Development of a Civil Space Traffic Management System

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What Problem Are We Trying to Solve?

• Space is becoming more congested
  • Cubesats and other small satellites are being launched with increasing frequency
  • There are near-term plans for “Mega-constellations,” with hundreds or even thousands of satellites
• The DoD attempts to keep track of objects in space, but being a “Space Traffic Cop” is not part of their core military mission
• There are no universally-accepted “Rules of the Road” for the safety of space operations
• An increase in the number of collisions in space could put astronauts and critical national security spacecraft at risk, and even make some orbital regimes unusable for future users
Increase in Space Objects

Collision of Cosmos 2251 and Iridium 33

Destruction of Fengyun-1C
Background

• The Commercial Space Launch Competitiveness Act (CSLCA), signed into law on November 23, 2015, observes that:

  • “It is the sense of the Congress that an improved framework may be necessary for space traffic management of United States Government (USG) assets and United States private sector assets in outer space and orbital debris mitigation.”

• The Act also directed the preparation of 3 reports related to Space Situational Awareness and Space Traffic Management.
CSLCA Report Highlights

The Section 108 Report (Mission Authority), approved by the OSTP Director and submitted to Congress on April 4, 2016, included recommendations for an authorization and supervision approach that would satisfy international treaty obligations. Specifically, it recommended implementation of the following legislative language provisions:

• “The Secretary of Transportation ... is authorized to grant authorizations for missions in outer space.”

• “The Secretary of Transportation, in coordination with the Secretary of Defense, is authorized to examine the planned and actual operational trajectories of space objects and advise operators as appropriate to facilitate prevention of collisions.”
The Section 110 Report (Space Surveillance and Situational Awareness Data), approved by the Secretary of Transportation and submitted to Congress on September 7, 2016, contains the following conclusions:

• “It is feasible for a civil agency, specifically the Department of Transportation (DOT) acting through the Federal Aviation Administration (FAA) Office of Commercial Space Transportation, to release safety-related SSA data…”
• “Statutory authority would be required…”
• “A civil agency would require immunity from lawsuits similar to the DoD immunity provision…”
• “Additional resources would be necessary…”
CSLCA Report Highlights (cont.)

The Section 109 Report (Orbital Traffic Management), performed by SAIC (under NASA contract) and submitted to Congress on November 21, 2016, contains the following conclusions:

•“[It] is in the U.S. national strategic and economic interests to have an improved domestic space traffic safety governance framework that specifically aims to mitigate and reduce the risk of possible space traffic safety incidents, while at the same time protect the economic vitality of the space industry. Likewise it is important to enable the Department of Defense (DoD) to focus on its space protection and defense mission operationally…”
“A Framework that best balances the needs for safety, national security, and economic interest is a framework led by a civil agency.”

The civil agency should:

- Provide advisory products and services that enhance operational safety
- Become the trusted open source of SSA data
- Balance the needs of Space Traffic Safety with the interests of space commerce and “encourage, facilitate, and promote” the uninterrupted and free flow of commerce in orbital space
- Interface appropriately with all interagency partners to ensure a whole-USG approach to Space Traffic Safety Governance
Deputies Committee

On November 14, 2016, the National Security Council Deputies Committee approved the Space Safety Engagement Work Plan, which contains the following task:

• “The FAA and DoD shall cooperatively create a civil space traffic system to support commercial and foreign entities, and should continue to work towards risk reduction initiatives. The civil space traffic system will require the Department of Transportation to be given statutory authorization to share safety-related space situational awareness information, immunity from lawsuits, and the necessary resources to accomplish the mission.”
Deputies Committee (cont.)

• “As a first step, the FAA and DoD shall jointly implement a pilot program for orbital safety services addressing U.S. commercial sector space situational awareness information and conjunction warning processes. In addition, the pilot program shall consider how to achieve improved accuracies and actionable conjunction warnings that are necessary to manage the safe operations of mega-constellations, and rendezvous and proximity operations.”

• The Pilot program is to be implemented by 2019, and the civil space traffic Initial Operational Capability (IOC) is to be 2020.
Program Status

• Although the Deputies Committee tasked the FAA and DoD to cooperatively create a civil space traffic system to support commercial and foreign entities, the new Administration may choose to revisit that decision.

• In addition, the Secretary of Transportation was clear in the Section 110 Report that Congress would have to provide the needed authority, immunity, and resources before the FAA could fully assume responsibility for operating a Civil Space Traffic Management System.

• In the meantime, we have been working closely with the DoD, industry, and other stakeholders to determine how best to implement such a system.

