SAFETY&DEFENSE ISSN 2450-551X

Anti-Satellite Weapons: A Political Dimension

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DOI: https://doi.org/10.37105/sd.129

Abstract

This article tackles the political dimension of the development of anti-satellite weapons. The main goal is to assess their significance from the American, Russian, and Chinese perspective to understand the emerging balance of power in space. While the U.S. is struggling to maintain its position of dominant space power, its main adversaries are developing technologies that can diminish American dominance. It is, therefore, widely believed that outer space is poised to be weaponized by multiple systems designed to destroy satellites in-orbit, both ground- and space-based. On the other hand, the United States is executing multiple fast-track research& development programs aimed at increasing the resilience of the U.S. space systems.

Keywords

international security, safety in space, space systems defense, space security, space weapons.

Submitted: 20.05.2021 Accepted: 15.06.2021 Published: 29.06.2021

1. Introduction

There is no need to discuss at length the utility of satellite systems and their significance for nation-states' economy, security and social sphere. Suffice it to say that the global satellite industry revenues reached 366 billion USD in 2019 (Satellite Industry Association, 2020), and security-related satellite applications are indispensable for every country, providing communications, earth observation and positioning. Satellites are also present in social life as they are a vital part of cyberspace, enabling many socially significant activities like multi-domain communications, social networks, and entertainment. However, these benefits are not absolute because many technologies designed to hinder space operations have been perfected within the last decade or so. Others are under development with a good prospect for entering operational service in the coming years.

This article tackles the political dimension of the development of anti-satellite (ASAT) weapons. The main goal is to assess their significance from the perspective of the United States, Russia, and China to understand the emerging balance of power in space. It will be argued that a slowdown or even freeze of the development of this kind of armaments is going to occur in the coming years.

As a military competition, strategic considerations and the global power struggle are referred to in this article; naturally, the realist paradigm has been adopted for the purpose of the research. This kind of approach will allow us to underline the basic characteristics of the relations among main global competitors, as our goal is to provide the most general answer to the question referring to their strategies. Qualitative methods will be performed with regard to open-source information and analyses available on the issue of ASAT weapons.

2. Anti-Satellite Weapons – a short summary

There are many ways to negate satellite capabilities, either partially or in full. Spacecraft may be dazzled or blinded, their signals may be jammed, spoofed or otherwise distorted. Antagonistic forces may also take orbiters over, physically or through cyber intrusion. Certainly, satellites may also be destroyed or damaged by hostile entities using various forms of physical or non-physical attack. These means are usually referred to as counterspace capabilities or counterspace weapons (Harrison et al., 2021).

This research directly tackles only one category of counterspace capabilities, which we refer to as anti-satellite weapons. We define them as ground- or space-based systems designed to damage or destroy satellites in orbit. However, other means of disrupting the operations of satellite systems are also considered in this paper as they are an indispensable context for the main argument. The following presents shortest possible summary of the ASAT capabilities of the United States, China and Russia.

The United States adamantly holds that it does not possess and is not developing any dedicated ASAT system. However, the Ballistic Missile Defense System (BMDS) consists of several weapons systems designed to attack ballistic missiles in space. This means that it possesses intrinsic ASAT capabilities (Grego, 2011). The most capable of the systems belonging to the BMDS is the Aegis/SM-3, installed onboard 48 U.S. Navy cruisers and destroyers (O'Rourke, 2020). According to the FY 2019 budget submission, the inventory of SM-3 interceptors reached 464 in 2021 (O'Rourke, 2019). The system may be scaled up relatively quickly, as BMD-capable ships can carry from 90-to-122 missiles each; therefore, the matter is only one of the production rates of missiles. Grego (2011) calculates that the SM-3IA/B variant can attack satellites at a distance of up to 600 km, and the SM-3IIA up to 1450-2350 km. Note that according to the Union of Concerned Scientists (2021), of the 3372 satellites active as of January 1st, 2021, roughly 2500 orbited below 1000 km.

