NASA Aerospace Safety Advisory Panel

Recommendation 2020-03-02: Designation of a Lead Federal Agency for Civil Space Traffic Management

Findings:

For several years, the Panel has expressed concern with the risk of damage to orbiting spacecraft and transiting astronauts due to micro-meteoroids and orbital debris (MMOD). The hazard from MMOD has been recognized as a major issue in every program. MMOD is the dominant contributor to the calculations of loss-of-crew predictions for both commercial crew vehicles and Orion, and it has been a factor in two of the top safety risks for the International Space Station (ISS). NASA declared it an Enterprise Risk in 2017.

Recommendation:

2020-03-02 Designation of a Lead Federal Agency for Civil Space Traffic Management

The Panel recommends that NASA**:**

- Support and partner with the Lead Federal Agency once one is selected.
- In the interim period:
    - Because of the direct relationship to astronaut and spacecraft safety, ensure that risks having to do with micro-meteoroids and orbital debris, Space Situational Awareness, and Space Traffic Management are addressed in NASA's ongoing activities and in future budget requests.
    - In collaboration with other government agencies and industry, develop and publish guidelines for Space Traffic Management focused on current and emerging challenges to maintain the safety of astronauts and spacecraft.
    - Develop a proposal for a Space Traffic Management technology roadmap.

Rationale:

The hazard persists and continues to grow exponentially. Space is becoming more congested. For example, CubeSats and other small satellites are being launched with increasing frequency, and several companies are now deploying mega-constellations with hundreds, or even thousands, of satellites. Some of these satellites incorporate the use of electric propulsion and autonomous on-board maneuvers with very short turnaround times, increasing the difficulty of tracking and planning for collision avoidance.

It is important to recognize the prevalence of the issue. Orbital debris events and close calls are not rare, but they are in fact becoming more and more frequent as space becomes more congested, and as national and international space players – who rightfully seek to leverage the high ground of space for commerce, science, and national prestige – continue to populate the space domain with new satellites. The risks are growing, and a more strategic approach to the

problem is now necessary to arrest the risks and to assure that the domain of space remains sustainable.

NASA currently has 20 missions in Low-Earth orbit, and the Agency definitely takes the risk seriously. But the issue is larger than NASA – it affects and is affected by all entities that conduct operations in space, and it endangers all of those functions on which the public has come to rely – communications, navigation, weather prediction, to just start the list. While the ASAP is principally focused on the serious hazards to NASA spacecraft and astronauts, the Panel recognizes that the issue must be tackled on a broader front.

The Panel was encouraged in 2018 when the National Space Council issued Space Policy Directive-3 (SPD-3), the National Space Traffic Management Policy, which acknowledged and addressed this issue and the need to improve Space Situational Awareness, and Space Traffic Management. SPD-3 promoted the implementation of a number of steps to address the orbital debris risk and recommended that the Department of Commerce take responsibility for implementing a Civil Space Traffic Management framework. The Panel is dismayed that Congress and the Administration have not yet reached an agreement on the appropriate response to that recommendation, resulting in departments and agencies not being able to move forward on implementing a framework that will both materially reduce the STM risks and increase the sustainability of space as an international strategic domain.

It is well overdue that the U.S. exert some effective international leadership in the safety of space operations, and begin doing so by designating – including providing authority and resources to – a Lead Agency to see to the provision of timely and actionable safety data to all space operators; work proactively within government, with industry, and in partnership with the international community in developing standards, guidelines, best practices, and "rules of the road" for safe space operations; and support the conduct of scientific research and technology development for related areas, such as improved sensors, software, constellation management techniques, and methods for active debris management.

