

Russian military space-related capabilities: The vital deterrence role of counterspace weapons (Part II)

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Abstract

Russian anti-satellite (ASAT) weapons play a critical role in the country's military strategy by targeting NATO's dependence on space-based technologies, especially C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance) and missile guidance systems. The Russian military views these ASATs as effective deterrents that can impose strategic restraint on NATO by threatening critical satellite infrastructure. This paper examines the types of ASATs Russia is developing – kinetic physical, non-kinetic physical, and non-kinetic non-physical – and assesses their operational and strategic impact, particularly in maintaining Russia's nuclear deterrence and second-strike capabilities. It also discusses the application of ASATs in the ongoing Ukraine war, where these capabilities are being tested and refined. It concludes that by potentially neutralizing NATO's satellite-dependent advantages, Russian ASATs could significantly influence NATO's strategic decision-making.

About the Authors

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Introduction

Part I established that developing anti-satellite (ASAT) weapons is a ‘critical objective’ of the Russian Federation.¹ This stems from perceived vulnerabilities in relation to NATO, which the Russian military views as being both stronger and hostile towards Russia. Within the higher echelons of this military, there is a prevailing sense of weakness vis-a-vis NATO, coupled with a rhetorical expectation that the Alliance is preparing for an imminent attack on the country.² One source captured this general sense of angst: ‘over the last three decades [NATO] has been covertly preparing for a massive assault on Russia.’³

The vulnerabilities felt by Russia are primarily strategic. These concerns are twofold: first, the fear that the United States may develop a space-based defence system similar to the Strategic Defense Initiative (SDI) of the 1980s, and second, that the partially deployed US Prompt Global Strike (PGS) system could be used against Russia.⁴ Both SDI and PGS are viewed as existential threats to the country. Additionally, the Russian military feels vulnerable at the operational level, understanding that any large-scale kinetic conflict with NATO would ‘inevitably end in heavy defeat for Russia.’⁵ The Russian military acknowledges its numerical and, more importantly, technological inferiority compared to its NATO adversary.⁶

In response to these perceived vulnerabilities, Russia has increasingly adopted an asymmetric approach to warfare, focusing on turning NATO’s strengths into weaknesses.⁷ From Moscow’s perspective, much of NATO’s military power relies on space-based technologies, which provide enhanced capabilities across a wide spectrum.⁸ A crucial element is missile guidance, notably for ballistic and cruise missiles, including those in the PGS system. Denying NATO access to its space-based technologies would significantly weaken, in Russian eyes, its military capacity.⁹

Russia’s counterspace strategy aims to neutralise NATO’s satellite capabilities through kinetic destruction or interference with data gathering and transmission. ASAT weapons are seen as effective and resource-efficient tools for disrupting NATO’s satellite-reliant systems, from ICBM guidance to basic navigation. The goal is to create uncertainty regarding NATO’s faith in these systems during conflict. Russian ASATs, above all, can serve as tools of *deterrence* by creating a degree of ‘intimidation’ that imposes ‘restraint’ on NATO.¹⁰

The following draws primarily on Russian sources to examine the development and potential effects of Russia’s ASAT weapons, including their use in the ongoing Ukraine war (as of July 2024). It will also assess the threat these weapons pose to NATO at both the operational and strategic levels, as well as their potential impact on NATO force planning.

Russian Counterspace Systems

Russian ASATs threaten NATO’s strategic satellite systems in three ways. First, they can target those satellites that guide the Alliance’s intercontinental and submarine-launched ballistic missiles (ICBMs and SLBMs). Disabling these satellites would significantly impair missile accuracy, particularly in strikes aimed at Russia’s ICBM silos, where precision is essential. This would enhance the ‘survivability’ of Russia’s nuclear arsenal, increasing its ‘sufficiency’ – to borrow from the nuclear



From Moscow’s perspective, much of NATO’s military power relies on space-based technologies

deterrence lexicon – and preserving its second-strike capability.¹¹ As one Russian analyst notes, ‘it is easier to fight [NATO guidance] satellites than it is to destroy [incoming] enemy missiles’.¹²

Second, Russian ASATs at the nuclear-strategic level are designed to target NATO satellites that track the movements of Russia’s road-mobile ICBMs, such as the Topol-M and Yars missiles, which are mounted on Transporter Erector Launcher (TEL) vehicles. These mobile launchers are crucial to Russia’s nuclear triad.¹³ Disabling NATO’s reconnaissance satellites would prevent accurate targeting of these launchers with cruise missiles from the PGS system. In turn, this would significantly enhance their survivability and further bolster Moscow’s second-strike capability.¹⁴

Third, Russian strategic-level ASATs would target NATO satellites that support what the Russians refer to as ‘anti-missile defence’ (*protivoraketnaya oborona* or PRO), and which NATO calls its Anti-Ballistic Missile (ABM) shields. The focus here would be on disrupting NATO’s ABM defences by targeting the satellites involved in radar acquisition and in the guidance systems of the missiles designed to intercept Russian ICBMs and SLBMs.¹⁵ Kaitlyn Johnson, from the Aerospace Security Project at the Center for Strategic and International Studies, explains the Russian logic: ‘Clearly, the Russians are trying to develop systems to get around the missile defence systems the US has been developing’.¹⁶ Without an effective NATO ABM shield, a significant proportion of Russian ICBMs and SLBMs could reach their targets, increasing their ‘penetrability’.¹⁷ This greater degree of penetrability would not only strengthen Moscow’s second-strike capability but could also enhance the potential for a Russian pre-emptive nuclear *first*-strike, if ever considered.