As the Office of the Secretary of Defense (2020, p. 65) believes, the Chinese military "has an operational ground-based Anti-Satellite (ASAT) missile intended to target low-Earth orbit satellites". However, publicly available sources of reliable information provide no clue as to the nature of the system dubbed SC-19 (Harrison et al., 2021). There is also no open-source indication of whether this weapon has been adopted for operational use or put into combat service. Additionally, it is thought that China is pursuing other ASAT capabilities, including direct-ascent (DA) systems able to threaten geosynchronous orbit (GEO), co-orbital (CO) systems, and lasers with the potential to damage or destroy satellites (Harrison et al., 2021). However, the operational deployment of these advanced capabilities is the somewhat distant future.

Weeden and Samson (2021) argue that "Russia is almost certainly capable of some limited DA-ASAT operations, but likely not yet on a sufficient scale or at sufficient altitude to pose a critical threat to space assets." Current Russian anti-satellite development programs refer to both direct-ascent and co-orbital systems. The PL-19/Nudol missile represents the former tested several times in recent years (Podvig, 2020). It is, however, unknown whether any decision regarding the production or deployment of the operational units of this system has been made. It is frequently repeated that the S-400 air defense system, deployed in large quantities throughout Russia and abroad, is capable of conducting ASAT missions. We do not share this conviction, and we agree with Weeden and Samson (2021,) who do not list the S-400 as an anti-satellite weapon. However, the next-generation Russian air defense system, the S-500, will most probably be able to intercept medium-range ballistic missiles in space (Weeden & Samson, 2021). This feature would render the S-500 capable of ASAT operations, but it is not known if such a mission is envisaged for it. According to current estimates, the S-500 is slated to be deployed in significant numbers by 2025 (McDermott, 2021). Additionally, a noteworthy number of rendezvous proximity operations (RPOs) executed by Russian satellites have been observed in recent years, which might suggest that work on co-orbital ASAT weapons is in progress. Laser weapons are also being tested in Russia, and they may have some limited ASAT capabilities (Cooper, 2019).

Finally, it is necessary to point to the important context in which ASAT weapons must be considered, as they are just a part of a vast arsenal of counterspace capabilities. Other means of space warfare, even though non-destructive, present formidable opportunities to harm an enemy's systems and negate their capabilities. All three leading space powers have perfected electronic and cyber warfare against adversaries' space systems. China and Russia (Defense Information Agency, 2019), in particular, have developed the capabilities to negate missions of the American satellites. According to Harrison et al. (2020, p. 25), there is "overwhelming evidence that Russia has employed the use of mobile, ground-based electronic counterspace weapons on a regular basis both within its borders and abroad". The United States also possesses extensive electronic warfare counterspace capabilities (Weeden & Samson, 2021), although it is not known if they have actually been used.

3. Trends in the Development of Military Satellite Systems

The development of ASAT weapons must be placed within the context that relates to satellite systems' evolution. Indeed, current military constellations pose relatively easy targets because they consist of a relatively small number of huge and expensive satellites, which are difficult to replace quickly. This feature makes ASAT weapons such a tempting remedy for the U.S. military preponderance; the "high ground" space systems occupy for executing their missions turn out to be a weak position as far as defense is concerned, as they are exposed, easily targetable and fragile. As Harrison, Johnson and Young (2021, p. 12) observed, "[w]hile U.S. space capabilities remain far ahead of other nations, some adversaries, namely China and Russia, are arguably making advances in counterspace weapons faster than the United States is making advances in protections against these threats."

On the other hand, however, in the last several years, we have witnessed a surge of concepts, ideas, and developmental works regarding increasing space systems' resilience to offset the development of anti-satellite weapons and other counterspace measures. This development must be mentioned within this paper because it forms one of the most important contexts for analyzing an emerging strategic balance in space. We will, therefore, briefly review these ideas below.

