	No	TBD
7.4 Traffic Coordination Platform as a Service	TBD	TBD

World Economic Forum SSA Data Report

- SSA data and information should be made open by default while remaining consistent with national laws and regulations.
- Spacecraft owners/operators should share up-to-date contact information, ephemerides, manoeuvre plans and spacecraft characteristics (*including size, mass, dimensions and manoeuvre capabilities*) as openly as possible.
- Spacecraft owner/operator information should be provided to at least one SSA provider. This provider should then make the data available to all other SSA providers.
- Government SSA providers should share conjunction warnings, and, ...share information about their satellite catalogues and sensor observations.

Global Future Council on the Future of Space

Space Situational Awareness Data and Information Sharing Principles

BRIEFING PAPER
SEPTEMBER 2024

WORLD ECONOMIC FORUM

The number of spacecraft orbiting Earth has increased rapidly in recent years, from fewer than 1,500 in 2014 to more than 9,800 today, and more than 80 nations are involved in space activity.[1] Satellites have become critical to the global economy, providing communications, timing, navigation and information services that support global industry. Individuals rely on satellites for their daily weather reports, directions and internet connectivity. While the increasing activity provides significant benefits to individuals on Earth, it also poses challenges for space safety and sustainability as space becomes increasingly congested and the risk of unintentional collisions increases.

Space situational awareness (SSA) – the ability to monitor the location of objects in orbit, predict their future location and warn of potential collisions – provides the foundation for space safety and sustainability.[2] Accurate SSA information promotes greater understanding of evolving conditions in space and prevents collisions that create harmful debris. SSA information and services also provide the foundation for the stability and predictability needed for the continued growth of the global space sector.

Information sharing among space actors improves the accuracy and effectiveness of SSA information and services. Space safety requires spacecraft operators around the world to communicate with SSA providers and with each other to avoid potential collisions. As the number of SSA providers worldwide grows, it is becoming increasingly important that these providers coordinate and share information to improve their predictions and avoid providing conflicting information to operators. There are significant opportunities for improving global SSA data and information sharing to support space safety and sustainability, even while protecting valid national security and commercial competitiveness interests.

Adopting the United Nations' (UN) *Guidelines for Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space* (specifically Guideline B1) has promoted consensus on the importance of SSA data sharing. Many industry and government best practices documents have reinforced the importance of this issue.[3] Yet significant gaps in data sharing remain. This paper identifies key actors and data to be exchanged and proposes principles for global SSA data and information sharing.

SSA data and information

Many actors in the space sector involved in providing and using SSA information and services could exchange various types of data and information to improve space safety.

SSA service providers to spacecraft operators: Governmental and private entities operate many sensors that observe objects in space. Meanwhile, private and governmental SSA service providers use these observations to generate and update a catalogue of space objects – a listing of objects in space and their locations at a given time. Because space objects generally move in predictable orbits, SSA providers can also conduct analyses of these observations over time to generate predictions of where space objects will be in the future and to identify potential collisions or conjunctions between objects. Timely provision of these conjunction warnings to satellite operators enables them to respond and avoid potential collisions.

In addition to SSA information and services, SSA providers and organizations with relevant expertise may share their knowledge by providing training for spacecraft operators. Such training helps ensure that spacecraft operators can efficiently use the information and products provided.

Spacecraft operators to SSA service providers: Satellite and other spacecraft operators should proactively seek to receive and use these SSA services (including conjunction warnings) in accordance with national law and regulations. Spacecraft operators also have a fundamental role to play in data sharing. Usually, spacecraft operators have more precise and timely information about the orbital location and trajectory of their spacecraft (spacecraft ephemerides) than SSA service providers do, and they inevitably know more about their own contact information and manoeuvre plans. SSA providers need all this information to supply timely warnings, and fellow operators need it to coordinate a response.

Owners or operators could supply SSA providers with these plans when planning manoeuvres. This would enable the incorporation of planned manoeuvres into the predictions of future spacecraft locations, thereby greatly enhancing the accuracy of conjunction analyses.

Goals of TraCSS Data Policy

- Emphasize openness and transparency of data.
- Provide space situational awareness (SSA) data and services that support global spaceflight safety, sustainability, and international coordination.
- Implement SPD-3 guidance to enable greater SSA data sharing, consistent with national security constraints.
- Access to data can also enable:
  - Support of the growth of the global SSA industry
  - Encourage entrepreneurship and the development of value-added services
  - Advance research and development in SSA technology
  - Encourage transparency and public engagement

TraCSS Open Data

- DoD public element sets catalog (aka two-line elements (TLE) catalog).
- DoD public satellite catalog (SATCAT), including satellite name and NORAD ID, launch date, launch location, international designator, apogee, perigee, period, inclination, and size (binned RCS) provided by the DOD.
- NASA mass and size catalog, developed by NASA based on U.S. sensor data and additional sources.
- Satellite attributes provided to TraCSS by satellite owner/ operators.
- Satellite ephemerides with covariance and maneuver plans provided to TraCSS by satellite owner/ operators.
- “Emergency event” conjunction notifications for all events that meet “emergency criteria” defined by TraCSS, including events involving operational objects and/or debris.
- Other publicly-available information, as relevant.

TraCSS Restricted Data

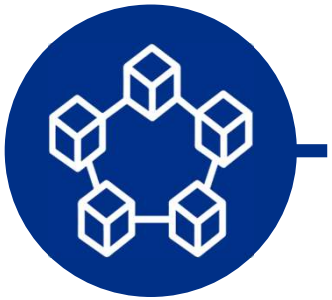
Owner/ Operator Operational Contact Directory:

- Available to all registered TraCSS users
- Also shared with other national or regional SSA providers to facilitate international coordination

Conjunction Data Messages:

- Available to spacecraft owner/ operators involved in conjunction (and registered in TraCSS)
- Available to government entities with which satellites are associated

The “Global SSA Future” Vision



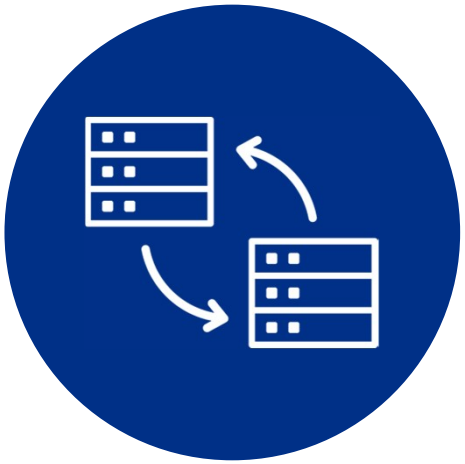
We envision a **global coordinated system of space situational awareness providers**, with a series of national or regional hubs providing information and services to spacecraft operators. **These centers will be supported by networks of international and commercial partnerships.**

Government services will be augmented by a **robust global commercial space situational awareness sector that provides value-added services** to support business intelligence and other advanced services.

The Department of Commerce is committed to maintaining an **open and transparent system** that enables global coordination with other global SSA providers.

“Global SSA Future” Implementation

SSA Data Standards



SSA Information Sharing Principles

Satellite Operator Engagement

International Partnerships & Communication

Engage with OSC on TraCSS

TraCSS webpage

https://www.space.commerce.gov/tracss

News, videos, and information on engagements, including past and upcoming public listening sessions

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tracss.commerce@noaa.gov

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