Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space

Agenda Item 8: Space Debris

(6 February 2020, Vienna)

UNIDIR Contribution

Thank you for your attention. UNIDIR welcomes this opportunity to address the Scientific and Technical Subcommittee of COPUOS on the topic of space debris. While debris is largely considered to be a safety challenge, emerging security threats can also generate debris, further exacerbating the risks to space objects.[1] In this context, I would like to tell you about some of our thinking on space security and debris, and synergies between different policy communities pursuing the common goal of long-term sustainability of space activities.

At the outset, I would like to thank Dr Moriba Jah, Associate Professor at the University of Texas at Austin and UNIDIR non-resident fellow, for his assistance with this paper. His department provided technical data for this presentation.

Introduction

As many of you know, several countries have developed anti-satellite (ASAT) capabilities that can target satellites and disrupt or even destroy them.[2] This is largely due to the increased importance of satellites to military services, capabilities and activities. Satellites provide communications for troops, valuable reconnaissance information and even provide targeting for long-range missiles. As such, some States seek the means to neutralise these capabilities by developing an array of tools that range from jamming equipment to destructive kinetic weapons.[3] The latter category is of particular concern because, if used successfully, they can physically impact a satellite and cause a break up, creating space debris. Depending on the altitude of the impact, this debris may remain in orbit for many years.

The challenge posed by kinetic ASAT technology does not require a full-blown conflict in space between major military space powers in order to disrupt the space environment as we know it. Indeed, the mere testing of destructive ASAT technology can generate debris, posing a threat to any and all Resident Space Objects (RSOs) in a given orbit (which can include human spaceflight).

Recent ASAT Tests and Demonstrations

There are several examples of ASAT tests and the proliferation of debris. Throughout the latter half of the 20th century, ASAT tests using missile interceptors and explosive co-orbital drones generated around 1,000 pieces of trackable debris, in addition to non-trackable debris that is too small to detect.[4] These tests were carried out in low-Earth orbit (LEO). While most of their debris only remained in orbit

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[1] For the purposes of this paper, "safety" refers to occurrences without intent (namely accidents) while "security" refers to occurrences with intent (such as attacks).

[2] *See* Daniel Porras, "Towards ASAT Test Guidelines", UNIDIR Space Dossier File 2, 17 May 2018, https://www.unidir.org/publication/towards-asat-test-guidelines

[3] *See* "Global Counterspace Capabilities: An Open Source Assessment", Secure World Foundation, April 2019.

[4] Daniel Porras, "Towards ASAT Test Guidelines", UNIDIR Space Dossier File 2, 17 May 2018, pp. 4-5, https://www.unidir.org/publication/towards-asat-test-guidelines

a few years, some remained for much longer. The last such test of the 20th century was conducted in 1985.

In 2007 live testing resumed, leading to three high-profile demonstrations. In the first instance, a direct-ascent ASAT missile struck a weather satellite at an altitude of roughly 850km, generating more than 3,200 pieces of debris that will remain in orbit for decades or even centuries.[5] Figure 1 shows a current space traffic map of LEO comprised of the debris still being tracked by that demonstration.[6]