At this ‘commanding heights’ level of nuclear deterrence, Russian ASATs have their greatest utility

The logic of deterrence is evident. The more Russian ASATs can be seen to undermine NATO’s nuclear first-strike potential for ‘assured destruction’, to support the survivability of road-mobile ICBMs, and to degrade NATO’s ABM shields, the greater Russia’s own relative nuclear advantage and deterrent capacity becomes. Thus, if Russia develops enough ASATs of sufficient quality, it could reduce its strategic vulnerability and theoretically shift the nuclear balance in Moscow’s favour.

At this ‘commanding heights’ level of nuclear deterrence, Russian ASATs have their greatest utility. However, they also have another significant strategic-level role in preventing the accurate satellite-based targeting, by missiles of the non-nuclear PGS system, of Russia’s domestic critical infrastructure (CNI) and military command and control (C2) nodes.

The threat posed to NATO reconnaissance and guidance satellites linked to either ICBM/SLBM or PGS strikes is seen by Russia as an important deterrent to any NATO pre-emptive use of them.¹⁸

In Russian thinking, ASATs can also have significant impact at the operational level. The Russian military acknowledges its technological deficiencies at the operational and tactical levels compared to NATO, particularly in C4ISR capabilities. To mitigate this, Russia is deploying and developing ASATs to target those NATO satellites crucial to operational-level activities. From Moscow’s perspective, NATO might then reconsider, because of such targeting, any conventional ground force attacks on Russia or Russian-held territory. However, this operational-level deterrence role remains secondary to the ASATs’ broader strategic deterrence tasks.

The OST bans certain ASATs to prevent the fielding of space-based weapons. However, it only restricts placing ASATs *in orbit*, i.e., ‘installed on...celestial bodies [i.e. satellites]’.¹⁹ ASATs not ‘in orbit’ are not banned – a distinction discussed later.

The Russian military's attack methods using ASATs that are both currently in use and in preparation, fall into three categories: kinetic physical, non-kinetic physical, and non-kinetic, non-physical.

Kinetic, Physical Counterspace Systems

Kinetic physical counterspace systems target either satellites in orbit or the ground stations responsible for managing their uplinks and downlinks. The focus here is on weapons designed to strike the actual satellites directly, detonate a device near them, or physically manipulate them. These ASATs generally come in two forms: Direct-ascent ASATs (DA-ASATs) and co-orbital ASATs. Direct-ascent ASATs are launched from the Earth's surface on a sub-orbital trajectory to either collide with or explode near a satellite, primarily in Low Earth Orbit (LEO – approximately 300 to 1,700 km altitude).²⁰ Co-orbital ASATs, on the other hand, are launched into orbit, where they function as satellites and can disable their target in various ways. These co-orbital ASATs are theoretically banned under the OST.²¹

DA-ASATs

DA-ASATs can be launched from ground, sea, or aerial platforms. Notably, all variants developed by the Russian military are still in the testing phase and are not fully operational. The most advanced among them appears to be the ground-launched Nudol (technically *Nudol'*), also known by its NATO designation, PL-19. The Nudol, which is based on a Soviet-era ICBM first tested in 1982, can deliver a Kinetic Kill Vehicle (KKV) into space to target satellites in LEO. However, it is currently unable to target satellites beyond LEO. According to the Russian Foreign Ministry, the Nudol does not violate the OST as it is merely launched *into* space, and its KKV does not remain in orbit permanently or semi-permanently as a 'celestial body'.²²

The Russians have indicated that the Nudol system could be used against the US Air Force's X-37B reusable orbital vehicle, which is still being developed. While the exact purpose of the X-37B remains unclear, there is speculation within both Russian and US military circles that it might serve as a 'strike-combat weapon'. This has raised concerns in Moscow, with some viewing the X-37B as a sign of US 'dirty tricks' (*pakosti*) and a violation of the OST. According to one Russian source, the Nudol system is designed to counter such 'tricks', stating that the 'Nudol stands up to protect us from the [US] Boeing X-37B'.²³ Another Russian source has described the Nudol as 'the most dangerous enemy of the American Boeing X-37'.²⁴

Test launches of the Nudol have been conducted from the military cosmodrome at Plesetsk and, since 2018, from a road-mobile TEL system. The mobility of the TEL expands the range of orbiting targets that can be selected, though it still requires a guidance radar at a fixed site. While the Nudol has undergone several tests in recent years, only the most recent launches have included testing an actual KKV.²⁵

A key issue with the Nudol, as currently configured, is that even when fully operational, a single, costly rocket might only destroy one or two satellites in LEO, and only when they pass over a limited area centred on Plesetsk (though the use of TELs can expand the range). However, the mere *threat* posed by the Nudol, particularly against any future SDI-style system deployed by the United States, might be enough to deter Washington from ever pursuing such a deployment²⁶ – or, indeed, that of the X-37B.²⁷ The Nudol, therefore, holds significant deterrence value simply by being in development. This could be the primary reason the Russian Space Forces are investing so much in it.²⁸



