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AMERICAN, RUSSIAN, AND CHINESE ANTI-SATELLITE WEAPONS: A COMPARATIVE ANALYSIS

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Abstract
Since China's successful test of anti-satellite (ASAT) weapons in 2007, a growing interest in this type of weapons has been observed worldwide. Attention is mainly paid to the capabilities of the Middle Kingdom (China) and the United States, while often neglecting those of Russia. However, in view of the growing rivalry between global superpowers, a return to perceiving international security in terms of "spheres of influence", the increasing militarisation of space, and Moscow's successful test of anti-satellite weapons conducted on 15 November 2022, it seems advisable to conduct a comparative analysis of the ASAT capabilities of the three largest military powers in the world. This article presents the technological infrastructure of the United States, Russia, and China, the anti-satellite weapons tests conducted, and the attitude of the political elites towards these weapons. During the research, studies and articles published in the following papers and released by the following institutions were used:National Defence University, Contemporary Security Policy, Bulletin of the Atomic Scientists, The Space Review, The Carnegie Endowment for International Peace, Stockholm International Peace Research Institute, Foreign Policy, Globalsecurity, Defence24, Arms Control Association, Air&Space Forces, US Department of Defence, Secure World Foundation, Project2049 Institute. Before commencing the research, the following questions were formulated: Which of the three superpowers has the greatest ASAT potential? What are the means of destroying satellites, alternative to direct strike? What is the direction of the ongoing militarisation of space and the development of anti-satellite weapons? According to the author of this article, effective anti-satellite weapons are available to all three states under consideration, including direct-ascent anti-satellite weapons for the direct destruction of satellites (the US SM-3, the Russian PL-19 Nudol, and the Chinese SC-19 and DN-2), hypersonic weapons that can be used to destroy command and control centres located on the enemy's land, hacking attacks enabling the disruption of satellite operation, rendezvous and proximity operations (RPOs) involving satellites that perform deliberate manoeuvres to get closer to other space objects, and laser or nuclear weapons deployed in space. Despite the progress made by China and Russia in the field of space militarisation, the United States' ASAT potential is still the greatest. It comprises over 400 SM-3 missiles deployed on warships, SM-3 missiles in Poland and Romania, and 44 ground-based interceptors, with another 20 planned to be deployed in the future. Some of Russia

and China's systems are still at the testing stage and, while the exact number is not known, it appears reasonable to assume that the number of those already in use is low and the systems at hand would be treated primarily as deterrents and weapons of last resort.

Keywords
Anti-satellite weapons, United States, Russia, China

Introduction

Initially, the development of anti-satellite (ASAT) weapons was dominated by the United States and the Soviet Union. Its origins date back to the Cold War and the launching of the first artificial satellite, Sputnik I, in October 1957. At that time, concerns were raised in the United States that, in years to come, satellites would be equipped with nuclear weapons. With a view to tackling the new challenge, Washington developed its first anti-satellite weapons: the Bold Orion and the High Virgo, both air-launched ballistic missiles. The Bold Orion test, conducted on 8 December 1958, was considered a success. Although the missile passed the satellite at an altitude of 251 km, it was assumed that the nuclear warhead used would have destroyed the target. Instead, the Soviet Union concentrated on developing orbital weapons, one of these being the Istriebitiel Sputnikov System. It consisted of a launcher and an orbital module designed to approach the target and detonate the fragmentation warhead. On 1 November 1969, a test was conducted in which Cosmos-248, a Soviet military anti-satellite target, was destroyed by a satellite intercept vehicle. This was the first incident of this kind and the first satellite destroyed in orbit, other than through a nuclear explosion. The system reached its operational status in November 1979 (Kopeć, 2022, p. 264). Unlike in the Soviet Union, the three American missiles–the Bold Orion, the High Virgo, and the ASM-135, the last of these being successfully tested in 1985–were not put into service.

As regards anti-satellite weapons, China joined the arms race about 30 years later. China's anti-satellite weapons test, conducted on 11 January 2007, came as a huge surprise to the US political and military elites. They began to ponder on how to respond to the development of the new strategic weapons which could compromise the strategic balance of the superpowers. Considering the emerging voices, one effective solution could hardly be found. On the one hand, China's intention might have been to draw the United States into a new arms race in the anti-satellite weapons domain, which would result in reducing the funding for other important projects. On the other hand, Washington could not remain idle. Among the possible solutions, the following were mentioned: developing the capability to destroy Chinese launchers during wartime, including the DF-21 located in the Chinese mainland; promptly replacing the damaged satellites with new ones; building smaller satellites using stealth technology and deploying them over a large area; increasing the use of manned and unmanned tactical reconnaissance aircraft unrelated to space exploration; and using satellites owned by the allies, thus forcing Beijing to escalate the conflict and have third countries join in on the US side. Other proposals included the need to profoundly change the American way of war-making and learn how to fight without satellites, or to choose a completely different path based on diplomatic solutions. In the latter case, efforts could be made to sign a treaty on preventing an arms race in space, including a ban on holding any anti-satellite weapons. A diplomatic solution could also involve adopting an international code of conduct for states in space or launching a political Space Security Initiative, with the aim of punishing any activities jeopardising the functioning of satellites, including anti-satellite weapons tests (Saunders & Lutes, 2007).

