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Na orbitální frontě stále klid? Pomalá proliferace proti-satelitních zbraní

Still All Quiet on the Orbital Front? The Slow Proliferation of Anti-Satellite Weapons

Adam Strauch

Abstrakt

Článek si klade za cíl prozkoumat problematiku pomalé proliferace proti-satelitních zbraní. Až do současnosti vyvinuly protisatelitní zbraně pouze tři státy. Problematika je zkoumána skrze analyticky oddělené faktory, jež by mohly státy motivovat nebo odrazovat od vyzbrojení protisatelitními zbraněmi. V rámci článku jsou definovány hlavní strategické role, jež protisatelitní zbraně mohou hrát v bezpečnostní politice státu, a následně je zhodnocena jejich relevance z hlediska proliferace. Zmiňované strategické role zahrnují: obranný nástroj proti jaderným zbraním protivníka umístěným v kosmu, podpora jaderného prvního úderu, protiopatření k překonání protivníkova systému protiraketové obrany, asymetrická odpověď na konvenční převahu protivníka, a zbraň proti orbitální civilní infrastruktuře. Další diskutované faktory, jež mají potenciální význam pro rozhodnutí státu, zdali přistoupit k proliferaci protisatelitních zbraní, zahrnují legální omezení, environmentální a technické aspekty.

Abstract

The article strives to explore the issue of relatively slow proliferation of anti-satellite weapons (ASATs). Until now only three countries developed the ASATs. The issue is examined through the analytically separate factors that might motivate or dissuade the ASAT proliferation. The main strategic roles that ASATs may play in a state's security policy are defined, and their relevance vis-à-vis proliferation is assessed. The roles include: a defensive measure against adversary's space-based nuclear weapons, a force multiplier for a nuclear first strike, a countermeasure against adversary's anti-ballistic missile defense (ABM), an asymmetric counter to a technologically superior adversary, and a counter-value weapon. Other explored factors carrying a potential relevance for the ASAT proliferation include legal constrains, environmental and technical aspects.

Poznámka

Příspěvek obsahuje výhradně názory autora, založené na analýze veřejně dostupných zdrojů, a nevyjadřuje stanoviska žádné z organizací, ve kterých autor profesně působil.

Klíčová slova

Proti-satelitní zbraně; ASAT; kosmický prostor; proliferace.

Keywords

Anti-satellite weapons; ASAT; outer space; proliferation.

INTRODUCTION

"No matter how vast, how total, the failure of man here on earth, the work of man will be resumed elsewhere. War leaders talk of resuming operations on this front and that, but man's front embraces the whole universe."

Henry Miller

The proliferation of anti-satellite weapons (ASATs) was on the fringes of academic interest for much of the 1990s and the 2000s. As a subtopic of the broader space weaponization debate, itself a comparatively minor topic in the strategic studies, it has been discussed mainly as a part of the missile defense issue. The January 2007 Chinese ASAT test, a significant event in the context of the looming sino-american strategic competition, has understandably drawn a considerable attention of both academics and practitioners, and for a time returned the ASATs to the academic spotlights of the analysts worldwide. The renewed interest has been further strengthened recently by the Indian debate on the ASAT development, continued testing of the Chinese system as well as an alleged restart of the one or several Russian ASAT programs.

The proliferation of ASATs, horizontal and vertical, was rather limited both throughout the Cold War period and in the following two decades. The original two superpowers were the only states to field ASATs and until the abovementioned Chinese test also the only ones to test these systems. As the development of the Indian system became a matter of policy discussions in New Delhi, the horizontal proliferation of the ASATs might soon reach four states. Although the number increased since the Cold War era, it still remains rather low figure. In terms of vertical proliferation, deployment of ASATs has never been robust, they have tended to be more of a limited experimental capability rather than a routine tool of states' military policies.

