Satellite Industry Association (SIA)[1] White Paper: The Future of Space and Space Traffic Coordination and Management

1. Introduction

We are at an important time in the advancement and use of space with U.S. industry bringing vast innovation to space. There are many innovative ways to use space which drive the increased need for a futureproof space traffic coordination and management (STCM) regime. These uses include everything from large constellations of communications satellites bringing broadband to everyone, commercial human spaceflight, position navigation and timing, and greater space exploration and monitoring.

SIA projects the profile of active satellites operating in low earth orbit will change substantially in the upcoming 5-10 years. Tens of thousands of satellites have been proposed, and many ventures have been applying for regulatory approvals, seeking investment and developing designs and even operating. Regardless of how many of the proposed large constellations are eventually flown, it is clear that that the current framework of space regulations and policies requires review and, in some cases, revision to prepare for the imminent surge in space usage, innovation and investments that SIA members foresee. Recent and ongoing commercial innovations in spacecraft design, space debris tracking, space data collection, fusion and analytics, and space weather can enhance the current space safety regime and ensure that safety of flight products are comprehensive, timely, accurate and highly-available.

SIA urges thoughtful consideration of the STCM regime in a way that facilitates operators appropriately responsible for safe space operations and fosters the ongoing safe and efficient use of the shared space environment going forward. This White Paper shares SIA's members' views and recommendations on what is necessary to create a modern STCM regime that can support space innovation and promote space sustainability over the long term.

2. What does the future look like

SIA's members are active in virtually every aspect of the wave of commercial innovation in space. Below we capture what the future space environment might look like at a high level, with a focus on the deployment of commercial satellites.

A. A Variety of Space Objects

Objects in space today are predominantly space debris, having accumulated from previous launches, spent stages, deployed spacecraft, and collisions and explosions of these devices over our sixty-year use

[1] SIA Executive Members include: Amazon; AT&T Services, Inc.; The Boeing Company; EchoStar Corporation; Intelsat S.A.; Iridium Communications Inc.; Kratos Defense & Security Solutions; Ligado Networks; Lockheed Martin Corporation; OneWeb; SES Americom, Inc.; Space Exploration Technologies Corp.; Spire Global Inc.; and ViaSat Inc. SIA Associate Members include: ABS US Corp.; AIRBUS U.S. Space & Defense, Inc.; Amazon Web Services; Analytical Graphics, Inc.; Artel, LLC; Astranis Space Technologies Corp; Blue Origin; Eutelsat America Corp.; ExoAnalytic Solutions; HawkEye 360; Hughes; Inmarsat, Inc.; Kymeta Corporation; Leonardo DRS; Lynk; Omnispace; OneWeb Satellites; Panasonic Avionics Corporation; Peraton; Planet; Telesat Canada; and XTAR, LLC. For more information on SIA, see www.sia.org.

of space. A variety of satellite types operate in this space environment, including satellites operating at geostationary orbit (GEO at 35,786 kilometers above the earth's equator), middle earth orbit (MEO, in between GEO and LEO) low Earth orbit (LEO orbits up to 2,000 km) in both temporary and long-term missions. These satellites may be deployed for the purposes of providing communications services, earth imagery, weather or other environmental purposes, or for science or research purposes. The space environment also includes non-satellite space objects, such as launch vehicles, vehicles for human space flight, and other space use vehicles. In addition, there are also space objects occupying elliptical orbits that transit one of more orbit regimes, as well as disposal orbits. Finally, there are a number of new ways of operating in space that impact the overall space environment and must be taken into account, such as on-orbit servicing and active debris removal. All of these objects must coexist and operate together in a safe and sustainable manner.

