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SPOTLIGHT

WHAT KINETIC ASAT TESTING TELLS US ABOUT SPACE SECURITY GOVERNANCE

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The testing of kinetic anti-satellite (ASAT) weapons and the debris that they produce are currently garnering global attention and concern. This is partly because of the November 2021 ASAT test conducted by Russia; partly because of our expanding use and dependence on outer space; and partly because of the accelerating development, testing, and demonstration of kinetic ASAT capabilities.

Not only is this testing at the crux of the relationship between safety, sustainability, and security in outer space, but its effects touch on all users and uses of this domain. The current inability to constrain such testing points to ongoing gaps in outer space security governance.

This report examines the dangers of kinetic ASAT weapons and their testing, as well as the ways in which improved governance mechanisms can lower risks, enhancing both sustainability and security in outer space. Although most measures require collective action, some can be taken unilaterally. All can be supported by civil society.

ASAT TESTING A PART OF SPACE HISTORY

Kinetic anti-satellite weapons use physical force to damage or destroy their targets. Direct-ascent weapons, which launch a missile or other projectile from Earth to intercept a satellite on orbit, are closely related to anti-ballistic missile (ABM) defence systems; modified anti-ballistic missiles have been tested against space

objects on numerous occasions.

Kinetic ASAT capabilities have been around since the early days of the space age, although there is no record that they have ever been used in any hostile action against the assets of another state. During the Cold War, the Soviet Union conducted several kinetic ASAT tests using a co-orbital weapon system that targeted objects in space from orbit. The United States, China, Russia, and India have each conducted direct-ascent kinetic intercept demonstrations targeting their own defunct satellites.

The first direct-ascent intercept of a satellite was demonstrated by the United States in 1963, using a modified Nike-Zeus nuclear-tipped anti-ballistic missile that targeted a spent rocket stage in orbit. Nuclear explosions in space were later banned, but various non-nuclear iterations of the ASAT program continued into the 1970s.

In 1984, the United States developed the ASM-135 Air Launched Miniature Vehicle. The missile was mounted on an F-15A aircraft and could intercept targets in low Earth Orbit (LEO). An intercept test against a U.S. Solwind P78-1 satellite flying at an altitude of 555 kilometres (km) was conducted in 1985. Another direct-ascent ASAT system, the Kinetic Energy ASAT (KE ASAT) program, was developed in the 1990s but never tested against a space object.

While weapons testing in outer space has been happening for decades, the growing population of satellites and even humans in orbit dramatically increases the risk of catastrophic collisions and other reverberating effects from space debris.

More recent activity includes China's use on January 11, 2007 of what is believed to have been a midrange anti-ballistic missile to destroy the FengYun 1C weather satellite at an orbit altitude of 865 km. On February 20, 2008, the United States launched a modified Standard Missile 3 (SM-3) interceptor from the Aegis sea-based missile defence system to target de-orbiting U.S. reconnaissance satellite USA-193. And on March 27, 2019, India used a Prithvi Defence Vehicle Mk II anti-ballistic missile to intercept the Indian military's Microsat-R satellite at an orbital altitude of approximately 300 km.

The 2021 ASAT test marked Russia's first direct-ascent kinetic intercept of an object on orbit. The initial claim that an ASAT test had taken place came from U.S. Space Command on November 15, following news of a "debris-generating event" in outer space. This claim was confirmed by Russian Defence Minister Sergey Shoigu. The target was Cosmos 1408, a Soviet-era Tselina-D electronic intelligence satellite.

Some experts believe that the system tested was the Nudol ASAT system, which is believed

to have been flight-tested at least 10 times over the last decade, but without intercepting a physical target. Like most Earth-to-space ASAT systems that are based on anti-ballistic missile capabilities, the Nudol is described in open-source documentation as a direct-ascent ASAT weapon that uses an anti-missile interceptor. But Russia's statement leaves other analysts unsure.

Data compiled by the Secure World Foundation lists some 75 known ASAT tests, both ground-based and co-orbital, 17 of which have hit a target in space. The remaining tests either failed or involved non-destructive flight tests.

THE RISKS OF KINETIC ASAT WEAPONS TESTS

While weapons testing in outer space has been happening for decades, the growing population of satellites and even humans in orbit dramatically increases the risk of catastrophic collisions and other reverberating effects from space debris.

ENVIRONMENTAL DAMAGE

Kinetic tests of ASAT weapons are one of the most significant causes of artificial space debris. The Secure World Foundation calculates that such tests have generated 6,536 pieces of catalogued debris – pieces 10 centimetres in diameter or larger and actively tracked by the U.S. Space Surveillance Network. Many thousands of additional pieces too small to be catalogued have also been produced and pose significant risks to space objects.