• Conducting a CSTMS Pilot Program could go a long way towards answering remaining questions and lowering programmatic risks.
Full Suite of *Approaches* for Future U.S. Civil SSA Services

- Continued Service Provision by DOD
- Provision by a Civil Government Organization
- Provision by NGE (Industry Self-Provision)
- Provision by International Organization
Why Not a DoD System? (the Status Quo)

- Being a “Space Traffic Cop” is not a core military mission
- Concerns about security classification and data sensitivity issues have prevented increased transparency both for the space object data itself and for the analysis processes being used
- The legacy hardware and software that are part of the current system are not able to easily incorporate new and innovative technologies or to take advantage of data from non-DoD sensors
- Since it is not a regulatory agency, the DoD is not well-positioned to work with industry or foreign governments on the development of safety guidelines, standards, or norms
Why Not an International System?

• Space Traffic Management is clearly an international issue, and one that is of interest to all space-faring nations.
• Currently, however, there does not appear to be an international organization that is ready and willing to take on the leadership responsibility for creating and operating a Space Traffic Management System.
• Achieving transparency while properly protecting classified and/or sensitive information would be challenging.
• It is not clear where the funding needed to develop and operate an international system would come from.
• Gaining international agreement for such a system right from the start would be extremely challenging, and would likely take many years.
Why Not a Private System?

• Gaining access to and properly protecting classified and/or sensitive information could be challenging
• It is not clear what the business case for a private system would be. Several companies are currently providing services on a contract basis. However, if customers are required to pay for the services provided, many satellite operators may not be able to afford to subscribe.
• A private entity may encounter challenges in working with industry or foreign governments on the development of safety guidelines, standards, or norms
Why Does a Civil System Make Sense?

• A Civil Agency could focus on enhancing the safety of space operations, rather than providing safety services as a collateral responsibility
• A Civil Agency could partner with the DoD to resolve issues associated with classification or data sensitivity
• A Civil System could take advantage of new technologies and innovative approaches that are being identified by private industry and academia
• A Civil Agency (especially a regulatory agency) would be well-positioned to work with stakeholders (including industry and other governments) to develop safety guidelines, standards, and norms
Results of SAIC Assessment

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<th>Protect and Enhance National Security Space (NSS) Interests</th>
<th>Ensure the Economic Vitality of the Space Domain and Space Industrial Base</th>
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Why is the FAA a Good Choice?

• Although other civil agencies (including NASA, NOAA, and the FCC) have been asked about their interest in taking on the STM mission, none have expressed a willingness to do so.
• The FAA has been engaged in working this issue with the White House, Congress, industry, academia, and other key stakeholders, since publication of the National Space Policy in 2010
• The FAA already has responsibility for overseeing commercial launches and reentries, and has a knowledgeable and experienced workforce
• Our dual mission (both to ensure public safety and to encourage, facilitate, and promote the industry) provides an appropriate regulatory balance
Full Suite of **Options** for FAA/AST to Provide Civil SSA Services

- **Continued Service Provision by DOD**
  - Option 1: FAA/AST Embedded within DOD/JSpOC
  - Option 2: Independent FAA/AST Capability Using DOD Systems
    - In-House at FAA/AST
    - Vendor Site

- **Provision by a Civil Government Organization**
  - In-House at FAA/AST

- **Provision by NGE (Industry Self-Provision)**
  - In-House at FAA/AST

- **Provision by International Organization**
  - Option 4: FAA/AST Certifies NGES to Provide Capability
CSTMS Program Description

• The Civil Space Traffic Management System (CSTMS) consists of the hardware, software, data and communications connectivity, and personnel that are needed to accept and process observations, create and maintain a catalog of space objects, perform safety-related analyses, and develop and distribute safety-related products and services.
Mission

• The mission of the Civil Space Traffic Management System is to enhance the safety of space operations, and to preserve the space environment.
Guiding Principles

• The CSTMS will be designed to use an open architecture, with the capability to accept observations from multiple sources, use interchangeable software modules to compute orbital parameters and populate a master catalog, and allow alternate approaches to predict and analyze potential conjunctions.

• The CSTMS will be designed to maximize the use of commercial capabilities.

• The CSTMS will strive to be a “learning organization” right from the start, with improved capabilities being integrated as they become available, and with processes to test and incorporate innovation and new technologies from both private industry and academia.
Guiding Principles (cont.)

• Transparency is a key principle; however, classified and/or sensitive U.S. space operations will be protected appropriately, both by technical means and via operational procedures.

• The CSTMS will operate cooperatively with existing Space Situational Awareness architectures, while maintaining the ability to function independently for resiliency.