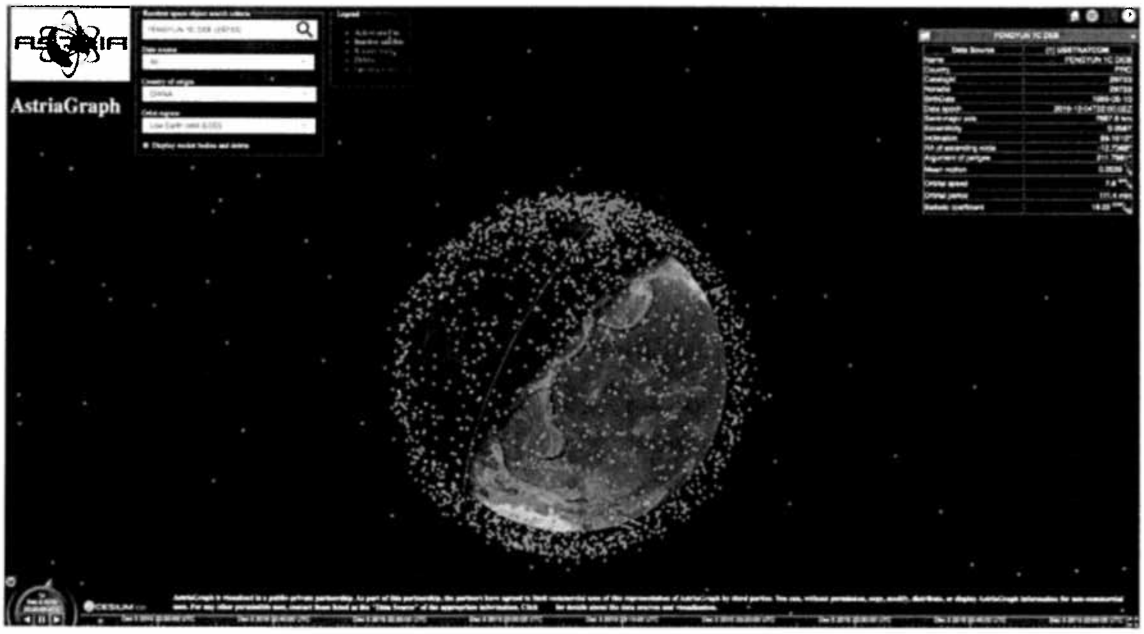

Figure 1

The following year, another direct-ascent ASAT missile was used to destroy a faulty satellite, generating another 174 pieces of trackable debris. This operation took place at less than 250km in altitude, and it took nearly two years for all the trackable debris to de-orbit. This was longer than the State carrying out the test expected.[7]

Finally, in March 2019, another ASAT demonstration was carried out, generating more than 250 pieces of trackable debris.[8] This intercept took place at 280km and, a year later (at the time of writing this report), at least 30% of the debris remains in orbit.[9] ASTRIAGraph currently tracks 22 related pieces of debris. These pieces of debris are at altitudes of approximately 400 kilometres above the surface of the Earth, which is at similar altitude to the International Space Station. Figure 2 shows a current snapshot of the trackable debris from this event.

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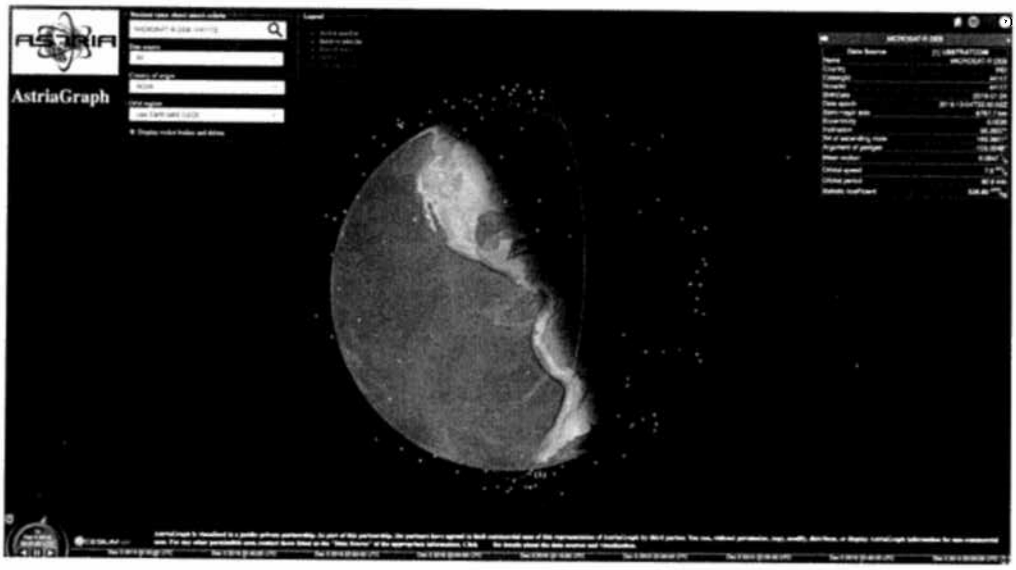
[5] Leonard David, "China's Anti-Satellite Test: Worrisome Debris Cloud Circles the Earth", Space.com, 2 February 2007, https://www.space.com/3415-china-anti-satellite-test-worrisome-debris-cloud-circles-earth.html.

[6] Courtesy of Astrigraph: http://bit.ly/astriagraph

[7] Nicole Petrucci, "Reflections on Operation Burnt Frost", Air Power Strategy, 5 March 2017, http://www.airpowerstrategy.com/2017/03/05/burnt-frost/.

[8] Caleb Henry, "India ASAT debris spotted over 2,200 kilometers, will remain a year or more in orbit", SpaceNews, 9 April 2019, https://spacenews.com/india-asat-debris-spotted-above-2200-kilometers-will-last-a-year-or-more/.

[9] "Six months after India's ASAT test", SatTrackCam Leiden (b)log, 27 September 2019.