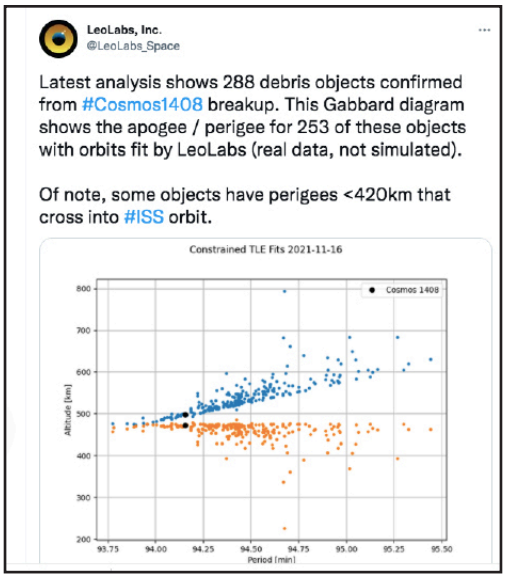
By far the most intentional creation of artificial space debris (3,449 pieces) was caused by China's intentional destruction of the FY-1C satellite in 2007. According to Phillip Anz-Meador, this single incident produced approximately 20% of the artificial objects that have been catalogued.

But *all* kinetic ASAT tests produce harmful space debris. While the size of the target and the orbital height at which it is intercepted have an impact on how much debris is produced and how long it stays in orbit, eliminating the debris impacts of destructive activities in orbit is not yet possible.

The 2008 U.S. intercept of a satellite as it re-entered Earth's orbit created roughly 200 pieces of trackable debris, as well as non-trackable shards, the bulk of which re-entered Earth's atmosphere within one year of the demonstration. In an effort to limit debris from its test in 2019, India intercepted its target at an altitude below 300 km, but some pieces of debris were kicked up far higher; three pieces of tracked debris were still in orbit at the end of 2021.

Weighing approximately 1,750 kilograms, Russia's selected target in 2021 has been described by Harvard astrophysicist Jonathan McDowell as "on the bigger side." The U.S. Space Command initially tracked 1,500 pieces of debris connected to the test. The intercept took place at an

altitude of 480 km, which was lower than China's test, but higher than India's. Although most of the debris should re-enter Earth's atmosphere within three years, tracking shows that some debris has been kicked up into higher orbits, where it will stay for at least a decade.



Space debris poses a significant, relentless, and indiscriminate threat to the sustainability of the space environment and the operational integrity of *all* spacecraft. Moreover, the impact of each additional piece of debris is not linear; the Kessler Syndrome posits that space debris could reach a critical mass that triggers a cascade effect, exponentially increasing the probability that operating satellites will be damaged or disabled.

THE RISK TO SATELLITES

Low Earth orbit is the orbit most heavily used by satellites and the one selected for many of the large constellations currently being developed. Such heavy use adds further stress to the space environment.

In LEO, debris can travel up to 7.2 km/second, or 28,000 km/hour. At this speed, objects as small as paint flecks can cause serious damage to satellites. In March 2021, a Chinese satellite that was hit by a piece of Russian debris left by a rocket launched in 1996 broke into fragments. A piece of debris generated by China's ASAT test in 2007 is widely believed to have damaged a Russian nanosatellite in 2013.

Analysis by commercial space situational awareness (SSA) firm COMSPOC indicates that the risk of collision for some satellites has increased dramatically since the November 2021 test. Other estimates suggest that the number of avoidance manoeuvres required by satellite operators is likely to increase by 100%. Each manoeuvre requires layers of warnings, coordination, and approval; each uses precious fuel, reducing the operational life of a satellite; and each risks a disastrous collision and yet more space debris.

THE RISK TO HUMANS – IN SPACE AND ON EARTH

Debris poses a risk to humans onboard the International Space Station (ISS) and future crewed space stations in Earth orbit. Prior to the 1985 Solwind ASAT test conducted by the U.S. Department of Defense, NASA scientists determined that the resulting debris, which was calculated to remain in orbit until the 1990s, would require enhancement of the shielding for the then-planned space station. Concerns about the potential risk to the ISS were a big part of the decision-making for Operation Burnt Frost in 2008.

Despite India's attempt to limit the amount of debris produced by its 2019 ASAT test, NASA officials warned that at least 24 pieces of the resulting debris posed a threat to the ISS. And in November 2021, the ISS was manoeuvred to avoid a piece of space debris left behind by China's 2007 test.