American ASAT potential

During the Cold War, the United States carried out a range of projects aimed at developing anti-satellite weapons. Examples include Project BAMBI (Ballistic Missile Boost Intercept), Project 505, Project 437, the Prototype Miniature Air-Launched Segment (PMALS) – later renamed the Air-Launched Miniature Vehicle (ALMV)–and the Strategic Defence Initiative (SDI), dubbed "Star Wars". Within its framework, a number of new weapon systems were developed in the 1980s. These included the Excalibur X-ray laser, expected to destroy up to 50 targets through a nuclear explosion; the "Brilliant Pebbles" programme, which involved placing a large number of small interceptors in space; the BEAR (Beam Experiments Aboard a Rocket) particle thrower; a railgun used to generate the magnetic field to accelerate a missile to very high speeds; and the Mid-Infrared Advanced Chemical Laser (MIRACL). Nonetheless, no weapon system was completed under the SDI, which would be later put into service. Economically speaking, it proved to be a sort of a financial trap for the Soviet Union, in which it was actually caught. The programme was cancelled in 1991 under President G. H.W. Bush's decision (Saunders & Lutes, 2007).

After the Cold War, the US government significantly reduced funding for missile defence and anti-satellite weapons projects. However, this did not put an end to the militarisation of space. The motivation for other efforts in this field was the First Gulf War, which was referred to as the first "space war". Although it did not involve the upper layers of the atmosphere, GPS satellites played a key role in the warfare. If the US troops had not had them at their disposal, they would have found it much more difficult to navigate, communicate, and direct fire over hundreds of kilometres in Iraq and Kuwait. This way, it became apparent, back in 1991, that satellites were both a key and weak point in US national security. There was a proliferation of voices advocating the continuation of work on projects fostering the military control of space. Such a view was expressed, *inter alia*, by General Thomas Moorman, Vice Chief of Staff of the US Air Force. In 2001, *The Report of the Commission to Assess United States National Security Space Management and Organisation*, drawn up by a group of officials led by Donald Rumsfeld, was released to present to the federal government the significance of space for national security. It stipulated that a surprise attack on satellites would mean a space Pearl Harbor for the United States. Therefore, the government must take the threat of using anti-satellite weapons seriously and implement appropriate preventive measures (Aerospace Security, 2001).

The withdrawal of the United States from the Anti-Ballistic Missile Treaty in 2001 was the first major political event with consequences for the military use of space after the end of the Cold War. This decision was justified by the development of ballistic missiles by so-called rogue states, i.e., North Korea and Iran, and the need to develop the state's own anti-missile systems (Bateman, 2022). Another major event was Operation Burnt Frost, conducted a year after China's January 2007 anti-satellite weapons test. The reasons behind this operation were explained by Nicolas Johnson, the late NASA space debris expert, in an article released in *Space Policy*, titled "Operation Burnt Frost: A View From Inside". It discussed the shooting down of a secret US spy satellite with the aim of preventing toxic debris from falling into populated areas. The satellite, identified as the USA-193 and belonging to the National Reconnaissance Office, was launched into low orbit by a Delta II carrier rocket on 14 December 2006. Although the launch was successful, the controllers soon lost contact with the satellite. Having considered different variants, a decision was made that the satellite would be shot down using the SM-3 missile carried by US Navy cruisers. The warship was chosen due to its high mobility, as the flight path of the USA-193 relative to Earth changed each day. In addition, this solution enabled the selection of the exact site and the use of several ships, which could be crucial if one of them could not launch the missile for whatever technical reason. The operation was conducted on 20 February 2008 by the Ticonderoga-class guided-missile cruiser, the USS Lake Erie, located north of Hawaii. Four minutes after the launch, the SM-3 USA-193 was hit at high speed at an altitude of about 150 miles, as the satellite was heading northeast, towards Canada.

It is estimated that more than 400 SM-3 missiles are currently at the US disposal. These are available in three versions: the SM-3 IA, the SM-3 IB, and the SM-3 IIA, varying in range, precision, and electronics. In addition to these, there are SM-3 missiles which can be launched from the military bases in Poland (24 missiles) and Romania. Moreover, the United States' ASAT potential is increased by ground-based interceptors placed in underground silos, forming part of the Ground-based Midcourse Defence. In 2021, 40 missiles were deployed at Fort Greely in Alaska, while four were deployed at the Space Force base in Vandenberg, California. Another 20 missiles were being developed (Missile Threats, 2021).