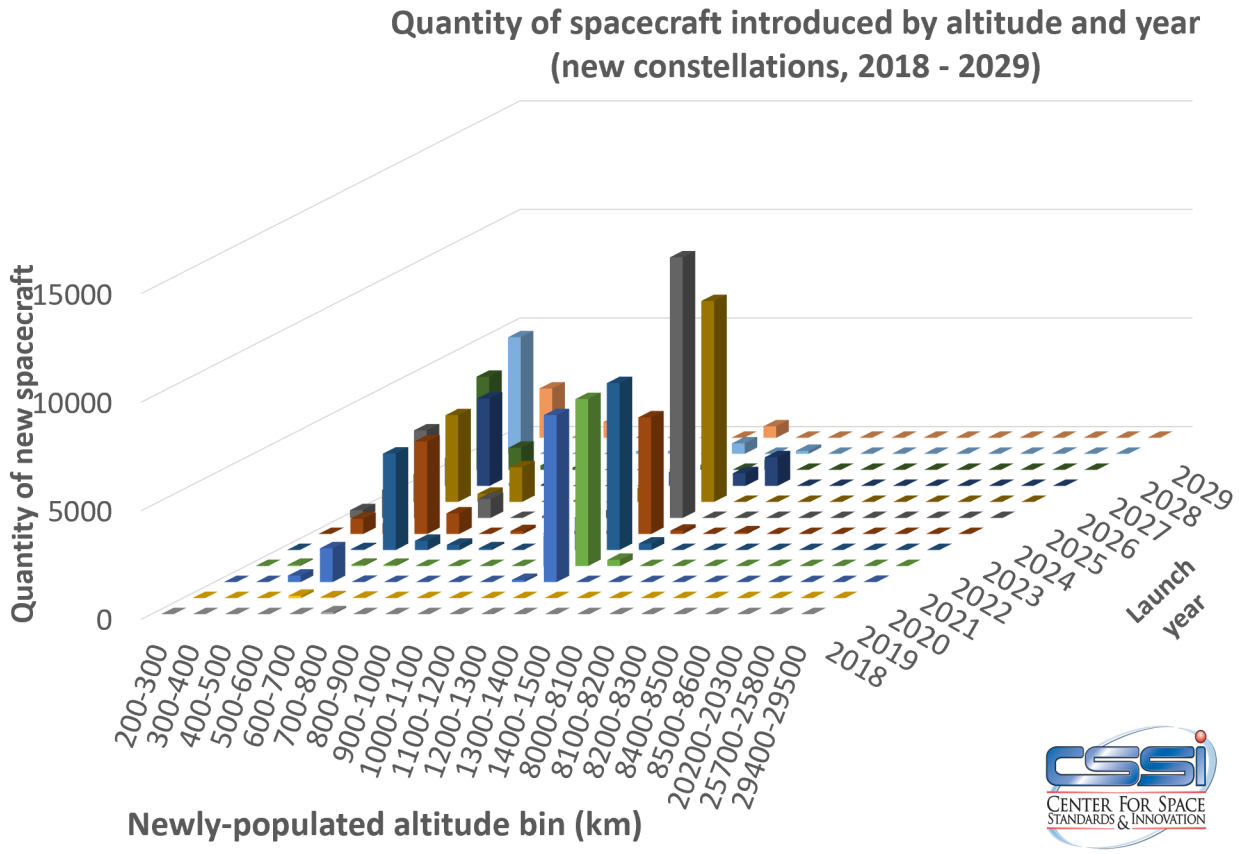
B. A Pyramid of Satellites

Many satellite projects have been proposed or are now operating with the purpose of providing commercial services. Below we provide a projection of the commercial satellites on orbit by 2029. Because many projects are in developmental stages, SIA offers offer conservative, mid-range and optimistic projections of the numbers of both active and proposed satellites in all orbital regimes.

Estimate of satellites on orbit by 2029[2]

Total Satellite Estimate by 2029	**Number of Satellites**
Low (conservative)	10,000
Medium	30,000
High (all satellites filed)	107671

[2] Alfano, S., Oltrogge, D.L., and Shepperd, R., "LEO constellation encounter and collision rate estimation: An update," 2nd IAA Conference on Space Situational Awareness, IAA-ICSSA-20-0021, January 14, 2020.