News of the most recent Russian test first emerged after astronauts and cosmonauts on the ISS were ordered to take shelter as the station passed through a cloud of debris. First moored in lifeboats for two hours, the ISS crew were forced to repeat the exercise 90 minutes later. Although Russia has stated that the remaining debris poses no threat to space activities, NASA scientists claim that the risk of debris puncturing the ISS has increased twofold because of the test.

In January 2022, the Chinese space station had a close encounter with a piece of debris attributed to Russia's ASAT test.

As well, by potentially damaging critical space systems that provide capabilities for global navigation, transportation, communication, and information processing, debris can also have negative impacts for billions of humans on Earth. Because of the extent to which the use of technology enabled by space systems permeates civilian life on Earth, the International Committee of the Red Cross describes potential damage to those systems as "a matter of humanitarian concern."

THE RISKS TO GLOBAL SECURITY

The accelerated development of a range of counterspace weapons provides further evidence of a simmering arms race in outer space. Kinetic ASAT tests serve to directly upset the delicate balance of non-aggression that exists in outer space. even when the targets belong to the actors conducting the tests.

There are indications that interest in the pursuit of offensive weapons capabilities increased following China's ASAT test in 2007. For one thing, India developed an ASAT capability. While the United States is not known to have conducted ASAT tests in over a decade, there are some reasons for believing that it intends to test a counterspace weapon in the future, although it may not be a kinetic weapon.

The growing risk to satellites is spurring renewed interest in so-called defensive weapons for space that could be used to pre-empt perceived threats. But such weapons would also have offensive capabilities, inevitably increasing the security dilemma in outer space and adding fuel to the arms race.

KINETIC ASATS AND INTERNATIONAL LAW

Aside from a ban on the placement in orbit, installation on celestial bodies, or stationing of nuclear weapons and other weapons of mass destruction in outer space that is contained in Article IV of the Outer Space Treaty, arms control restrictions in outer space are few. Bilateral talks between the United States and Soviet Union to ban ASATs failed.

States continue to criticize this gap in multilateral arms control discussions but little progress has been made. The United Nations has been discussing the topic "prevention of an arms race in outer space" (PAROS) for roughly four decades. But this discussion has focused primarily on the placement of weapons in outer space, and not the use of Earth-based weapons against objects in space.

It is noteworthy that the latest (2014) draft treaty to be submitted for consideration by China and Russia, the "Prevention of the Placement of Weapons in Outer Space, The Threat or Use of Force Against Space Objects," would not restrict either the development of such systems or their testing against a state's *own* satellites, although it would ban the threat or use of force against foreign satellites.

Indeed, following its own kinetic ASAT test in 2019, India's Ministry of Foreign Affairs stated that it did not violate the OST. Muted international responses to ASAT tests have not challenged this assessment. And despite several diplomatic initiatives following China's 2007 test, the overall response was to lament, but not declare such activity illegal. Russian officials have likewise insisted that its latest test did not violate any international agreements. While Canada has pitched a multilateral effort to ban kinetic ASAT weapons or testing, the idea has thus far not been formally taken up by any of the international arms control bodies.

However, kinetic ASAT testing is not *only* an arms control issue. The numerous risks outlined point to other relevant principles of the OST, including that

- The use and exploration of outer space is for peaceful purposes and to benefit all humankind (Article I);
- Each state party is Internationally liable for damage caused by objects launched into space (Article VII);
- Each state party is to notify the UN Secretary-General of any phenomenon which could pose a danger to the health or safety of astronauts (Article V);
- Each state party will act with due regard for the interests of other states, and will avoid harmful contamination of celestial bodies; each also has the right to request international consultations prior to potential harmful interference by another state party because of its activities (Article IX).

Yet these principles have not been leveraged in any response to ASAT tests. While the United States consulted with states prior to intercepting a satellite in 2008, it is not clear that such consultation was linked to a perceived treaty obligation to do so.

WHAT ABOUT NORMS?

Norms of behaviour are essential. They help to interpret and put international law into

practice. But international practice has made a mess of both weapons testing and debris norms.

While at various times there have been signs of normative restraint on the testing of weapons in space, a 2020 survey of experts pointed to the steady erosion of such restraints. Following a 1985 U.S. kinetic ASAT test, the Soviet Union/Russia and the United States each observed unilateral moratoria on such testing. China's kinetic ASAT test in 2007 ended this era of restraint. International response to the 2007 test was not as strong as it could have been. While several states conducted formal démarches – protests issued through diplomatic channels – the United States did not.

The environmental damage of the 2007 test caused the international community to focus on the topic of debris mitigation and prevention. A subsequent U.S. demonstration of an ASAT capability in 2008 was purposefully conducted at a very low altitude with the intention of creating limited, short-lived debris.