There are many possible ways to ensure the uninhibited operation of satellite systems that may be considered in designing the next-generation constellations. The first category of passive defense contains propositions for changes in the architecture of space systems. In general, this idea embodies the drive to create military constellations in such a way that they would represent a much larger target. Simply speaking, the multiplication of systems and elements within systems will make adversaries commit to more information gathering on assets, targeting devices and interceptors to harm a constellation. It will also take more time to accomplish these things, as the attacked system will not instantly lose its capabilities and would degrade gradually.

The second group of passive methods for protecting satellite systems are of a technical nature. It encompasses sophisticated prospective means that are difficult to explain without delving into technicalities, such as increasing space situational awareness (Bielawski, 2019), strengthening electronic warfare capabilities, installing technical means of protection of satellite lenses and electronics, increasing the jamming-resistance capacities of radio frequencies, using advanced encryption protocols, and so on. These means are mostly suited to confronting non-destructive, electronic or cyber counterspace weapons, but they can also contribute to defense against ASAT systems.

Finally, there are operational ways to complicate counterspace activities, particularly ASAT missions. For example, satellite constellations may be kept in-store and rapidly deployed if necessary. In this case, the adversary will be suddenly confronted with previously unknown systems it may not be prepared for. Similarly, the existing space systems may be backed up by components stored on the ground to reconstruct compromised constellations quickly. Additionally, the maneuverability of spacecraft may be somewhat augmented; stealth technologies may be employed in their construction, and they also may be equipped with countermeasures such as decoys or chaff.

Furthermore, we should mention possible forms of active defense, ranging from jamming, spoofing, dazzling, and blinding interceptors or ground components of ASAT systems to equipping spacecraft with defensive weapons. Co-orbital anti-satellite systems may also be pre-emptively seized or destroyed, and numerous actions against ground-based ASAT infrastructure may be taken, including electronic, cyber and kinetic pre-emptive attacks. It is safe to assume that in the case of hostilities, the adversary's anti-satellite infrastructure will be the first priority of the U.S. forces.

Many aerospace companies, scientific institutions, and military organizations in the United States are currently working on concepts for the next generation of space systems to make them more resilient. It is impossible to list them all within this article's framework, and suffice it to say that fast-tracked research and development works aimed at countering the effect of counterspace weapons (Strout, 2021), with particular attention to ASAT, are underway in the U.S. and allied countries. The scope of these activities suggests that a sort of revolution in military space system operations has begun. Within the next decade, we will probably witness the advent of a new generation of military constellations substantially more resistant to adversaries' actions.

It should also be mentioned that many of the most promising technologies or operational concepts for strengthening space systems are very expensive. However, since the United States decided it was crucial to increase its space systems' resilience dramatically, we may expect that billions of dollars will be spent to reach the desired level of resilience. On the contrary, it is doubtful whether China or Russia are ready to do the same with their own satellite systems, which may remain vulnerable in the foreseeable future while the American will gradually become safer.

4. The Emerging Strategic Equation in Outer Space

It is frequently argued that outer space is poised to be quickly weaponized due to research and development works in progress in many countries, most notably in Russia and China (Raymond, 2020). Some even argue that, due to the dual-use nature of satellite systems, the weaponization of the Earth's orbit is a natural development as almost every satellite invokes a security dilemma (Lubojemski, 2019). Consequently, this purportedly unavoidable process will add to the already existing and widely used non-destructive counterspace capabilities. All in all, as the argument goes, the times of actual "star wars" in which lasers, microwave weapons, EMP pulses, and missiles will be used to damage and destroy satellites are about to come in the not-so-far future.