During Barack Obama's presidency, the United States did not take any significant steps either to reduce the testing of anti-satellite weapons or to develop its own anti-satellite weapons systems. The US interest in using space for military purposes renewed during Donald Trump's presidency. The Space Force was established as an independent type of a military force. President Trump also repeatedly emphasised the need to develop a power projection capability into space and from space towards Earth. During Joe Biden's presidency, the greatest challenge for the US administration was posed by the Russian tests of anti-satellite weapons conducted in 2020-2021. Although the significance of Russian anti-satellite weapons was described in Washington as limited, it triggered discussions about the consequences of the increasing number of tests and the proliferation of such weapons to other countries (India and Israel). Representatives of the federal government–more specifically, Kathleen H. Hicks, Deputy Secretary of Defence, and John Plumb, Assistant Secretary of Defence for Space Policy–called for establishing an international memorandum of understanding to ban anti-satellite weapons tests that could generate debris dangerous to astronauts and space stations (Bateman, 2022). Heed was eventually paid to this call in April 2022 when the United States adopted a voluntary moratorium banning the testing of direct-ascent anti-satellite systems. Meanwhile, an appeal was made to other countries (China, Russia and India) to take similar legal steps (Panda & Silverstein, 2022). This provoked questions about whether the United States was to abandon the development of anti-satellite weapons, allowing other states to gain an advantage in this field over time. The answer was obviously not. The moratorium prohibits testing but not research into anti-satellite weapons systems.

A direct kinetic strike is not the only way to destroy satellites. This can also involve destructing a ground station, hampering communications, or perpetrating hacking attacks. With its extensive arsenal of precision-guided munitions, the United States can destroy ground stations using cruise missiles or ballistic missiles, sending special forces, or providing allied paramilitary groups operating in the territory of a hostile state with appropriate military equipment. Attempts can also be made to hinder communications between the ground station and satellites, rendering the latter useless. A hacking attack on command, control, and communications systems, involving the spread of a computer virus which could damage or destroy the satellite, is yet another option.

Capabilities for rendezvous and proximity operations have been developed by the United States for several decades. These RPO technologies enable a wide range of space activities, including in-orbit inspections, repairs, refuelling, parts replacement, equipment life extension, intelligence, observation, and satellite destruction operations. The satellite known as "Prowler" was perhaps one of the earliest examples of RPO operations launched for military purposes. Secretly launched into orbit in 1990 by a space shuttle, it performed a series of manoeuvres to get closer to Russian satellites, the aim being to collect intelligence while remaining undetected by Russian space observation systems. It is said to have been withdrawn from service around 1998, although the United States has never officially confirmed its existence. In 2006, the US Air Force launched two small satellites, officially referred to as the Micro-satellite Technology Experiment (MiTEx), into geosynchronous orbit to test certain technologies that were supposed to facilitate subsequent missions of this sort. Meanwhile, the two satellites were found to be located close to the American DSP 23, a satellite providing early warning of missile launches and other infrared events. In the following years, the United States began implementing the Geosynchronous Space Situational Awareness Program (GSSAP) using pairs of small satellites deployed above and below the GEO belt. Their official purpose was to inspect various types of objects. The first pair of satellites was launched on 28 July 2014, the second on 19 August 2016, and the third in January 2022. While the US Armed Forces did not provide any data on their location or heading, information presented by other entities, including the Russian Academy of Sciences, indicated that the satellites had performed hundreds of manoeuvres, approaching Chinese and Russian military objects. In 2023, the Chinese admitted to tracking GSSAP satellites, making at least 14 approaches to their installations. These are but a few examples of the rendezvous and proximity operations conducted by the United States. It is estimated that the United States had launched at least 16 different types of satellites as part of the RPO by 2024, inter alia, conducting signals intelligence (SIGINT) processes and examining satellites of other countries, mainly Chinese and Russian (Samson & Brett, 2025).

Mindful of the progress made by its strategic rivals in recent years in the field of ASAT weapons, the United States has been conducting further research projects aimed at increasing the country's defensive and offensive capabilities in space. As noted by Gen. B. Chance Saltzman, Chief of Space Operations, United States Space Force, the United States needs three types of weapons: directed energy weapons (lasers), radio wave jamming systems, and new kinetic weapons. Some research has been conducted by DARPA, including research into the High Energy Liquid Laser Area Defense System and the Modular Efficient Laser Technology Program. The purpose of the former is to deploy laser weapons on mobile platforms, such as aircraft and ground vehicles, while the latter is meant to improve the power efficiency of lasers (Berman, 2025).