Numerous voluntary guidelines have since been adopted to mitigate the production of debris. They include:

- Inter-Agency Space Debris Coordination Committee (IADC) debris mitigation guidelines, which include a provision to avoid the intentional destruction of spacecraft or other harmful activities that may increase the risks of collisions or breakups;
- UN debris mitigation guidelines, which echo this restriction;
- UN Committee on the Peaceful Uses of Outer Space voluntary guidelines for the long-term sustainability of outer space.

Additionally, a consensus report published in 2013 by a Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities mandated by the UN First Committee on Disarmament and International Security included a recommendation for "measures related to establishing norms of behaviour for promoting spaceflight safety" such as "consultations that aim at avoiding potentially harmful interference," as well as "limiting orbital debris and minimizing the risk of collisions with other space objects."

Although sustainability norms associated with debris mitigation are consistently cited, a specific norm against destructive ASAT tests is ambiguous at best. This norm was tested by India's ASAT test in 2019, which India framed "responsible." Although the test did produce debris that threatened the ISS, international response from states was mixed. China was one of the few to respond, calling for the upholding of international peace in outer space. NASA, as well as private sector operator Planet publicly raised concerns about the debris generated. However, the U.S. State Department failed to condemn the test, instead taking note that it sought to minimize debris.

Experts believe that the lack of strong international condemnation may have helped to normalize activity that was framed as minimizing debris. Indeed, a recently released set of tenets on responsible behaviour in outer space that was adopted by the U.S. military notably includes a commitment to avoid generating "long-lived debris."

But a focus on limiting "long-lived" or "harmful" debris from ASAT tests has not reined in

destructive activities. While the size and orbital location of Russia's target in its 2021 test resulted in significantly more debris than that produced by other recent tests, Russia, too, declared that the debris impact of its test was insignificant and international criticism hypocritical.

Yet ASAT testing – especially the debris that it creates – is clearly of concern to many states. In 2020, the United Kingdom initiated a new process at the United Nations General Assembly First Committee on International Security and Disarmament to advance norms of responsible behaviour in outer space, specifically focused on reducing threats in the context of security-related activities. Thirty states, plus the European Union, submitted views on the topic to the UN Secretary-General. Almost all highlighted the threats posed by space debris and many noted concerns with weapons testing and ASATs more broadly.

CALLS FOR ACTION AFTER THE 2021 RUSSIAN ASAT TEST

In contrast to the international response to India's 2019 ASAT test, the reaction to Russia's 2021 test was swift and largely condemning.

U.S. Space Commander General James Dickinson called the Russian test a "deliberate disregard for the security, safety, stability, and long-term sustainability of the space domain for all nations." NASA called it "reckless and dangerous." The UK Space Command called it "irresponsible."

Commercial operators Planet and Astroscale and the Satellite Industry Association, among others, also spoke out. Civil society organization Secure World Foundation called the act "an unsustainable, irresponsible, and destabilizing activity in space in which no responsible spacefaring state should engage."

While a few statements, such as that by Australia, referred to international security in outer space, the international response focused on safety and sustainability and a call for new norms. The U.S. State Department asserted that it "will work with our allies and partners as we seek to respond to this irresponsible act" and called on all "responsible spacefaring nations" to contribute to the development of norms of responsible behaviour in outer space. Such sentiments were echoed by Germany, France, Canada, the Netherlands, and Japan.

There have also been renewed calls for a formal ban on destructive ASAT testing. Civil society organizations including SIPRI and Secure World Foundation endorsed such a call by international experts who signed on to an international letter to the UN Secretary-General earlier in 2021. Project Ploughshares also supports this ban.

HOW TO PREVENT ADDITIONAL KINETIC ASAT TESTS

There are numerous unilateral and collective measures that can be adopted to prevent the further testing of kinetic ASAT weapons in space. Better yet, they can be layered on top of one another.

STOP CONDUCTING KINETIC ASAT TESTS!

- States can unilaterally adopt moratoria on further testing. Such measures by the

United States and the Soviet Union helped to quell anti-satellite weapon testing during the Cold War.

REINFORCE EXISTING PRINCIPLES, RULES, AND OBLIGATIONS

- States could take steps to publicly reinforce and promote existing governance agreements and practices, such as the debris mitigation rules outlined above, which include a commitment to avoid the intentional destruction of objects in orbit.
- States could practise consistent compliance with existing rules, and publicly identify and validate such rules and practices.