However, other factors should also be taken into consideration. More than a simple drive to offset the American strength governs Russian and, especially, Chinese actions. Both countries must consider many other issues regarding their own use of satellite systems, ranging from the general goals and aims of the respective states' strategies, through technical and operational considerations, to economic constraints. Furthermore, this is not to mention the so-called Kessler effect (Kessler & Cour-Palais, 1978), which looms over all human space activities. In essence, it means that the destruction of even a small number of satellites would lead to the obliteration of at least a significant portion of the whole space architecture. This would happen because destroyed spacecraft would, in most cases, be reduced to a great amount of fragmented debris, which, in turn, would hit other satellites, producing a potentially massive cascade effect. Furthermore, vital orbits would be rendered inaccessible for decades.

Therefore, we believe that the decision to deploy dedicated ASAT weapons systems in quantities significant enough to alter the existing military balance will not be based only on the sheer technical capabilities demonstrated during laboratory and field tests. The most important question revolves around the security dilemma (or trilemma): whether the deployment of a novel weapon would bring more benefits than costs. Every leg of the arms race has its own dynamics, and, contrary to the common view, not every weapon which has been developed must be deployed or used. For example, during the Cold War both sides considered fractional orbit bombardment systems (FOBS); the Soviet Union even managed to design an operationally capable model of such a weapon. Nevertheless, it was never deployed in significant quantities because both sides decided that it was impractical, extremely costly, and would add dangerous volatility to the strategic balance without offering many advantages. The same happened to strategic missile defense, which was designed, developed and deployed but in strategically insignificant quantities. In simple terms, before a novel and costly weapon is put into full operational capacity, the user must decide whether the potential costs and dangers do not exceed gains. We believe that it is the case with ASAT weapons as well.

The "benefit side" of the security dilemma (trilemma) associated with ASAT weapons that China and Russia face is apparent. If Moscow or Beijing has a significant number of ASAT weapons deployed today, it would mean that the U.S. vital satellite systems are held hostage. This would represent political leverage in peacetime and a critically important advantage in case of a crisis and conflict. This is undoubtedly true, but five important contexts of various kinds should be considered at the "cost side" of the security dilemma (trilemma). Firstly, the United States already possesses significant ASAT capabilities, which hold the space assets of China and Russia hostage. Thus, in the case of a conflict, the U.S. could quickly retaliate if confronted with an act of aggression in space. The U.S. Navy BMD-capable cruisers and destroyers scattered throughout the world can "clear" the LEO of enemy's satellites using their independent detection, tracking and targeting capabilities. Therefore, the retaliation would happen even during an unlikely but possible scenario in which the instant and total annihilation of the American space systems would occur. Of course, the United States is more dependent on satellite systems than its main competitors, so one might say that such a space Armageddon would harm the U.S. side more. However, others, China or Russia, would also lose their vital assets, and the balance that would emerge out of such an event would still favor the U.S. even if some capabilities had been nullified. China, particularly, would lose the assets indispensable for its most cherished strategy of expanding global reach and strengthening its military's power projection capability (Biddle & Oerlich, 2016). The American intelligence community (Office of the Director of National Intelligence, 2021, p. 7) underline that "Beijing is working to match or exceed US capabilities in space to gain the military, economic, and prestige benefits."

Secondly, the scenario mentioned above assumes that China or Russia do have significant ASAT capability at the moment. We have made this assumption to illustrate the consequences of the exchange of strikes against the space infrastructure. However, the reality is different. Neither China nor Russia have significant ASAT capabilities. On the other hand, the United States already has formidable anti-satellite weapons systems, even though it is not officially acknowledged. This means that any anti-satellite arms race initiated by China or Russia would be doomed to be lost by them, simply because the U.S. already has a huge numerical and technological advantage in DA anti-satellite systems, which will surely grow once the race is on. The same goes with future co-orbital ASAT weapons or lasers powerful enough to damage or destroy a satellite. The U.S. retains so great an economic and technological advantage that even if surprised by the rapid deployment of first units procured by adversaries, it would certainly be able to quickly catch up and overtake competitors in every aspect of the race. This is the most important reason that makes the whole idea of the ASAT arms race an impractical and futile effort from the point of view of the Russian or Chinese interest.