NASA Response:

NASA concurs on the recommendation to support and partner with the lead Federal agency for Space Traffic Management (STM) once one is selected. Since the National Space Council issued Space Policy Directive-3 (SPD-3), the National Space Traffic Management Policy, Congress has offered conflicting legislative proposals to address STM, none of which have become law. However, two recent events offer optimism that definitive congressional action may be forthcoming in 2021 or earlier. On August 20, 2020, the congressionally directed independent review by the National Academy of Public Administration was released, which states that the Department of Commerce (DOC) is "best suited to perform STM tasks within the federal government." In addition, on October 21, 2020, the Chairman of the Senate Committee on Commerce, Science and Transportation introduced the Space Preservation and Conjunction Emergency (SPACE) Act to authorize the DOC to provide space situational awareness (SSA) services to civil, commercial, and international space operators.

Pending congressional action, NASA is taking steps in the interim to address the ASAP recommendation, as outlined in detail below.

Regarding astronaut and spacecraft safety, through the leadership of the Office of Safety and Mission Assurance (OSMA), NASA continues investing in characterizing and managing risks to spacecraft and astronauts from meteoroids and orbital debris. Specifically, NASA is investing in research and development (R&D) in more than 50 technical areas that could be applied to STM and SSA. Of these, only R&D related to orbital debris mitigation is specifically intended for STM and SSA application. In order of priority, the myriad of technical areas being funded can be grouped into four broad disciplines as they relate to NASA's investment in R&D in STM and SSA:

1. *Orbital Debris Mitigation.* Developing, maintaining, and updating orbital debris [and meteoroid] environment models and their associated uncertainties. Conducting measurements of the orbital debris environment and conducting other research as needed to support the development of the orbital debris (and meteoroid) environment models.

2. *Space Environment Monitoring and Awareness.* Developing tools to characterize the space environment as a means towards producing improved orbit predictions and understanding spacecraft anomalies.

3. *Prediction Algorithms.* Enhanced computing (i.e., machine learning) to best leverage the increased quantity and quality of data that could be provided through improved and more prolific sensors and timing.

4. *Sensors.* Space, airborne, and ground-based sensors better able to remotely detect and characterize space objects with better perceptivity and resolution as well as reduced uncertainty over a wider range of observable aspects.

Regarding development of guidelines for STM, the NASA Office of Chief Engineer (OCE) has developed two documents in support of the ASAP recommendation. One serves to capture best practices for ensuring safe space operations with respect to collision avoidance, and the other ensures future NASA missions continue to plan for and implement collision avoidance practices.

The first document is a NASA Conjunction Assessment Handbook (HBK), now publicly available for use by all space operators. The HBK is the result of close collaboration with other agencies to establish a best practices document for collision avoidance and conjunction assessment topics. The document contains a variety of background, context, and technical information needed by space operators. The HBK addresses the full life-cycle of a typical spaceflight mission, from design considerations through launch and on-orbit operations.

Departments and agencies consulted in developing the HBK material include the USSPACECOM's Strategy, Plans, and Policy Directorate; the 18th Space Control Squadron (18 SPCS); the Departments of Commerce and Transportation; and the Federal Communications Commission. The HBK was released in December 2020. Future updates to expand the HBK's coverage are expected in calendar year 2021 and later years as the industry continues to evolve.

This will also permit aligning the best practices with emerging space traffic management guidance by the selected lead agency.

In parallel, OCE also developed a NASA Interim Directive (NID). While the HBK is a set of best practices for all space operators, the NID defines requirements for NASA's future near-Earth human and robotic missions. This will ensure that NASA continues to serve as a leader in operating safely in space. Similar to the HBK, the NID requirements address various aspects of spacecraft design and operations, including ensuring trackability by the Space Surveillance Network, sharing of ephemeris information, proactively coordinating with other operators regarding systematic conjunctions (including human spaceflight), and defining minimum thresholds for mitigating a close approach.

The NID was approved and issued in November 2020. The NID contents will be updated and integrated into the permanent NASA policy framework in calendar year 2021.

Finally, regarding development of a proposal for a STM technology roadmap, given the current and future investments in STM and SSA R&D and the pending best practices and requirements outlined above, OSMA and OCE will work with the Space Technology Mission Directorate throughout 2021 to outline a proposal for a STM-related technology roadmap, focused on gaps that are not being otherwise addressed.