The Nudol... holds significant deterrence value simply by being in development

Another DA-ASAT system that appears to be a derivative of the Nudol is the S-550. While its primary role is as an anti-aircraft weapon capable of engaging incoming ICBMs, it also seems capable of striking targets in LEO.²⁹ Indeed, other more basic Ground-Based Air Defense (GBAD) systems in the Russian arsenal, such as the S-500 – which is primarily designed to target aircraft, cruise, and ballistic missiles – might also be able to strike satellites in LEO.³⁰ Certainly, the S-500 has demonstrated the ability to hit targets at a range of approximately 500 km.³¹ In 2020, General Sergei Surovikin, then head of the Aerospace Forces, appeared to confirm this capability.³² The first S-500 system is expected to become fully operational sometime in 2024. It is already being dubbed in the West a potential ‘satellite killer’.³³ Pavel Sozinov, the chief designer at the Almaz-Antey firm (which manufactures most Russian anti-aircraft missiles), has described the S-500 as being for ‘short-range targets’ in space, with the S-550 designed for ‘long-range’ targets.³⁴

Co-orbital ASATs

Russia is also exploring the use of co-orbital ASATs, which could target satellites not only in LEO but also in Medium Earth Orbit (MEO – approximately 1,700 to 20,000 km altitude) and Geostationary Earth Orbit (GEO – approximately 20,000 to 36,000 km).³⁵ Unlike the Nudol system, which delivers a KKV on a sub-orbital trajectory, co-orbital ASATs are placed into orbit and can conduct rendezvous proximity operations (RPO). These operations involve manoeuvring toward targeted satellites and disabling them through various methods, such as direct collision, dispersing destructive fragments, deploying a robotic arm to alter the satellite’s course,³⁶ or using Electronic Warfare (EW) means, including, eventually, directed energy weapons (lasers).³⁷

In the 1980s, the Soviet Air Force began developing the Kontakt, an air-launched ASAT missile. This three-stage DA-ASAT was released from a MiG-31D at high altitude, with the KKV as the final stage. However, tests were limited.³⁸ In 2009, Russia appeared to revive the concept, this time aiming to deliver a co-orbital ASAT.³⁹ In 2018, a MiG-31BM was photographed at Ramenskoye airfield near Moscow with a large missile attached, which is believed to be able to carry several small manoeuvring satellites. These could act as interceptors to disable targeted satellites, potentially even in GEO, although Western sources generally believe they would be limited to LEO.⁴⁰



Despite being dismissed by some as ‘useless,’ Russia continues to invest in inspector satellites

The name of this new carrier missile, Burevestnik (not to be confused with the Russian long-range nuclear-powered cruise missile of the same name), may refer to the missile or the entire project.⁴¹ It delivers interceptors called Burevestnik-M or Burevestnik-KA-M, which can also be launched into LEO by ground-based vehicles such as Soyuz-2 rockets.⁴² Although a Burevestnik test was planned for late 2022, there is no evidence it occurred. The test was to involve a ‘Project 293’ missile launched from a MiG-31BM, targeting a satellite placed in orbit by a ground-launched rocket.⁴³ The Burevestnik system’s infrastructure is based at Plesetsk.⁴⁴ It seems that work on a runway there for the MiG-31s has been stalled for several years.⁴⁵

Recent Russian media reports suggest that Burevestnik development has faced challenges due to technological limitations, but that these will soon be overcome.⁴⁶

As mentioned in Part I, Russia has launched multiple ‘inspector satellites’ that reportedly manoeuvre near Western satellites to determine their function. These satellites, described by one Russian source as a ‘means of combating NATO satellites’, have drawn skepticism in the West.⁴⁷ Despite being dismissed by some as ‘useless,’ Russia continues investing in them, with the latest satellite, Kosmos-2576, being launched in May 2024.⁴⁸ These satellites appear to serve a crucial role in target prioritization for Russia’s limited kinetic ASAT resources, which are expensive to

build and deploy. These need to be reserved for vital targets and not, as one Russian source notes, used ‘at random’.⁴⁹



The Olymp-K in GEO could also be capable of targeting satellites...in the US Defense Support Program

These inspector satellites do seem to play a key role in target selection.⁵⁰ Moreover, once their target is identified, they may even become ASATs themselves, raising concerns about potential OST violations. Western unease has grown, especially after an incident in May 2024 when an Olymp-K (also called Luch) came within 10 km of a GEO satellite of unspecified function. This followed US Ambassador Robert Wood’s complaint at the UN Security Council that Kosmos-2576 is ‘likely a counter-space weapon capable of attacking other satellites in low Earth orbit’.⁵¹ The Olymp-K in GEO could be capable of targeting satellites in the US Defense Support Program. This array monitors ballistic missile launches from Russia and China.⁵²

Non-Kinetic, Physical Counterspace Systems

Non-kinetic physical ASATs, such as directed-energy weapons, including lasers, are designed to disable or disrupt satellites without relying on physical collisions or kinetic strikes. These systems can interfere with a satellite’s functionality in a variety of ways. For example, a laser beam can incapacitate electro-optical sensor satellites by creating a dazzling effect (temporary) or a blinding effect (permanent). Lasers can also interfere with inter-satellite communications. Satellites, such as those in the Starlink array that use ‘inter-satellite laser links’,⁵³ could be disrupted by an external laser targeting these links.⁵⁴

One key advantage of lasers as ASAT weapons is that they generate little to no debris, unlike kinetic strikes. This avoids the Kessler effect, which could indiscriminately endanger any satellite.⁵⁵ Lasers could also provide plausible deniability in today’s era of ‘grey-zone warfare’. However, it is hard to envision the use of offensive laser weapons against satellites outside of a major conflict scenario.