Russia's ASAT potential

On 15 November 2021, Russia conducted one of its most prominent direct-ascent anti-satellite (DA-ASAT) weapons tests. The target was Cosmos-1408, a 2200kg satellite and part of the Soviet electronic intelligence infrastructure. The ground-launched PL-19 Nudol anti-ballistic missile was used to destroy the satellite, hitting it at an altitude of 480 km (Raju, 2021). In consequence, a cloud of more than 1500 fragments, with a diameter of 10 cm or more, was created, including 250-300 fragments described as "larger" by LeoLabs, an independent start-up. The test was condemned by the United States a few hours after it was carried out. Critical opinions were also expressed by Australia, the European Union, France, Germany, Japan, NATO, and South Korea, concerning mainly the creation of a large amount of debris that could pose a threat to other objects in space. Right after the destruction of Cosmos-1408, the crew of the International Space Station, including several Russians, was forced to shelter in their spacecraft due to the risk of colliding with the approaching debris cloud (Rzeczpospolita, 2021). By destroying its own satellite in space, Russia achieved two goals. First, it strengthened its defence and deterrence capabilities and demonstrated its power before anti-satellite weapons tests were challenged by international law. Second, it made its way to the group of states that could participate in future negotiations on the use of anti-satellite weapons in space (Paikowsky, 2021). General James Dickinson, Commander of the US Space Command, claimed that these actions reflected Russia's expansion of its anti-access capabilities. According to Dickinson, by increasing its ASAT capabilities, Russia intended to actively deny the United States and its allies access to space.

However, this was not the very first anti-satellite weapons test. On 15 April 2020, the Air and Space Forces conducted a test launch of an anti-satellite missile–presumably the Nudol PL-19, as in 2021. Information about the event was released by the US Space Command, highlighting that a DA-ASAT-class missile was being tracked. While Russia did not admit to having arranged the test, a few days earlier it had published a Notice to AirMen (NOTAM) concerning restrictions imposed on civilian air navigation over the Plesetsk cosmodrome region in northern Russia, the Chosha Bay, and a large area of the Laptev Sea. It can be inferred that this was where the target may have been located. Some sources reported that the target was the Cosmos-1356 satellite intended for deorbiting in the future (Muczyński, 2020). The rocket was launched using a mobile launcher at the Plesetsk cosmodrome carrying a dummy kill vehicle, which did not eventually hit any objects in low Earth orbit. The vehicle is said to have crashed in the Laptev Sea, in the Arctic Ocean (SpaceWatch.Global, 2020). While the Nudol PL-19 missile, forming part of the A-235 anti-ballistic missile system, has been Russia's most tested anti-satellite weapon, the Kremlin has other anti-satellite weapons systems at its disposal. These include the S-550 launchers, the Kontakt missile carried by the MiG-31BM aircraft, and the laser system known as the A-60. Most of these, however, have not been used by the armed forces yet and have remained at the research or funding stage.

The history of laser weapons transported by the Il-76MD-90E aircraft began in the early 1980s, when the first lasers were mounted on two machines. The first such flight took place on 19 August 1981. The secret programme continued until 1993 and was then suspended due to the shortage of funds. In 2009, efforts were resumed under the name "A-60SE" and involved mounting a 1LK222 laser on aircraft. However, it is not ultimately intended to serve the purpose of destroying satellites, but rather blinding them or burning sensitive optics and sensors. The expected range of the laser beam is 1500 km, enabling the location of reconnaissance satellites in low Earth orbit. According to some sources, the Russians had also initiated work on a more powerful laser, capable of neutralising manned aircraft and missiles. In 2011, that project was suspended due to the shortage of funds. However, the idea became popular with the Russian strategists who described it as an "asymmetric" response to the imminent space threat from the United States. The Russian laser weapons should not be treated as equivalent to the American airborne laser developed and tested in the early 21st century. In fact, the Pentagon developed a much more powerful chemical laser, the YAL-1, presented in 2010 (Eshe, 2016). According to some international observers, the Russian programme resumed again in 2016. The ongoing work was so promising that the Ministry of National Defence was willing to build new aircraft to transport laser weapons, rather than adapting the existing machines to perform this task, as was the case with the Il-76MD (the Beriev A-60 programme) (Dura, 2018).

In addition to laser weapons, Russia's anti-satellite weapons systems include the 79M6 Kontakt missile transported by the MiG-31D aircraft. Yet this is not a new weapon as it was designed in the mid-1980s, similar to the MiG-31 aircraft, to meet the need for a weapon that would counter enemy satellites in low Earth orbit over the Soviet Union's territory by missiles launched from manned aircraft. The plan was to develop missiles in two versions: the first capable of destroying targets at an altitude of 120-600 km and the second designed to neutralise satellites at altitudes of up to 1500 km. Ultimately, the Air and Space Force was to develop the capability of destroying at least 24 satellites in 36 hours or 20-40 satellites in 24 hours (Globalsecurity.org, 2023). Due to the collapse of the state and the financial crises of the 1990s, design work on the missile was discontinued, and the already produced items were placed in storage. They again attracted attention in 2018, when a previously unknown black missile was spotted on a MiG-31D photo. At the time, the Russian media reported that it was the 79M6 Kontakt rocket (Nokolov, 2023). It is a three-stage rocket, with the first two stages featuring solid-fuel rocket engines developed by OKB-16 (the Kazan Engine Design Bureau), and the third stage having a liquid-fuel rocket engine. The rocket is about 10 m long, 74 cm in diameter, and weighs 4550 kg. It is launched from an altitude of 15-18 km and can hit targets moving at 120-600 km above the ground (Globalsecurity.org, 2023).

