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Leck, Chris; Verspieren, Quentin

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Providing for the Safety and Sustainability of Space Activities: The Deorbiting of Defunct Space Objects

By Chris Leck and Quentin Verspieren

SYNOPSIS

To ensure the safety and sustainability of space activities, space objects should be deorbited at the end of their mission life. However, such an exercise is not without safety risks, given the large number of new satellites expected to be launched and deorbited in the coming years. A space traffic management and coordination system that can facilitate the large-scale deorbiting of space objects is essential.

COMMENTARY

Close to 10,000 satellites are orbiting the Earth as of December 2022, including about 2,500 defunct satellites. In addition, it is estimated that there are 36,500 pieces of space debris greater than 10 cm, and one million pieces between 1 and 10 cm. These space debris mostly originate from satellite fragmentation, releases during launch operations, in-orbit collisions, and anti-satellite tests.

Humanity continues to add to in-orbit debris and congestion at an exponential rate, as satellite technologies become ever more important for earth observation, communications, navigation and other purposes. 2022 was a record year, with over 180 rocket launches carrying over 2,500 satellites into space. More than 100,000 satellites could be in orbit by 2030, mostly as part of large constellations planned by companies such as SpaceX, OneWeb, Amazon and the China Satellite Network Group.

These developments lead to a growing risk of collisions in space, taking us closer to the so-called Kessler syndrome, where a series of collisions generate a chain reaction, eventually making space inaccessible. Near misses are getting increasingly frequent. In January 2023, an old rocket body and a defunct satellite missed each other by a few dozen meters. This was potentially catastrophic as even the smallest pieces of

debris such as rivets or specks of paint can prove deadly, given the velocity at which objects travel in space. Launch providers are also worrying about their future ability to identify safe launch paths.

Space Debris Mitigation Guidelines as a Stop-Gap Measure

Over the years, the international community has worked on measures to deal with the problem, although progress towards a truly comprehensive solution has been, and remains, slow. Among others, the Inter-Agency Space Debris Coordination Committee – comprising 13 space agencies from all major launching states – and the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) have adopted various guidelines focussing on space debris mitigation.

These guidelines are largely based on the US Government Orbital Debris Mitigation Standard Practices (ODMSP). However, they are non-binding and provide only broad guidance. They include basic recommendations on design and passivation measures to minimise risks of break-up, on collision avoidance, and on deorbiting space objects in low Earth orbit (LEO) within 25 years after the end of their mission.

The "25-year rule" has been adopted by regulators in some countries, although the overall rate of compliance remains low. For one, many countries do not comprehensively regulate their space activities. For another, there is often a lack of clarity on when a space object's mission life has ended, to allow effective monitoring. In fact, space objects are often operated well beyond their expected or planned lifetimes, which could lead to failures and the inability to conduct proper post-mission disposal.

Many parties have suggested that 25 years is too long a timeframe, as objects are being launched into space very much faster than they are deorbited. The Space Safety Coalition, formed in 2019 by a large number of major space operators, have called for a five-year rule instead. In the same year, the US government embarked on the revision of its ODMSP. Although most US agencies pushed for a five-year rule, the *status quo* was eventually maintained in the updated ODMSP, mostly due to NASA's opposition, which considered the impact of the reduction marginal.

Most recently, in September 2022, the US Federal Communications Commission (FCC), an independent federal government agency, inscribed the five-year rule into its licensing requirements (although there appears to be room for waivers in certain cases). The rule applies to both US-licensed satellites (except those of federal government agencies) as well as those from other jurisdictions seeking US market access.

The Challenges of Deorbiting Space Objects at Scale

The move by the US FCC to adopt a five-year rule is a noteworthy one, although it remains to be seen if this will lead to a new global standard. There is also the question of how the five-year rule (or even the 25-year rule) will play out in reality, when LEO could host 100,000 or more satellites from 2030, even presuming that issues such as the reliability of satellites and their post-mission disposal systems – on which much progress remains to be made – are adequately dealt with.

With the mission life of a satellite in LEO ranging from 3-5 years, this suggests that many thousands of satellites could be deorbited each year, likely through the use of on-board thrusters rather than natural decay. Thousands of satellites deorbiting – thrusting down presumably over several months, and their replacements thrusting up – could in fact heighten collision risks if the process is not properly managed, both operationally and in terms of information-sharing and coordination with other operators. The risk is further heightened if the operator of a deorbiting satellite is ill-equipped to manage the de-orbiting process, as may be the case with new space actors such as start-ups and emerging space-faring countries.

Development of a Space Traffic Management and Coordination System that can Support Deorbiting at Scale

Although there is global agreement on broad principles and norms underpinning space safety and sustainability – as demonstrated by the adoption of the Long-term Sustainability guidelines by COPUOS – their translation into globally accepted rules and operational practices remains to be realised. To ensure that collision risks are minimised when deorbiting of space objects takes place at scale, a space traffic management and coordination system that can facilitate this would be needed. But the 'rules of the road', coordination mechanisms and technological solutions for such a system are unfortunately not available, as yet.

When aircraft or ships are headed for each other, the 'rules of the road' are clear – each shall alter course to the right to avoid a collision. There is no such rule governing two space objects on a collision course, and this is presuming that both have the ability to manoeuvre, which is not necessarily the case.

Nor are there coordination mechanisms – whether centralised or decentralised – that would allow satellite operators to closely coordinate collision avoidance manoeuvres at scale, and some degree of automation with AI would be necessary to manage this. To enable such systems, much improvement would be needed on space situational awareness, both in terms of collection capabilities – in particular *in-situ* – and in terms of data sharing among operators.

An example of successful data sharing among operators is the Space Data Association, which was established in 2009 by established satellite constellation operators (e.g., Inmarsat, Eutelsat and Intelsat) for exchanging operational data to reduce risks of collisions. How existing and future large satellite constellation operators will approach data sharing and facilitate the processing of data (to avoid the collision of space objects) at a scale never seen before is a key challenge for the next era of satellite constellations.

It would behove both regulators and industry to ensure that efforts to develop a global space traffic management and coordination system that can meet the demands are sped up, in tandem with the policy intent to have a deorbiting regime that is fit for purpose. Both global convergence on concrete rules and practices and the improvement of space situational awareness will be needed to ensure safe and sustainable space activities.

Chris Leck is an Adjunct Senior Fellow at the S. Rajaratnam School of International Studies (RSIS), Nanyang Technological University (NTU), Singapore; and the former Deputy Executive Director of Singapore's national space office, the Office for Space Technology & Industry (OSTIn), Singapore. Dr Quentin Verspieren is Assistant Professor at the Science, Technology, and Innovation Governance (STIG) programme of the University of Tokyo's Graduate School of Public Policy.

S. Rajaratnam School of International Studies, NTU Singapore
Block S4, Level B3, 50 Nanyang Avenue, Singapore 639798
T: +65 6790 6982 | E: rsispublications@ntu.edu.sg | W: www.rsis.edu.sg