Lasers do have drawbacks. They require enormous amounts of energy to generate a beam with sufficient power and range. This limits their ability to operate remotely from a substantial power source. Moreover, if fired from the ground, weather conditions such as fog or clouds can reduce the beam’s effectiveness, as can general atmospheric interference, particularly over long distances. Ideally, ASAT lasers should operate as high above the ground as possible to mitigate such interference.

Given that lasers cannot yet be based in space due to the OST and power-source limitations, high-flying aircraft represent the ideal platform. The Soviets began experimenting with this concept in the 1980s, using an Il-76MD transport aircraft fitted with a laser. While this laser could strike high-flying reconnaissance balloons, it was less successful against actual satellites.⁵⁶ Work stopped in 1993 after the Soviet Union’s collapse, but it resumed in 2002 with the development of a new aircraft-mounted ASAT laser called the Sokol-Eshelon.⁵⁷

Sokol-Eshelon

The Sokol-Eshelon system consists of a 1LK222 laser, supposedly with a range of 1,500 km, fitted in the cargo hold of an Il-76MD. The Beriev company modified this Ilyushin aircraft, designating it the Beriev A-60.⁵⁸ In addition to the laser, a large radar was installed in the nose of the aircraft to track targets and allow for precise laser focusing. Two protrusions were added to either side of the aircraft’s fuselage to house the generators needed to power the laser. Despite reports that the entire project was ‘suspended’ in 2011,⁵⁹ this A-60 aircraft made its maiden flight in 2014.⁶⁰

A second Beriev carrier aircraft was delivered in 2015, with flight tests reported in 2016.⁶¹ It was assumed this aircraft would also be fitted with the Sokol-Eshelon laser, but this does not appear to have happened. In fact, little has been heard about the Sokol-Eshelon in recent years. The original A-60, based at Taganrog near the Sea of Azov, has not been airborne for several years, although it has not been dismantled. The second A-60, based at Ulyanovsk, east of Moscow, has not flown since March 2020.⁶²

The Russians may have recognised that developing an airborne ASAT laser is both costly and difficult to achieve.⁶³ A similar US system, the YAL-1 Airborne Laser, mounted on a Boeing 747-400 aircraft ('the most expensive aircraft in history'), was under development for several years but was abandoned in 2012 as it was not considered cost-effective to continue. This US system was, moreover, only designed to target ICBMs rather than satellites.⁶⁴

The Sokol-Eshelon project may not have been abandoned but merely mothballed.⁶⁵ There still appears to be some Russian investment in the ASAT laser concept. However, the focus has seemingly shifted to two ground-based systems, which appear to have better prospects: the Peresvet and the Kalina.

Peresvet

In 2018, President Putin announced that the Russian military-industrial complex had developed several new and highly sophisticated weapons systems, including the Peresvet, an 'electro-optical' weapon. The Peresvet is a powerful laser mounted on a ground-based vehicle.⁶⁶ Its primary purpose is reportedly to dazzle (or possibly blind) satellites up to 500 km above the Earth, although a range of 1,500 km has also been claimed.⁶⁷ The power source for these mobile systems may be a small nuclear reactor mounted on a separate accompanying vehicle.⁶⁸

The Peresvet was first deployed operationally in late 2019 and was field-tested in Syria in 2020.⁶⁹ It appears to be effective in intercepting drones and cruise missiles.⁷⁰ However, its main task is allegedly to disable, when required, US observation satellites designed to track the movements of Russia's mobile ICBMs, the Topol-Ms and Yars missiles. As noted, these missiles need protection from the non-nuclear cruise missiles that are part of the PGS system. Peresvet units are currently deployed with at least five (out of eight) mobile ICBM divisions across various parts of Russia.⁷¹

The Russian military sees the Peresvet as crucial to maintaining the viability of the country's second-strike capability. General Valeri Gerasimov, the head of the Russian military, has emphasised that the Peresvet's ability to 'mask the movements' of Russia's mobile ICBMs is vital for maintaining the country's strategic deterrence capacity.⁷²

If Peresvet functions as claimed against reconnaissance satellites, NATO planners can never be certain that they can locate and destroy *all* Topol-M/Yars missiles. As one Russian expert notes, Peresvet 'will *guarantee* the inevitability of Russia's retaliatory [nuclear] strike'.⁷³ This is why Putin promotes Peresvet as a key *deterrence* asset.⁷⁴ An article in the General Staff's journal, *Military Thought*, also confirms that Peresvet plays a role in Russia's 'strategic deterrence system'.⁷⁵

There is also speculation now that the Sokol-Eshelon system might be resurrected using this new Peresvet laser.⁷⁶ A Russian source notes, 'According to Deputy Defence Minister Alexei Krivoruchko, plans are in place to ensure the Peresvet's deployment on an aircraft in the coming years'.⁷⁷