Regarding Russia's ASAT potential, the S-550 system is another novelty. First information about it appeared in 2021, when representatives of the Ministry of National Defence reported that Russia would develop air and missile defence systems–more specifically, the S-350, S-500, and S-550 systems. The S-350 and S-500 medium-range launchers had been previously known, while the S-550 was a new addition. Initial work on the mobile anti-ballistic missile system was said to have begun already in Soviet times at the Almaz Central Design Bureau under the leadership of General Boris Bunkin and Alexander Lemanskiy. Comprehensive design documentation had been prepared, which was presumably destroyed in the early 1990s (Army Recognition, 2021). Initially, it was thought that the new system was only a short-range complement to the S-500, intended for neutralising ballistic missiles. However, Sergei Chemezov, an oligarch and a former KGB officer, later admitted that the range of the S-550 would be much greater than that of the S-500, and its task would be to protect Russia from the intercontinental ballistic missile rising high into space, before hitting their target twenty times faster than the speed of sound. Opinions were also disseminated that it would perform space-attack or space-defence tasks, including the interception of enemy spacecraft such as the US Armed Forces' X-37B. Unlike the S-500, no naval version of the launcher was planned to be built (Lenkov, 2023). The TASS Russian News Agency described the system as a continuation of the A-135 Amur and A-235 Nudol strategic missile system in a mobile configuration, with the first systems of this kind expected to be put in service by 2025, in line with the ongoing weapons programme until 2027 (Tass Russia News Agency, 2021). Contrary to the stationary A-135 system deployed around Moscow to protect the Central Industrial District (13 oblasts with a total area of 486,000 square kilometres), the new system will be suitable for deployment in any place within the Russian Federation, with a possibility to frequently change its location (Army Recognition, 2021).

For several years, Russia has also explored the use of satellites in rendezvous and proximity operations, including by means of the Olymp-K satellite. Also referred to as "Luch", the satellite was launched into geostationary orbit in September 2014. In 2015, it was positioned between two satellites operated by the American telecommunications company Intelsat. The purpose was probably to intercept communications. Kay Sears, then President of Intelsat General, stated that this behaviour was unusual and the company was concerned about it. In September 2015, "Luch" approached another Intelsat satellite, and in 2017, it manoeuvred towards the French-Italian military satellite Athena-Fidus (Johnson, 2020). In consequence, Florence Parly, French Defence Minister, accused Russia of spying. Two years later, the French Space Command was established to take active measures to defend space assets. Small satellites deployed to monitor the space around other military satellites and objects in their vicinity were used for defence purposes (SatelliteObservation.net, 2018). This was, by no means, the only example of Russia's proximate operations. In November 2019, the Kosmos 2543 satellite was launched into space, subsequently disintegrating into a smaller sub-satellite, Kosmos 2542. Three days after the disintegration, it performed an orbital manoeuvre to approach the US government satellite known as "USA 245". The attempt to separate the two satellites proved unsuccessful, and at some point, they were only 50 kilometres apart (Johnson, 2020).

It is also suspected by the United States that Russia has been developing a nuclear anti-satellite weapons programme. In February 2024, Congressman Mike Turner, Chairman of the House Permanent Select Committee on Intelligence, said that a serious threat to the US national security was posed by the development of the military capabilities of one of its rivals. John Kirby, Spokesperson of the National Security Council, further specified that this threat was caused by Russia's research into ASAT weapons, which was, at that time, at an the early stage of development (Borgen, 2024). Analysts paid special attention to the Kosmos 2553 satellite launched in early February 2022. The unusual use of the satellite was its launch into a part of space previously occupied by withdrawn objects. In its official statement, Russia claimed that the use of Kosmos 2553 was purely scientific and its purpose was to test the resistance of individual components when exposed to higher levels of radiation. Unofficially, however, it is suspected that the satellite may have been equipped with a dummy nuclear warhead and marked the beginning of a programme that would eventually facilitate the use of such weapons in space. Being aware of the United States gaining an advantage over Russia in terms of the number of satellites, the Kremlin would thus have a weapon to potentially destroy a significant portion of them in low Earth orbit (Schneider & Süß, 2025).