PUT EXISTING TOOLS AND MECHANISMS TO BETTER USE

- The OST points to existing mechanisms that could be put to better use to constrain undesirable activity. As noted above, the OST makes reference to several obligations and processes that have been underutilized, including requirements in Article IX for international consultations in the event of potential harmful interference with the activities of other states. Making consultations the rule rather than the exception, and developing formal processes to do so, would be another way to enhance both sustainability and security in space.

AGREE TO ADDITIONAL RULES AND NORMS OF BEHAVIOUR

- In December 2021, the United Nations General Assembly adopted Resolution 75/36 "Reducing space threats through norms, rules and principles of responsible behaviours," which establishes an Open-Ended Working Group (OEWG) to advance the results of consultations led by the UK in 2021. The focus of this process is on the identification of threatening and reassuring behaviours in space. States could use this forum to collectively clarify and strengthen norms and other voluntary commitments against further testing.
- Specifically, the OEWG can help to rectify the lack of uniformity of actions and statements by states on ASAT testing by creating an open and inclusive dialogue rooted in consensus. Among the most consistently cited threats in an initial consultation with states in 2020 are weapons testing and space debris.
- States can also use the OEWG as a venue to recommend a formal kinetic ASAT test ban (see below).
- Other topics ripe for discussion in this context include the interpretation and application of the principle of due regard in the context of military and other security-related activities.

PURSUE A KINETIC ASAT TEST BAN

- States can also consider adopting a formal ban against the testing of kinetic ASAT weapons. Not only are calls for such a ban growing among civil society organizations and policy experts, but the 1963 Partial Test Ban Treaty banning the testing of nuclear weapons under water, in the atmosphere, and in outer space sets a helpful precedent.

- Efforts to restrict the testing of kinetic ASAT capabilities would not only help to prevent the harmful and indiscriminate outcomes of such weapons, but would also constrain the ability to develop reliable and effective weapons systems themselves, and tamp down the escalatory security impacts of such testing.

SPACE SECURITY GOVERNANCE GOING FORWARD

The latest kinetic ASAT test is spurring the drive for additional governance measures to restrict activities such as weapons testing, which intentionally create space debris. But it also points to what is needed for effective governance of space security going forward. Consider, for example, the following:

- *Clear rules* that avoid ill-defined terms such as "long-lived" or "harmful." The most successful rules are based on clear-cut standards, such as bans, which avoid interpretive loopholes and facilitate monitoring and verification.
- *Timely and trusted data*, which is key to the successful implementation and evaluation of rules. The growing availability of commercial SSA data helps, as does the emergence of non-profit datasets such as the Satellite Dashboard. (in addition to commercial SSA data, see, for example, annual counterspace reports by Secure World Foundation and CSIS, and public reporting on UN First Committee by Reaching Critical Will). But political challenges remain. For example, while the United States asserted that the debris from the 2021 test posed a long-term risk, the Russian Ministry of Defence released its own data to establish that the debris is not harmful, at least to the ISS. This issue of data trust and data access was also raised during the 2020 consultation on norms.
- *Inclusive processes* for rule-making and implementation that include all relevant stakeholders, including commercial operators and grassroots civil society. Both have proven themselves indispensable.
- *Mutually beneficial solutions* to common challenges are needed to move beyond the cycle of public shame and punishment and support modifying behaviours to reach shared goals.
- *Formal processes and mechanisms* are necessary to enable better communication between states, to discuss security-related concerns, and to consider collective responses. For example, in the aftermath of Russia's ASAT test, experts have called for states to invoke the OST provision for consultations in the event of an activity that causes potentially harmful interference (Article IX). While Canada and other states have conducted démarches related to ASAT tests in the past, no cohesive and consistent approach to both upholding international rules in outer space and responding to perceived violations has been established.
- *Thinking beyond space* to consider the closely entwined interests, activities, and insecurities on Earth. As the use of modified ballistic-missile-defence capabilities for ASAT purposes shows, efforts to enhance security in outer space may not be feasible without addressing some of the political and technical dynamics on Earth, in which it is embedded.

CONCLUSION

The latest kinetic ASAT test is yet another reminder that there is no such thing as a safe or responsible debris-generating event in orbit. The risks range from environmental contamination and collisions to humanitarian impacts and arms racing. While ways exist to help ensure that no additional tests take place, there is also a clear need to enhance the governance infrastructure of outer space. We need to develop clear rules, facilitate access to trusted data, create inclusive processes for discussion, and put in place mechanisms that will allow key elements of the OST to be put into practice.

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Project Ploughshares is a Canadian peace research institute with a focus on disarmament efforts and international security, specifically related to the arms trade, emerging military and security technologies, nuclear weapons, and outer space.