Peresvet 'will guarantee the inevitability of Russia's retaliatory nuclear strike'

Kalina

An analyst who has served in the US military has observed that ‘it is not traditional rockets or ballistic weapons that keep our [US] space leadership awake at night – but a laser [the Kalina]... it is the perfect space weapon.’⁷⁸ The Kalina, whose development began in earnest in 2011, is regarded as a better ASAT laser than the Peresvet. It seems to have better beam accuracy and power, with a supposed effective range of 1,500 km. Unlike the road-mobile Peresvet, the Kalina is a static system. Reports indicate that a complex to house it is currently under construction at an existing space facility near Zelenchukskaya in Russia’s southwest.⁷⁹ The Kalina could be more destructive than the Peresvet, as it is more likely to permanently blind than temporarily dazzle optical reconnaissance satellites.⁸⁰



The Kalina is
the perfect
space weapon

If the Sokol-Eshelon project is revived using the Peresvet laser, the Kalina and the Sokol-Eshelon could complement each other. The airborne Sokol-Eshelon would offer greater flexibility, striking a wider target set than the more constrained ground-based Kalina. The Sokol-Eshelon’s Peresvet laser would encounter less atmospheric interference due to its higher basing altitude. However, its beam accuracy and range might be compromised by vibrations from being mounted on an airframe. In contrast, with its stable ground-based platform, the Kalina would face no such vibration issues. Therefore, if used together, each system could compensate for the other’s deficiencies.⁸¹

Unofficial reports are circulating that Russia is developing ASAT lasers that can be mounted on satellites, under a project called Stan. However, little detail is known. Placing lasers in space would provide ideal platforms, as there is no atmosphere to weaken the beam, making effective ranges extremely long.⁸² While putting a laser on a satellite is relatively straightforward, the real issue, as one Russian military source recognises, involves ‘solving the onboard power supply problem.’⁸³ In this regard, though, there is known to be Russian research (and probably to a more advanced degree than in the West⁸⁴) into both nuclear-powered and plasma generators that could be mounted on satellites.⁸⁵ Two particular projects, Ekipazh and Plazma-2010, are being pursued.⁸⁶

If space-based lasers could be perfected (a hugely expensive undertaking), they could potentially target important NATO satellites, even those in GEO, including the small but critical number of US early-warning satellites designed to detect strategic missile launches.⁸⁷ However, the deployment of any such lasers ‘in orbit’ would naturally contravene the OST.

Non-Kinetic, Non-physical Counterspace Systems

Non-kinetic, non-physical ASAT weapons disrupt or degrade satellite functionality without causing physical damage. These ASATs focus on jamming or spoofing via electronic warfare (EW) means or through cyberattacks.⁸⁸ They represent key components of Russia’s asymmetric warfare approach. These weapons, potentially far more cost-effective than laser or missile systems, can theoretically significantly degrade NATO’s satellite-linked technologies. They can generate a notable force-multiplier effect, particularly at the strategic level.⁸⁹

Satellite Jamming Via EW

While laser systems can effectively target reconnaissance satellites that use optical sensors, they are less effective against satellites that employ radar for remote sensing or against those that use radio-locating for surveillance. Moreover, lasers cannot disrupt the uplinks and downlinks of most communications satellites. The Russian

military has thus developed systems that use radio or electromagnetic transmissions to jam or spoof the data links of NATO satellites.⁹⁰ The Russian military views EW jamming as ‘one of the most effective and promising means of counteracting’ NATO satellite operations.⁹¹ One Russian source notes that EW jamming systems are the ideal ‘asymmetric response weapon’ when facing a more technologically sophisticated adversary.⁹²

Beyond the Zhitel system, which has localised capabilities,⁹³ there are four other notable road-mobile, ground-based systems that the Russian military has developed to specifically jam NATO *satellite* signals: the Pole-21, Krasukha-4, Divnomorye (technically *Divnomor’e*), and Murmansk-BN.⁹⁴

*Pole-21*⁹⁵

The Pole-21 system, introduced around 2016, has proven particularly effective in the Ukraine war. ‘Its impact’, as one Russian source puts it, ‘on missiles, drones, and aerial bombs has been significant.’⁹⁶ Another claims it is ‘capable of creating an impenetrable dome of interference.’⁹⁷ Western analysts also support these assessments. Pole-21 has been disrupting the satellite and radio guidance systems of Ukrainian missiles, drones, and artillery shells.⁹⁸ While some Russian sources suggest the system has a radius of only 50 km,⁹⁹ others claim it can create an ‘umbrella’ of suppression across a 150 km radius.¹⁰⁰ Interestingly, Pole-21 is said to be capable of not only jamming satellite signals but also of spoofing them.¹⁰¹

Krasukha-4

First operational in 2013, the Krasukha-4 was initially designed to jam signals from NATO’s Joint Surveillance Target Attack Radar System (JSTARS) aircraft. However, Russian reports indicate it can also disrupt GPS signals over a 300 km ground radius and be used against NATO radar-reconnaissance and radio-locating satellites in LEO. Using Krasukha-4 can make it much harder for NATO satellites to track the movements of mobile Russian military equipment. The Krasukha-4 is particularly aimed at the US Lacrosse radar-reconnaissance satellites designed to monitor the positions of the Topol or Yars TELs. The Krasukha-4 can mask these missiles’ location from satellite observation over an area of 100 km² and, moreover, is said to be able to jam the terminal guidance systems of any PGS cruise missiles targeting the TELs.¹⁰²