China's ASAT potential

Research into Chinese anti-satellite weapons began relatively late in the 1960s. The first programme was titled "Project 640". Conducted as a top secret venture, it aimed at developing an integrated air and space defence system including land-based radars, interceptor missiles, ballistic missiles, and anti-satellite weapons. Within the framework of Project 640, the Chinese produced several anti-satellite weapons systems, but trials revealed that none of them had reached the operational status and the venture was eventually terminated in 1980. Lessons learned from the unsuccessful trials were used in the subsequent project, numbered 863, which began in 1986 and involved exploring the latest technology not previously used, including biotechnology, information technology, laser technology, energy, and renewable materials expertise. These efforts resulted in a successful attempt to shoot down a meteorological satellite on 11 January 2007. On that day, an anti-satellite kinetic kill vehicle was launched from the Xichang Space Launch Centre using a ballistic missile. It collided with and totally destroyed the non-operational Fengyun satellite (FY-1C) at 863 km above the ground. The ballistic missile used in the trial was the SC-19, a modified version of the DF-21 (CSS-5). The nominal range of the missile is 2500 km for a 600 kg load. When used as direct-ascent anti-satellite weapons, the range is estimated to be 1000-1200 km. Prior to the successful trial, China had presumably scheduled several additional tests, but it remains unclear whether the configurations used were similar or different. The 11 January 2007 event was considered "revolutionary" in military affairs. It proved that the People's Liberation Army was capable of destroying a number of US military satellites in low Earth orbit, including both satellites used for reconnaissance, surveillance and meteorology purposes, and civilian dual-use communications satellites (Saunders & Lutes, 2007).

Nonetheless, despite its unquestionable military success, the test turned out a political failure. It not only failed to help China strengthen its political standing but was also met with international criticism against which the state was unable to defend itself. The collision of the kinetic kill vehicle with the satellite resulted in more than 3000 pieces of space debris, 2700 of which have continued to orbit the Earth (U.S. Department of Defense, 2023). In addition, scientists estimate that there may be up to 32,000 smaller pieces of FY-1C debris in space that are not being tracked. It has spread at an altitude from 175 km and 3600 km, forming the largest cloud of defunct human-made objects in space resulting from a single orbital event. Based on the generally available data, excluding FY-1C debris, a total of 2864 active or inactive satellites were tracked in orbit as of 22 January 2007, 1899 of which were hit by the debris to a greater or lesser extent. The first manoeuvre to avoid a crash with the debris resulting from the Chinese anti-satellite weapons test took place on 22 June 2007, when flight controllers from the Goddard Space Flight Centre activated the jet-powered engines on the TERRA satellite in order not to be hit by debris the following day (Weeden, 2010). Fifteen years after the test, the International Space Station was also forced to manoeuvre to avoid such a collision.

Criticism was expressed regarding the risk posed by the debris to civilian spaceflight and space station operations. It was also stressed that, in conducting the test, the Chinese political elite displayed much arrogance despite describing themselves as supporters of the peaceful exploration of space. The period immediately following the test is usually crucial for the government testing new military technology to communicate its intentions. In this case, however, Beijing remained silent for 12 days, failing to send any clear and transparent message to the international community. The course of events prompts a hypothesis that some of the Chinese ministries and decision-makers were unaware of the army's plans to conduct the anti-satellite weapons test. This might have resulted from the complex command system of the Chinese army, with two separate centres of authority–the Central Military Commission (the horizontal level) and the General Ordnance Department (the vertical level)–responsible for conducting research into military technology. Suspicion was also raised that higher-level leaders may not have been informed that the test could result in a large amount of space debris and jeopardise the operation of other satellites.

Given the numerous negative outcomes of the 11 January 2007 test, an inquiry was made as to why China had decided to take such a step. According to Philip Sauders and Charles Lutes (2007), Beijing's motivation was based on several factors. First, like any other strategic weapons–be it anti-ballistic, nuclear, or hypersonic weapons–anti-satellite weapons systems need to be tested at some point. Second, China had sought an asymmetric advantage over the United States already for some time, looking for a relatively low-cost weapon with which it could challenge US dominance in space. Third, the ability to neutralise US satellites would call the US military intervention to defend Taiwan into question. Fourth, anti-satellite weapons could be treated as a response to the development of the US missile shield. From Beijing's point of view, anti-ballistic missile systems might ultimately negate China's nuclear deterrence strategy, while anti-satellite weapons are seen as defensive (Saunders & Lutes, 2007).

There are no uniform records of China's anti-satellite weapons tests conducted in the following years. Some sources indicate that China did not retest such weapons in 2007-2022 but rather experimented with other capabilities to destroy satellites, using aircraft approaching them at a close distance (Hadley, 2023). According to experts from the Secure World Foundation, although no other test was as revolutionary as the one conducted in 2007, at least six other attempts had been made by the end of 2013. The first of these took place on 7 July 2005 and involved system testing with no clearly stated purpose. It was probably held to demonstrate the potential performance of the rocket. The second attempt was made on 6 February 2006. This time, the missile approached a satellite target without hitting it. On 11 January 2007, the above-described test was held using the SC-19 missile. Another one took place on 11 January 2010 and involved both anti-satellite weapons and anti-ballistic missile systems. The SC-19 missile hit a ballistic missile at 250 km without resulting in any space debris. Finally, on 27 January 2013, a test similar to the previous one was conducted. The SC-19 missile hit an unidentified ballistic missile at 250 km. Again, no space debris was produced.

