Thought Leadership in Space Sustainability

The world's first satellite launch was in 1957, which means the entire history of human activity in space fits within a single lifetime. Since those early beginnings, rapid advancements in technology and the profound benefits of satellite applications have accelerated the space industry. Today there are nearly 2,000 active satellites circling the Earth, and proposals to launch more than 20,000 new satellites hold great potential for benefits to humanity, as long as we proceed responsibly.

Commercial activity in space is accelerating

Rapidly declining costs of access to space are paving the way for many new players, large and small. The proliferation of microsatellites and the introduction of large constellations are advancing global communications, remote sensing, and a host of novel services that promise unprecedented opportunities for economic development, global education, rural healthcare, location-based services, and advancements in environmental science. The satellite design and operational practices we follow can have a big impact on the space environment and implications for the sustainability of space activities.

The footprint of human activity is always felt by the Earth's environments, and this is now as true for the orbital environment as it has been for our planet's lands, seas, and air

While natural environmental processes typically have some capacity to restore their own balances, that capacity is not always sufficient to counter human activity without very intentional stewardship, and at times, active remediation. In space, the only natural cleansing process is orbital decay via atmospheric drag, a force that weakens with altitude and is only truly effective for satellites in the lowest portions of low-Earth-orbit (LEO), and remediation (active debris removal) is not yet practical.

In 1978, when Donald Kessler wrote a seminal paper entitled, "Collision Frequency of Artificial Satellites: The Creation of a Debris Belt," he forewarned that reaching a critical point in the population of uncontrolled objects in LEO could lead to cascading collisions and self-perpetuating growth of orbital debris. While such a scenario would play out over long time scales, the consequences for space activity would be more immediate, and some studies suggest that we have already set this process in motion.

Debris mitigation standards to help avoid such a future were first developed by NASA in 1995, and publications were subsequently issued by other expert organizations, such as the InterAgency Space Debris Coordination Committee (IADC), the International Organization for Standardization (ISO), the European Space Agency (ESA), and others. However, these foundational works had no way to anticipate the tremendous scale of current and proposed satellite activities.

Environmental safeguards need to be updated

These are exciting times for the space industry, but with this increase in activity must come a re-examination of best practices and the recognition of our economic and technical responsibilities to preserve the natural resources on which we all depend. In this new era of large constellations and

low-cost access to space, it is urgent that we adopt the following, common-sense practices that are critical to the long-term environmental sustainability of LEO.

- **Large constellations should not overlap in altitude.**

- **If satellite failures occur during the deployment of a constellation, root cause(s) should be identified and corrected on the ground before additional satellites are launched.**

- **Spacecraft operators should be able to control the flight paths of their assets.**

- **Spacecraft should be disposed of promptly and reliably at the end of their missions.**

- **Deorbited objects should not pose a significant risk to people or property on the ground.**

OneWeb is not alone in its advocacy for space environmental stewardship. We are working with other, like-minded, LEO constellation operators to define and promote best practices for the design and operation of satellites in LEO. https://spacenews.com/op-ed-responsiblesatellite-operations-in-the-era-of-large-constellations/

Future Development

In addition to these sensible measures that can be implemented immediately for new systems, OneWeb is actively supporting the development of new technologies to support the sustainability of industry-wide space activities.

1. **Advancement of space situational awareness (SSA) Increased SSA benefits the entire community.**
   This is a broad topic that includes:

   a. supporting the development of commercial tracking capabilities for the purpose of creating a more complete and accurate catalogue that would be made available to all operators;
   b. supporting the collection and sharing of owner/operator information, including spacecraft ephemeris, meta information (e.g., satellite status, manoeuvrability, dimensions, etc.), and operator points of contact;
   c. supporting the development and implementation of techniques to facilitate ground-based tracking and identification, including spacecraft coatings, passive reflectors, and active beacons; and
   d. supporting the advancement of modelling techniques to improve solar activity, atmospheric density predictions, and orbit prediction accuracies, ultimately leading to higher confidence in conjunction assessments.

2. **Development and incorporation of anomaly resolution aides**.
   Anomaly detection, attribution, and resolution all contribute to a better understanding of our operating environment and lead to more resilient operations. Toward this end, it is beneficial to develop standardized, low-cost and low-size, weight, and power (SWaP) sensors to provide situational awareness of both external environmental conditions (e.g., radiation) and internal diagnostics (e.g., impact detection).

3. **Development and implementation of active debris removal (ADR) techniques.**
   Given the technical, economic, political, regulatory, and legal challenges of actively retrieving orbital debris, this is an area in particular need of community-wide attention and

collaboration. While deployment of commercially viable retrieval services still may be a few years away, it is not too early to anticipate such operations and to develop and incorporate aides to assist with satellite rendezvous and capture operations. Reflectors, fiducial markers, and low-power beacons could assist with rendezvous and proximity operations; and standardizing lightweight grappling fixtures could simplify capture operations.

Toward these ends, OneWeb is actively working with the ADR community to develop advanced grappling fixtures and commercially viable ADR services.