Divnomorye

Deployed first in 2018, the Divnomorye system is an upgrade and replacement for the Krasukha-4 and other similar systems. Unlike Krasukha-4, Divnomorye employs artificial intelligence (AI) and is fully automated. Once it detects a target, it analyses the signal output to determine its type, direction, and power and then selects the most effective type of interference. The system’s coverage is reportedly capable of extending over an area of 200 km² or more.¹⁰³

Murmansk-BN

The Murmansk-BN is a long-range, theatre-level system first deployed on the Crimean Peninsula in 2014.¹⁰⁴ A complete complex consists of equipment mounted on seven vehicles. While the Murmansk-BN supposedly has a range of 5,000 km, it likely cannot create significant effect beyond 1,000 km.¹⁰⁵ It can jam satellite communications uplinks and downlinks but reportedly not GPS signals.¹⁰⁶



EW jamming systems are the ideal ‘asymmetric response weapon’

Future Jamming Systems

The Russian military recognises the need to continuously advance its satellite-jamming technologies. They can have a critical impact at both strategic and operational levels. The latest system to be fielded is the ‘completely new’ Tirada-2S. First publicly mentioned in 2017, the Tirada-2S operates from a mobile or fixed platform and reportedly has a greater range than the Krasukha-4.¹⁰⁷ The Tirada-2S is allegedly capable of permanently disabling satellites,¹⁰⁸ or ‘decommissioning’ (*vyvodit iz stroya*) them.¹⁰⁹ It is reportedly designed to work with the similarly newly developed Bylina-MM satellite monitoring and suppression system.¹¹⁰ The Bylina-MM, which uses AI to prioritise and jam electronic signals, is currently in the early stages of operational deployment. By using the Tirada-2S and Bylina-MM together, it is said that jamming can be conducted across a broad range of data links from many different satellites.¹¹¹

In April 2023, one Russian news outlet reported that the Russian military had even developed an EW system with the power to not just suppress the signals of satellites out to GEO but also to permanently disable the electronics of any satellite in GEO.¹¹² This may refer to plans for equipping satellites in orbit with jamming technologies.¹¹³ However, the power-source challenge remains, although the nuclear/plasma generators envisioned for space-based lasers could potentially be used for this purpose as well.¹¹⁴



‘EW will evolve from an operational (combat) support type into a full-fledged element of armed conflict’

It is also noteworthy that senior officers from the Russian Space Forces foresee that ‘space combat [i.e., employing ASATs] will eventually become mostly [a case of using] EW’.¹¹⁵ Moreover, they suggest that EW will become increasingly important as a component of warfare in general. ‘In the future’, it is further suggested in another article by senior officers, ‘electronic warfare will evolve from an operational (combat) support type into a full-fledged element of armed conflict’.¹¹⁶ This could imply a shift from continued investment in costly, kinetically-based ASAT systems towards emphasising EW weapons.

Russian Satellite Jamming in the Ukraine War

The Ukraine war provides insights into Russian jamming capabilities. While the Russian military occasionally jammed NATO satellites before this conflict, such activities significantly increased once the war started. General B. Chance Saltzman, the Chief of Space Operations for the US Space Force, noted in April 2023, ‘We’ve seen...persistent SATCOM and GPS jamming [from the Russians]’.¹¹⁷ Targets have also included SpaceX’s Starlink array, which the Russians attacked using the Tirada-2S¹¹⁸ because they classified it as a ‘quasi-civil infrastructure’ that was actively assisting the Ukrainian military by providing target indication.¹¹⁹

The Russian military has also been jamming satellite signals to protect targets within Russia. It has created jamming ‘bubbles’ to block GPS signals around sites it deems sensitive, presumably to disrupt the guidance of missiles or drones launched from Ukraine.¹²⁰

However, the extent of Russian satellite jamming during the war has overall been less than many experts had anticipated. This could be due to overestimations of Russian capabilities, or it might be because Moscow is ‘risk averse’ and does not want to escalate tensions by destroying a US or European spacecraft indirectly serving Ukrainian forces.¹²¹ Regarding GPS, the limited jamming might also be because the Russian military itself uses GPS, and Russian civilian enterprises also rely on it (along with GLONASS) for accurate timing (as discussed in Part I). Widespread GPS jamming could have negative consequences for the Russian economy.¹²²

There is also the possibility of ‘sandbagging’. Here the Russian military might deliberately be withholding its full capabilities. It may not want to reveal its true jamming capabilities with a potential future conflict with NATO in mind. As one US source puts it, ‘Deploying Russia’s most sophisticated and powerful electronic weapons in Ukraine would enable adversaries to study technologies and tactics, leading to the development of countermeasures and making the weapons less effective in future conflicts’.¹²³ It does need to be said, however, that Russian EW effectiveness improved as the war progressed. As it transitioned to a more static, defensive phase in mid-2022, the environment became more suitable for jamming systems. The initial war of movement did not showcase Russian EW assets at their best, but once these assets were in more fixed positions, they became more operationally effective.¹²⁴