A very important anti-satellite weapons test was conducted on 13 May 2013. It raised concerns as to whether China might have acquired the capability to neutralise satellites in geostationary orbit, which had previously been beyond the reach of available systems. The trial utilised a mysterious DN-2 missile, which is an acronym for "Dong Neng" or "kinetic energy". According to observers of Chinese weapons systems, it could be based on the DF-21 medium-range ballistic missile or the DF-31 intercontinental ballistic missile. If this was the case, it had a much longer range than the SC-19 and could reach targets in geostationary orbit at an altitude of 36,000 km while maintaining mobility (Weeden, 2013). The Chinese officially reported that the rocket had been launched to an altitude exceeding 10,000 km (some people believed it could have reached as high as 30,000 km). The launch was arranged a few days after Ashton Carter, Deputy Secretary of Defence, stated that the USA had been working on methods to protect the state's military satellites from destruction by potential adversaries. The Chinese officially claimed that it was merely a scientific experiment in which a properly-equipped sounding rocket was used to test the ionosphere and the magnetic field. The expected results of obtaining data on the space environment at different altitudes were achieved. The rocket was reported under the name "Kunpeng-7". Nonetheless, the name related to the load, not to the structure itself. Gong Jian, Deputy Director of the Chinese Academy of Sciences, said that the test in question was similar to the one which took place on 5 April 2013, when the Kunpeng-1 probe was launched from Danzhou, in Haiannan Province, though at a much lower altitude and with less research equipment. The US Department of Defence released an official message stating that the flight of the rocket had been traced since its launch. It appeared to follow a ballistic trajectory leading into geosynchronous Earth orbit. No other objects were found to be brought out into space by the rocket. Nor was the formation of any space debris detected. The object probably re-entered the atmosphere above the Indian Ocean (Globalsecurity.org, n.d.).

For over a decade, to keep pace with the United States and Russia, China has also been conducting proximity operations tests. Beijing has publicly confirmed the implementation of RPOs, but not many details are available. The first Chinese proximity operation took place in September 2008, with a small BX-1 satellite being launched. While this was officially done to verify the possibility of inspecting objects in orbit, some observers claim that the aim was also to check whether it would be possible to carry out an ASAT attack. In the summer of 2010, the SJ-12 and SJ-06F satellites were launched, performing a series of proximity manoeuvres. The SJ-12 repeatedly changed its flight trajectory to eventually reduce its distance to the SJ-06F to only 300 metres. These manoeuvres were conducted between 12 June and 16 August 2010 and took several weeks to complete. In July 2013, three more satellites called SY-7, CX-3 and SJ-15 were launched into low Earth orbit. They approached another Chinese object at a distance of several kilometres. American officials speculated that this marked another secret ASAT weapons development programme and one of the satellites could "intercept" another. In 2016, the Aolong-1 satellite, also known as the "Advanced Debris Removal Vehicle" or the "Wandering Dragon," was launched in low Earth orbit. It was a small object developed by the Harbin Institute of Technology for the China Academy of Launch Vehicle Technology, with the official purpose of capturing space debris using a "robot arm". As the US Armed Forces claimed, the space debris capture experiment was fiction. In reality, the mission was to approach other Chinese satellites, with no physical destruction reported to occur. Similar operations were conducted in geostationary orbit. In November 2016, the SJ-17 satellite was launched to perform a rendezvous operation with the Chinasat 5A satellite. Keeping a distance of 50-100 kilometres, it revolved around it and then moved to a distance of several kilometres. Overall, China carried out at least eight RPO missions, with the last one at the end of 2024 (Samson & Brett, 2025).

Beijing has also been working on other non-kinetic ways to disrupt and destroy satellites. As reported by the *South China Morning Post*, Chinese scientists have manufactured the world's largest barium gallium selenide (BGSe) crystal, which can be another breakthrough in military affairs (RMA). Developed by a team of researchers led by Prof. Wu

Xaixin from the Hefei Institute of Physical Science, the synthetic crystal, measuring 60 millimetres in diameter, efficiently converts short-wave infrared lasers into far-infrared ones and can withstand laser power as intense as 550 megawatts per square centimetre. It can be used as an ASAT weapon, as a sensor for tracking targets, or for medical imaging purposes.

Supposedly, the first secret centres to conduct research on the new laser were established near Korla in the Xinjiang region, in the north-western part of the country, and in the town of Bohu. In the future, they may include objects in medium Earth orbit and in geostationary orbit. In case of war with the United States, their primary targets are likely to be the Global Positioning System and the Space-Based Infrared System, which Chinese strategists describe as key asymmetric "gaps" vulnerable to soft-kill attacks, not only with ground-based lasers but with cyber weapons as well (Honrada, 2025).