Thirdly, if, despite the above-mentioned facts, China or Russia decide to design and deploy a significant number of combat ASAT units, it will take not only a lot of financial and organizational effort but also much time. This very time will be used by the United States not only to speed up its own weapons deployment; the reconfiguration of the American space capabilities will also be quickened, first of all by changing their architecture and modes of operational use. And so, by the second half of the decade, the emerging ASAT force of China or Russia would be confronted with an increasingly complex and quickly evolving target, rendering any attack calculus very difficult. In other words, an anti-satellite force ready to be fielded within several years will operate alongside today's principles. Still, it will a face space architecture which, at least in significant part, will operate according to tomorrow's principles. Of course, this prediction is valid only if some unexpected technological breakthrough in anti-satellite weapons does not occur. Absent such a “black swan” event, the U.S. would remain well ahead of its competitors both in its offensive ASAT capabilities and measures aimed at increasing the resilience of space systems in the foreseeable future.

Fourthly, the above-mentioned Kessler effect must be seriously taken into consideration. This means that even a minor exchange of blows in space may lead to serious and uncontrollable consequences. Therefore, there is no room for an escalation-de-escalation strategy in space warfare. This renders ASAT weapons clumsy and inflexible as nuclear deterrents, and impractical as tools of everyday policies, though extremely expensive ones.

And finally, all three countries, most notably China and Russia, but we may safely assume that the U.S. as well, are engaged in day-to-day non-destructive combat in electronic and cyber realms. Laser blinding and dazzling is also commonplace. This ongoing activity carries much less political weight than the use of destructive systems, but it brings benefits and advantages without the risk of a space Armageddon.

5. Current Realities of the ASAT Race

Let us reiterate the point that if an ASAT arms race is triggered, the U.S. will most probably retain their decisive advantage. This means that the ability of America’s competitors to inflict significant damage on U.S. systems will bring inevitable risks for their own vital capabilities. Even if a successful “space Pearl Harbor” occurs, the likely Kessler effect will negate it by destroying most of the attackers’ satellites even without American action. The loss of its satellite systems would surely cripple the U.S. military, but America would remain the most powerful military in the world, even if its capabilities are diminished. Additionally, the economic consequences of damage to space architecture would be tremendous, not only for the parties to the conflict but also for the whole world, because all countries and commercial entities will have their space assets at least badly damaged. Furthermore, many orbits may be rendered unusable for a long time, which would degrade the world’s space capabilities for years or decades to come.

The risk/benefit equation should also be analyzed in light of the obvious and well-known advantages of the unhindered use of space systems. Even if they are somewhat compromised by non-destructive means of space combat, they are still indispensable in peacetime, in the case of crisis or heightened tensions, or during armed conflicts of various natures. Putting these advantages in jeopardy by initiating an anti-satellite arms race seems unreasonable.

Furthermore, it should be noticed that the development of ASAT weapons into a politically significant instrument requires much investment in technology, organization, training, and infrastructure. In addition, a doctrine of the implementation of a novel weapon must be developed in which the overall task, terms of use, and decision-making process must be operationalized. The next step is the formation of combat units and their final training and certification for operational use. Finally, hardware must be procured, and a number of units deployed to fulfill the ASAT mission envisaged for them. In the case of direct-ascent ASAT, a force that may be called significant would probably comprise of tens of combat units, dozens of launchers, hundreds of missiles, and thousands of personnel scattered across numerous installations. This might prove prohibitively expensive even for China, which already carries a burden of multi-domain military modernization.

Taking all of the above-mentioned arguments into consideration, we can easily notice that the anti-satellite arms race is not inevitable because no one would actually benefit from it. ASAT weapons are costly and impracticable, and also add to the inherent volatility of the strategic balance. Therefore, it is our assessment that no side in the emerging space deterrence equation will decide to deploy significant ASAT force. Thus, a full-blown anti-satellite arms race will not be started in the foreseeable future absent a sudden technological breakthrough would instantly nullify all of the capabilities of one side of the equation.