Cyberspace Operations Against Satellites

In many ways, cyber operations against space assets may represent the future of Russian ASAT activity, although their potential has not yet been adequately evaluated. Cyberattacks can be considered the use of ASAT weapons because all the uplinks and downlinks to or from any satellite pass through IT systems at ground stations. These are as vulnerable to cyberattacks as any other digital system. Data to or from satellites can be blocked, corrupted, or spoofed. The movement or activities of satellites can even be manipulated by malicious actors through cyber means, potentially inducing harmful satellite manoeuvres. Cyber interference with satellite links can be difficult to detect and may go unnoticed.¹²⁵

Cyberattacks on these links can be used in peacetime to create nuisance effects, but during major conflicts, they can have much more severe consequences. A key concern is the spoofing of satellite signals, which might go undetected. This can result in recipients being *unknowingly* fed erroneous data, leading to damaging outcomes. Once any spoofing is detected, NATO militaries may then find it difficult to trust any satellite-supplied data. Even minor spoofing attacks can act as significant force multipliers, degrading trust in the effectiveness of critical satellites, even when they are functioning correctly.¹²⁶

Russia is known to possess sophisticated cyber capabilities.¹²⁷ It is logical to assume that, alongside the other ASAT weapons described here, the Russian military is significantly investing in their cyber counterparts. Russia likely seeks to do what a leaked CIA report suggests China is already doing – building cyber weapons to hack enemy satellites that would render them useless during wartime. And, of course, a significant advantage of such cyber weapons is their ability to target entire satellite arrays, not just individual satellites, as traditional ASATs typically do.¹²⁸

In the Ukraine war, Russian cyber capabilities in the ASAT field have been noted, including those supported by the Wagner organisation’s ‘cyber troops’.¹²⁹ The ground terminals of the US civilian Viasat KA-SAT satellite network, which serves Ukraine, were targeted in a cyberattack coinciding with the start of the ground invasion.¹³⁰ This attack affected the Ukrainian military’s command and control (C2) and surveillance capabilities. It also left much of the Ukrainian population and other users across Eastern Europe who relied on Viasat without an Internet connection.¹³¹ Elon Musk’s Starlink system was also subject to hacking attempts in addition to the jamming mentioned earlier.¹³²

However, Russian cyberattacks on satellite ground stations during the war have not been as significant as expected.¹³³ This could be due again to overestimating Russian capabilities, to robust Ukrainian cyber defences (improved with NATO assistance



Cyber operations against space assets may represent the future of Russian ASAT activity

since 2014), or because of a Russian desire to withhold its best cyber tools for future conflicts. As Kofman et al. express it, ‘high-end cyber capabilities may have been held in reserve for conflict with the United States and NATO’.¹³⁴

Whatever the reality of Russian military potential in counter-satellite cyber operations, there is a strong argument that they may become a major factor in future counter-space activity. Cyber operations align perfectly with the asymmetric mindset discussed in Part I. Targeting ground IT systems using resource-lite cyber means is, on the surface, far more cost-effective than deploying the more expensive ASAT tools in the Russian military’s arsenal. This is especially relevant as NATO and Western civilian satellite providers increasingly deploy satellite arrays rather than individual units. The concept of targeting a single satellite with an ASAT weapon like the Nudol may be seen as outdated. Counter-space operations in cyberspace circumvent this by focusing on the actual input-output data to or from any satellite or array rather than just the physical entities themselves.¹³⁵ As David Burbach at the US Naval War College puts it, ‘The success of Russia’s attack on Viasat...shows that an invulnerable satellite fleet is irrelevant if cyberattacks can impair its ground-based control systems and user access’.¹³⁶



The logic of maintaining a diverse array of ASAT tools remains evident for the Russian military

However, as with any cyberattack, success is never guaranteed. There can never be total reliance on cyberattacks as a ‘holy grail’ ASAT tool. Offensive cyber actors can never be entirely certain of a satellite system’s cybersecurity defences. Therefore, Russia has a clear rationale for maintaining a range of other kinetic and non-kinetic ASAT weapons. This is especially true where targets might be individual satellites with specific and critical strategic or operational roles, such as the small number of US early-warning satellites in GEO. Hence, the logic of maintaining a diverse array of ASAT tools – including cyber – remains evident for the Russian military.

Conclusion

A review of Russian military journals, such as *Military Thought*, over the last 20 or so years presents a picture of a military that perceives itself – and by extension, the country – as vulnerable to aggression from a significantly more powerful NATO. This sense of vulnerability provides the context for the military’s overall asymmetric mindset, including its emphasis on developing ASATs. As noted, such development is a ‘critical objective...of the Russian Federation’.¹³⁷ ASAT weapons represent ideal asymmetric tools to counter NATO’s technical superiority across various capabilities. The threat these weapons pose has indeed been recognised in NATO quarters. As Daniel R. Coates, the US Director of National Intelligence, recently observed: ‘Russia...continue[s] to pursue antisatellite (ASAT) weapons as a means to reduce US and allied military effectiveness’.¹³⁸

At the *operational* level, ASATs can, at the very least, significantly stymie NATO C4ISR activities and degrade the accuracy of various precision-guided munitions. The possibility that ASATs could fundamentally undermine NATO battlefield strengths may, at the very least, create doubts in the minds of NATO planners about whether their forces could ‘prevail’ in any large-scale combat with Russian forces. This might lead to a blanket decision to avoid such combat in the first place. In other words, NATO might engage in the ‘restraint’ that the Russian military (as it claims) is explicitly seeking to impose with its fielding and development of ASAT weapons. Thus, ASATs can provide the Russian military with operational-level *deterrence*.