3. Current Issues for Space Traffic Coordination and Management

This section discusses the most important STCM issues we see today.[3]

1. *Timeliness:* The current and forecasted rates of launch and spacecraft deployment have increased dramatically, with many more objects being launched into space than before. Currently, space operators rely on SSA services and conjunction messages to characterize the space environment and anticipate and avoid collision. While these SSA services are important and useful today, they fall short of the actionability required to establish space safety and sustainability of the space environment. SIA members believe that there is an urgency to revise the current space safety construct by procuring and implementing a viable and effective system of STCM as soon as possible.

2. *Orbital accuracies.* Today's public, free SSA services feature suitable orbital accuracies to support flight safety decisions in some orbital regimes, but in many key orbital regimes they will fall short as space activity increases. Whether the accuracy is suitable is highly dependent upon the specific collision avoidance metric and threshold selected by the operator, the type of object, its size or reflectivity, tracking revisit and prioritization, the orbital regime it occupies,

[3] This list is not-exhaustive.

and its maneuverability. To accommodate these current orbital inaccuracies, operators often rely on very conservative assumptions for decisions to implement collision avoidance decisions, resulting in a flood of warnings. A focus should be on improving the accuracy of these datasets.

3. *The development of commercial tools to augment current space sustainability and safety service*. Several versions of commercial SSA and STCM services exist today to augment government systems in a highly complementary way. The continued development and adoption of both government and commercial services in a diverse STCM system will improve accuracy of decision-grade information for space operators.

4. *Tracking and advanced SSA analytics.* Observations from diverse SSA tracking networks and sensor types is required to build a robust, accurate SSA system. The data from these observations must be brought together using modern data fusion engines and analytics to produce accurate, decision-quality SSA content and collision alert warnings that operators can rely upon to make timely decisions.

5. *Open Architecture Data Repository (OADR).* Today, satellite operators have proven a willingness to proactively contribute data on their spacecraft, to include spacecraft positional time histories and predictions, maneuver plans, launch, early orbit and reentry data, and other data relevant to safety of flight. Commerical entities continue to lead the development and implementation of OADR capabilities. We need to now extend that space operator data exchange model across the global space operator population under a robust STCM enterprise, providing and OADR that can serve as the gathering place for authoritative spacecraft operator data.

6. *Availability of information.* It is imperative that SSA and STCM data be made readily available to all space operators, whether commercial or government, regardless of mission, altitude or nationality. Given the critical space safety role that this data products and supporting analytics provide, such data must be highly available, with a minimum of SSA and STCM service outage and operators need to contribute improved data to make this successful.

4. Recommendations

Recommendation 1: Action and funding is needed now. The commercial satellite sector is innovating quickly and driving U.S. leadership in space. SIA urges the U.S. government act now to implement a more modern STCM environment to support this innovation, including leveraging both commercial and government capabilities to yield a U.S.-developed cutting edge space sustainability model. This activity requires adequate funding to enable all the related activities foreseen in Space Directive 3.

Recommendation 2: The Framework should be established, but the specific technologies to meet requirements should not be dictated. Space companies are world-renowned for their ingenuity. Allowing innovative ways to meet the specified requirements of a modern space safety framework will encourage development and ensure the most cost-efficient and effective technologies are utilized.

Recommendation 3: Governments should encourage best practices. The commercial space industry has a long track record of responsible operations in space and counts on a safe environment to undertake ongoing and future space business. Solidifying the participation and support of the commercial industry to ensure wide-spread adoption of space safety practices is critical and will reduce the need for unnecessary and often burdensome regulations and is action that can be taken now.

Recommendation 4: Any effective solution must be whole of space and endeavor to meet global needs. A successful, modern and sustainable space traffic management system will include all of the types of space activities listed above, U.S. and international alike. This will require the relationships and leadership of the U.S. government, commercial stakeholders and like-minded space-faring counterparts to meet the important goals of space sustainability.