Table 1. A comparison of the US, Russian and Chinese ASAT potential

	The United States	**China**	**Russia**
DA-ASAT	▪ 400 SM-3; ▪ 44 GBI;	▪ SC-19; ▪ DN-1; ▪ DN-2; ▪ DN-3;	▪ PL-19 Nudol; ▪ S-550; ▪ Contact missile carried out by MiG-31BM;
ICBM	▪ 400 LGM-30G Minuteman III ICBMs ▪ 14 Ohio SSBN submarines, carrying Trident II D5 missiles; ▪ 76 strategic B-52 bombers and 19 strategic B-2A bombers;	▪ 310 RS-24 Jars, RS-36M2 Satan and RS-18 ICBMs; ▪ 10 SSBN Delta-class, Typhoon-class and Borei-class submarines; ▪ 60-70 strategic Tu-160 and Tu-95MS bombers;	▪ Over 200 DF-4, DF-5A, DF-5B, DF-21, DF-26, DF-31, DF-31A, DF-31AG and DF-41 ICBMs; ▪ Over 20 strategic H-6 bombers; ▪ 12 JL-2 submarines;
RPO	Developing RPO capabilities, including Prowler, MiTEx, GSSAP, ANGELS, MYCROFT, USA 271, USA 270;	Developing RPO capabilities, including BX-1, SJ-12, SJ-15, SJ-17, SJ-21;	Developing RPO capabilities, including Olymp-K "Luch"
Other types of ASAT	Developing laser weapons, also as part of the two DARPA research projects: the High Energy Liquid Laser Area Defense System and the Modular Efficient Laser Technology program	Developing ground-based laser weapons, including those based on barium gallium selenide (BGSe) crystals	Suspected of developing nuclear satellites to destroy American mega-constellations of satellites in low Earth orbit

Source: Author's own comparison.

Conclusion

Two opposing views on the future of satellites and anti-satellite weapons currently dominate the discourse. The first one implies that further militarisation of space is inevitable, given the rapid increase in the number of satellites, the development of dual-use weapons, and the research and development carried out with the aim of deploying weapons in Earth orbit. The second view emphasises that militarisation of space will be limited and anti-satellite weapons, similar to nuclear weapons, will be treated as weapons of last resort and will mainly be used for deterrence. If the militarisation process continues, it may be the most dynamic in China. Beijing will be interested in expanding the "asymmetric advantages" it has over the United States, with anti-satellite weapons being one of them. Space is described by US officers as the "Achilles' heel" of the entire army. If a war were to break out between China and the United States, the People's Liberation Army would first seek to eliminate satellites in low Earth orbit, including image reconnaissance satellites, synthetic-aperture radars (SAR), and electronic reconnaissance satellites. According to 2009 data, 20 anti-satellite strikes would cause destruction of six or seven EO/SAR satellites providing image reconnaissance to the United States. Other 20 strikes would cause destruction of four groups of satellites used by the Navy to determine the location of enemy ships and ground-based air defence systems. This would trigger a situation in which the US power projection capability would be severely impaired. In addition to directly hitting direct-ascent anti-satellite satellites, China has been simultaneously developing other technologies to which GEO satellites could be vulnerable, i.e., radio frequencies, cyberattacks, or laser weapons. Already in 2006, Beijing used ground-based lasers to blind US spy satellites flying over China. The Americans claim that the Chinese deliberately revealed their laser capabilities to demonstrate that they could neutralise the means of reconnaissance used by their opponents and to deter them from a possible attack. At the time, the People's Liberation Army was said to have at least one anti-satellite laser artillery unit, located in the north-western part of China, in the Tian Shan mountain range (Easton, 2009).

In view of the growing ASAT potential of China, a number of decisions have been made in the United States to prepare for potential confrontation in space and to enhance deterrence strategies. On 19 December 2019, the US Space Force was established as a new (sixth) type of the US Armed Forces (Space24, 2019). The Pentagon has also been developing a new deterring measure–the prompt global strike–thus making it clear to Beijing that it has at its disposal certain technologies (non-nuclear ballistic missiles, stealth bombers including bunker busters, and long-range cruise missiles) capable of destroying China's SC-19 missile launchers, along with infrastructure used to launch spacecraft. A key role during wartime would be played by the US military base on the Pacific island of Guam, which has undergone substantial modernisation in recent years. This involved constructing new facilities for Global Hawk UAVs, B-2 bombers, submarine bases, and aircraft carrier strike groups. The USS Ohio and the USS Michigan are mentioned as the submarines which could ultimately be used to destroy Chinese anti-satellite weapons systems.

At the same time, a number of arguments can be presented to support the view that a space war using anti-satellite weapons between the superpowers is a very remote vision and appears contrary to their interests. The United States maintains a quantitative and qualitative advantage of ASAT capabilities over its opponents, and presents a political line contradicting the development of such weapons. This is meant to discourage both Russia and China from any further anti-satellite weapons research and to prevent the construction of such weapons in quantities that would pose a threat to the United States. Even if a war broke out between the United States and China, the use of anti-satellite weapons would lead to a situation where an uninhibited exploration of space and the benefits it offers would be impossible. Moreover, while the militarisation of space is progressing, no orbital-Earth weapons have been deployed yet although the superpowers have had many technological opportunities to do so. Considering the above, the view emphasising that space will be treated primarily as an area of support and security for other Earth-based activities, with anti-satellite weapons used as a last resort, appears the most viable.

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