However, it is at the strategic level that Russian ASATs may be seen to have their most significant deterrent effect. From the Russian military's perspective, a credible ASAT threat might dissuade the US from any contemplation (however theoretical) of a nuclear first strike against Russia. Perhaps more pertinently, it could also dissuade Washington from deploying anything akin to the SDI of the 1980s. Elements of such a system might be seen as too vulnerable to ASAT activity and, therefore, not worth the expense or risk of deployment. While this manifestation of deterrence effect would be viewed on its own as welcome in Moscow, Russian ASATs' greatest strategic deterrence capacity probably lies in regard to any full-scale use by the US of the PGS system. If, as discussed both above and in Part I, ASATs can threaten to prevent PGS from achieving its designed strategic effects – whether the targets are Russia's Critical National Infrastructure (CNI), vital military C2 structures (i.e., 'decapitation' attacks), or mobile ICBMs – then the pre-emptive use of PGS by Washington might never be considered. Russian ASATs would, once again, impose 'restraint' on NATO planners.

These ASATs can also have two additional significant strategic effects. The first – following the logic inherent in their overall deterrence capacity – is that the availability of a significant number of high-quality ASATs could make Russia feel less vulnerable to the attack by NATO that it appears to 'fear'. ASATs could provide Moscow with what might be considered a degree of 'insurance' against any NATO pre-emptive strike (as discussed in Part I). A Russia feeling less *vulnerable* – without the element of 'fear' influencing policy – would theoretically be less likely to engage in what Moscow views as 'pre-emptive self-defence', i.e., actions designed to protect itself. It has been argued that the invasions of Georgia in 2008 and Ukraine in 2014 and 2022 fit this pattern. Following this logic, the world, with *more* Russian ASATs available, could ironically become a more stable place – though this might be wishful thinking.



NATO has become
too reliant on
its satellites

Of course, there is also the opposite side of the coin. Suppose the Russian military develops more numerous and potent ASATs, possibly in cooperation with China. In that case, Russia (and China) might one day feel confident enough to launch *offensive* actions against NATO forces. The first move in such an offensive would be to target US/NATO satellites with ASATs, aiming to negate a range of Alliance capabilities.¹³⁹ Moscow and Beijing might ask themselves, 'just how strong can NATO forces be if they are denied the major force-multiplier of their satellite assets?'

Here lies a fundamental issue. Arguably, NATO has become *too* reliant on its satellites.¹⁴⁰ As the US Assistant Secretary of Defense for Space Policy recently said, they are 'absolutely essential to our way of war'.¹⁴¹ These satellites underpin military strength, but entice the use of asymmetric actions by adversary states like Russia and China. The primary aim of any asymmetric approach is to transform an adversary's perceived strength into a vulnerability or point of weakness. NATO can field a wide range of sophisticated platforms and weapons systems, but if they rely on satellite support to function effectively, how 'effective' can they be? How can any form of major kinetic conflict with a peer-state adversary (or adversaries) end in NATO's favour if the 'absolutely essential' element of satellite input is denied? There is undoubtedly concern about these questions in NATO circles. To quote General Saltzman again, 'a top priority for the Department of Defense is to protect our capabilities in space'.¹⁴²

This brings us back to the idea proposed in Part I: that the Russian military is not trying to match US/NATO space capabilities but is instead concentrating on negating their effects through the threat of ASATs. True, Moscow will continue to deploy its own critical satellite systems – such as the early-warning Kupol. But with increasingly

sophisticated and resource-light ASATs in operation (especially those in the EW and cyber fields), what is the point of Russia's heavy and expensive investment in traditional satellite systems? Why not just let ASATs 'level the battlefield' with NATO? Thus, in many ways, the Russian military may be seen as leaving the traditional space-domain field free for NATO simply because satellites are becoming so prone to attack by ASATs. The US DoD acknowledges that Russia 'wants to avoid becoming overly dependent on space for its national defence missions because it views that as a potential vulnerability'.¹⁴³

Therefore, given the Russian military's propensity for asymmetric thinking, it is inevitable that it will continue to make significant investments in ASAT weapons. Moreover, experience gained in the Ukraine war is doubtless helping in their development. In the future, NATO can expect to face a Russian military that will not only have more ASAT weapons at its disposal but also ones that are more sophisticated (bearing in mind the potential constraints imposed by the sanctions' regime). Inevitably, developing a strength in counter-space weapons will continue to be a 'critical objective...of the Russian Federation'.¹⁴⁴ Such a strength will also, and just as inevitably, exert considerable influence on NATO force planners. Russian ASATs must give NATO pause. This pause may be most evident in any decision to counter future Russian military aggression beyond, or even as part of, its current operation in Ukraine. NATO may not feel able to 'stand up' to such aggression *primarily* because of Russian ASAT capabilities. In this scenario, perhaps more than in any other, Russian ASATs could prove to be significant – if not profound – tools of deterrence.

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