Unpredictability of Debris

One of the biggest challenges with space debris is that it is extremely difficult to know or predict the real location of objects in space. Numerous inputs determine the motion of resident space objects, including gravitational and non-gravitational ones. The gravitational forces depend on where the object is located, while non-gravitational forces depend on the specific size, shape, materials, orientation, and, if actively controlled, human inputs of the given object. Most of this information is unknown *a priori,*_making it very difficult to know or predict where objects are located. Knowing exactly where any given object is will depend on modelling and predicting of both gravitational and non-gravitational inputs.

If this were not hard enough, it is even more difficult to predict where debris left behind after a collision will end up. As shown by the most recent instance of ASAT use, we are still a long way off from being able to model such complex dynamics. Until such time, the only thing we can be certain of when there is an ASAT test is that the debris will spread across a wide area and will continue to circle the Earth for an unpredictable amount of time, or until that debris collides with other objects.

Possible ASAT test guidelines

At present, there are no laws and few rules relating to the use of destructive ASAT technology. One of the few existing possible norms on this matter is Guideline 4 of the COPUOS Space Debris Mitigation Guidelines, which states that "intentional destruction of any object should be avoided". Guideline 4 stops short of imposing any formal obligations on space actors. The Guideline also stipulates that if the destruction of an object is necessary, it should be done at an altitude low enough to limit the lifetime of debris. However, there is no explicit indication of what is "sufficiently low" or what is acceptable in terms of the orbital lifetime of resulting fragments.

In 2018, UNIDIR published a report exploring the development of specific ASAT test guidelines, based on the same fundamental principles as those contained in Guideline 4: *no debris*, *low debris*, and *notification*.

First, on "no debris", any ASAT test in orbit should not create any debris that can then pose a threat to other space objects. Indeed, physically striking a target is not necessary for a State to show that it has the capacity to destroy a space target. Fly-bys and virtual targets can also satisfactorily confirm that an ASAT system can successfully complete its mission.

Secondly, on "low debris", there is a question as to what altitude might be acceptable as a limit for the actual striking of an object in space. Muted public reaction to the most recent ASAT demonstration suggests there is some tolerance to ASAT tests under 300km in altitude. Experts in the scientific community like Dr Moriba Jah, argue that collisions or breakups occurring at this altitude will still pose considerable risk to resident objects in LEO, and that a lower limit should be expressly adopted. In order to avoid politically sensitive issues, it might be worth considering setting a limit on kinetic ASAT testing at an altitude that still permits for mid-course intercepts of intercontinental ballistic missiles.

Thirdly, States should notify, at the very least, those actors that might be adversely affected by the debris a kinetic ASAT test would generate. This could entail notifying many individual actors, or notifying a single international entity that could then widely disseminate the relevant technical information. The point here is that States be aware of an upcoming test so that they can prepare from a safety perspective (in case an object needs to move) and from a security perspective (so as not to misinterpret the test). Secure lines of communication might also be used where appropriate.

Adopting Guidelines

The adoption of ASAT test guidelines could strengthen the effectiveness of the LTS Guidelines and be a tangible step towards achieving the long-term sustainability of space activities. Indeed, in the Conference on Disarmament in Geneva, several States have already signalled that ASAT test guidelines could be a useful approach to improving space security, including Canada and Switzerland. One form that such Guidelines might take is that of a Resolution, setting explicit but voluntary norms for States to follow when developing ASAT capabilities. If such a voluntary norm is possible, then perhaps a legally binding prohibition on the testing of ASATs above a certain altitude might one day be feasible. However, in the current geopolitical climate, small steps, towards a voluntary measure, might have a greater chance of success, building confidence for subsequent work towards a legally binding agreement in the future.

If ASAT test guidelines were to be adopted, how would monitoring and assessment of compliance with the ASAT test guidelines be done? To that end, one approach would be to leverage public databases such as ASTRIAGraph that could provide timely information based upon one or more independent sources of space object information. Such a use-case was successfully demonstrated in determining compliance and non-compliance with UN COPUOS LTS Guidelines for GEO Disposal.[10] This system can be scaled to assess any number of inferred behaviours against guidelines, policies, laws, and regulations, and made publicly available, including the detection and attribution of ASAT tests.

Conclusion

In closing, the space environment is becoming increasingly important for civilians and military forces alike, making the continued use of space critical for people all over the world. The emergence of ASAT capabilities could threaten the long-term sustainability of space activities, even in those ASAT systems in their testing and development phases. To this end, ASAT test guidelines might be a first but meaningful step towards strengthening security in space and mitigating the harmful effects of space debris.

Thank you for listening.

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[10] The results of this assessment can be accessed at: http://astria.tacc.utexas.edu/compliance.