However, the question still arises as to why China and Russia continue developing ASAT weapons, even though they are so obviously impractical. We assume that these works are not intended to lead to the deployment of significant ASAT forces. This means that, in our opinion, the decision to weaponize outer space is not going to be made either in Moscow or in Beijing. However, this does not preclude the conduct of research and development activities that may be deemed practical for at least several reasons.

Firstly, both countries may intend to accumulate knowledge and expertise as a hedge against possible future changes in the strategic balance, especially should the U.S. decide, and paradoxically it is not unlikely to trigger an ASAT arms race sometime in the future. Secondly, it is possible that China and Russia count on some technological breakthrough that could rapidly change the balance in their favor. Thirdly, the development of anti-satellite weapons may be continued in order to retain a bargaining chip in possible future strategic arms limitation/reduction talks, be they two- or three-sided. Finally, both countries might strive to use their ASAT development to gain international prestige. This would especially be the case of Russia, as Vladimir Putin frequently boasts about novel Russian superweapons. They are surely formidable, but they do not change the strategic balance within current strategic realities, especially considering the shrinking Russian military budget. The same goes with China's ongoing drive to display its technological prowess. A small, experimental in nature, ASAT force, even if undeclared, would have a similar propaganda effect.

In this way, research and development work on anti-satellite weapons may continue, and the deployment of a small ASAT force may even occur, but the strategic equation of the space MAD will hold anyway. All sides of the new strategic balance will refrain from deploying a full-blown anti-satellite force. This will make their vital space capabilities relatively reliable, and satellite war will continue with non-destructive methods. It will also spare military budgets the burden of a new arms race. Finally, rudimentary anti-satellite capabilities will be retained as a hedge against future developments and as a kind of hidden deterrent.

6. Conclusion

In conclusion, we reiterate that considering the current state of affairs, especially with regard to technical and organizational issues, anti-satellite weapons will not materialize in the quantities significant enough to influence the strategic balance. Most probably, they will not be deployed at all. It is, however, unclear whether this is going to happen only with a tacit acknowledgement of the existing balance or perhaps along the lines of some legally binding international agreement. We assume that, in the foreseeable future, the former will be the case. However, we cannot exclude some regulations in the more distant future, probably as a part of some wider strategic balance-imposing treaty. Surely, concluding such a treaty will not be easy, especially since three sides are involved, which dramatically complicates the negotiation process. Nevertheless, reaching such an agreement is not impossible, provided the world powers will understand their interests and recognize the threats and risks. It is also possible that after several years or maybe a decade or so of uncertainties caused by the multi-dimensional crisis of the international system, some new system will emerge. This would make the main powers more susceptible to compromise, and the regulation of ASAT weapons might become part of the strategic realities of a new international system. However, more detailed consideration with regard to this is rather premature at the moment.

The realist perspective that we have adopted assumes that nation states act more or less rationally regarding realistically defined interests. The analysis above is based on this premise. However, for the sake of comprehensiveness, we should add that it is also possible that leaders or elites within the countries will indeed act irrationally and contrary to their own best interests. It may also occur within the sphere we have just described. For example, the Chinese leadership may relentlessly push for the deployment of a significant number of direct-ascent ASAT systems to offset the U.S. military advantage at any cost. Furthermore, the Russian leadership may decide that the deployment of anti-satellite capabilities would serve in favor of Russia's image as a world power despite the financial burden that it would bring. Moreover, in the United States, the military or industrial lobbies may feed on popular fears and push through the weaponization of space for their own sake, regardless of the state's interest. The American Department of Defense (2020) has already identified outer space as a warfighting domain. However, these possible outcomes require a more detailed and nuanced approach and implementation of a different theoretical paradigm.

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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