• The CSTMS will provide safety products and services as a public good. The FAA will not levy fees for the products and services it provides.
Key Elements

• Space Object Observations - Data is available from the DoD, based on observations made using the Space Surveillance Network.

• Computational Capability - Hardware and software required to compute orbital elements and populate a civil catalog are available from industry through purchase or lease.

• Personnel – Although many of the processes could be automated, conducting round-the-clock operations would require several teams of staff members, including Orbital Analysts, Aerospace Engineers, and/or Space Industry Analysts.
Tasks/Activities

The Office of Commercial Space Transportation (AST) will manage and operate the CSTMS, which will perform the following tasks for civil, commercial, and international space operators:

- Conjunction Assessment (predict close approaches for orbital objects)
- Collision Avoidance (support maneuver planning)
- Launch Deconfliction (identify and resolve predicted conjunctions during launch windows, launches, and initial spacecraft orbits)
- Deorbit/Reentry Support (provide conjunction assessment support for maneuvers and reentries)
Tasks/Activities (cont.)

• Disposal/End-of-Life Support (advise on disposal orbits and related maneuvers)
• Anomaly Resolution (provide tracking data related to health/status verification)
• Operation of a web-based customer portal (allows civil and commercial space operators to have access to an unclassified web-based database)
• Development (in collaboration with industry and other stakeholders) of recommended practices, guidelines, and standards for commercial space operations
Program Schedule

- The CSTMS Program consists of 3 Phases:
  - Phase 1 – A Pilot Program, leading to the development of a Partial Mission Capability
  - Phase 2 – Development of an Initial Operational Capability
  - Phase 3 – Development of the Full Operational Capability
- Each Phase has an estimated duration and defined success criteria
- The overall Program philosophy will be to “crawl, walk, run,” so that all of the key stakeholders are comfortable with the approaches being used, with the progress that is being made, and with the products and services that are provided.
Program Schedule (cont.)

- Phase I (FY 2018 - FY 2019) – This Phase involves the establishment of a Pilot Program to demonstrate the ability of the FAA to provide orbital safety services. The objective is to stand up the capability to accept observations, generate at least a partial catalog of space objects, and analyze potential conjunctions. Specific activities include the testing, selection, and test-bed operation of various hardware and software modules and subsystems. Data produced by the program during this Phase will be compared and validated with DoD data. At the end of this phase, once the basic technical capabilities have been demonstrated, the system will have reached Partial Mission Capability (PMC).
Program Schedule (cont.)

• Phase II (FY 2020) – During this Phase, the CSTMS will develop an Initial Operational Capability (IOC). The CSTMS will make products and services available to interested satellite operators in parallel with what is being provided by DoD operations. The success criteria for exiting this Phase will be whether the products and services being provided are at least as complete, at least as accurate, and at least as timely as those being provided by the DoD.
Program Schedule (cont.)

• Phase III (FY 2021) – During this Phase, the CSTMS will reach Full Operational Capability (FOC). Once civil, commercial, and international users are satisfied with the space safety products and services being provided by the CSTMS, the FAA will assume full responsibility for these activities, and the DoD can stop providing them to non-national security users.
CSTMS Pilot Program

• The CSTMS Pilot Program would be a joint activity between the FAA and the DoD.

• The purpose would be to demonstrate the ability of the FAA to provide orbital safety services as part of a Civil Space Traffic Management System.

• Key steps in the process include being able to:
  • Accept and process observations
  • Compute orbital parameters and generate at least a partial catalog of space objects
  • Analyze and assess potential conjunctions
  • Generate collision avoidance warnings as required

• Data produced during the Pilot Program would be compared and validated with DoD data.
Questions a Pilot Program Could Answer

• In terms of completeness, accuracy, and timeliness, how would the products and services from an FAA-managed Civil Space Traffic Management System compare to those currently available from the DoD?
• What are the potential benefits of using observations from non-DoD sources, either instead of, or in addition to, the data currently being used by the DoD?
• Can innovative analysis techniques be used to decrease uncertainty and cut down on “false alarms” for potential collisions?
• Is it possible to increase transparency of the data and the process, while still protecting classified and/or sensitive national security information?
Conclusions

- Space is becoming increasingly congested, and we need to act now to enhance the safety of space operations and preserve the space environment.
- The FAA is eager to work with the DoD to jointly implement a Civil Space Traffic Management System Pilot Program.
- Such a program could demonstrate technical feasibility, provide helpful information on optimal architectures, answer questions on potential system performance, and validate system cost estimates.
- Initiating a Pilot Program in FY18 could lead to an Initial Operational Capability in FY20, and a Full Operational Capability in FY21.