This text strives to explore the factors influencing the ASAT proliferation. What are the essential drivers and inhibitors of the ASAT proliferation? What are the prospects for further ASAT proliferation in the future? These are the key questions that shall be covered below. A brief overview of historical and current state of the ASAT proliferation in the four relevant countries in the first part of the text, is followed by discussion on several analytically distinct potential roles ASAT may play in a nation's strategy (some degree of overlap and inter-connectedness among the roles does exist, however). The perceived value and utility of these roles (or lack thereof) for the states then serve as indicators to measure the ASAT proliferation potential. The natural starting point for assessment of such roles is the intellectual realm of classic nuclear strategy, as it was this very milieu that first spawned the ASAT and subsequently strongly determined the scope of its proliferation for four decades. We shall identify three main potential roles the ASATs may play in a broadly understood nuclear strategy. The first three ASAT roles discussed are therefore: a defensive measure against adversary's space-based nuclear weapons; a force multiplier for a nuclear first strike; and a countermeasure against adversary's anti-ballistic missile defense (ABM). The fourth potential role covered in the article, an asymmetric counter to a technologically superior adversary, belongs to the realm of conventional warfare, while the fifth role, a counter-value weapon, goes beyond. The rest of the text then tackles other factors carrying a potential relevance for the ASAT proliferation, namely legal constrains, environmental and technical aspects.

The article does not strive to reach a conclusion regarding how much the discussed strategic roles and other relevant factors impact the ASAT proliferation in quantitative terms and relative to each other. The isolation of analytically separate factors should rather serve to stimulate further academic discussion on the topic. The article also does not cover the historical and technical background more than is necessary to illustrate its points (both has been covered extensively elsewhere). As the focus of the article is on the physical ASAT threats, the emerging topic of the ASAT cyberwarfare is only briefly noted. Although the relevance of the cyberwarfare for the study of the anti-satellite warfare has been increasing, the complexity and breadth of the issue lies outside the analytical framework of the presented paper.

PAST AND PRESENT SCALE OF THE ASAT PROLIFERATION

ASATs have been traditionally divided into three categories. The co-orbital ASAT is carried to orbit by a space launch vehicle, then reaches its target only after one or two orbital revolutions. These were rather inflexible systems due to significant time required to reach the target and limited orbital inclinations they could reach. They were also limited to targets in the low Earth orbits (LEO)[1], and although in theory these systems could reach higher orbits (provided a more potent launcher), such capability was not tested historically. The direct ascent ASAT is carried by a missile launched from ground, air or sea and reaches its target directly without entering the orbit. These systems are more flexible due to shorter time needed to reach their target, especially if an easily re-deployable vehicle (a jet fighter, a ship, a mobile erector launcher) is used to carry them, which significantly expands their reach. These have been, however, also limited to targets in the LEO. Both co-orbital and direct ascent ASATs can use either kinetic-kill mechanism, or conventional/nuclear explosion to eliminate the target. Directed energy ASATs can be deployed on ground or in space. These, in theory, would be the quickest satellite killers, limited only by their line of sight. However, significant constraints exist for their efficient operational use when deployed in either of the environments (the Earth's atmosphere for the ground-based system, and overall technological difficulty for the space-based one).

The first **US** ASAT capability was developed in parallel across several programs in the 1950s and the early 1960s. Of those, only two ultimately reached operational status and were deployed for a brief period of time and a on a very limited scale. Nike-Zeus system primarily developed for missile defense purposes was modified under the Program 505 for ASAT mission. The new direct-ascent nuclear ASAT was successfully tested in 1963 and declared operational shortly after. A single missile with a live nuclear warhead was maintained in a ready status. The program was, however, officially cancelled in 1966, as the administration's support shifted to a competing ASAT development project. The Program 437, another direct-ascent nuclear ASAT based on a modified Thor IRBM, reached initial operational capability in 1964. The system consisted of two missiles deployed at Johnson Island, operating on a 24-hour reaction time, and two further missiles at the Vandenberg AFB as a backup. The program was underfunded, the readiness level was decreased to 30 days in 1970. The system ceased to be operational by 1972 before the final cancellation came three years later. Capabilities of both of these systems were severely limited - their particular fixed locations and range limited potential engagement trajectories, Nike-Zeus missile could not carry a warhead with sufficiently high yield and suffered from technical problems, while Thor missiles required considerable preparation times.[2] A significantly more sophisticated and capable US ASAT was developed between 1977 and 1987. The ASM-135 was an air-launched kinetic kill missile carried by F-15. The system was tested five times (mostly successfully) and the plans were to deploy 20 dedicated aircrafts (two squadrons) and 112 missiles, before the program was abandoned.[3] Another kinetic kill ASAT system development program followed in 1989, this time titled KE-ASAT. It survived its official termination by DoD in 1993, as a limited level of funding was maintained throughout the 1990s and well into the 2000s.[4] Nevertheless, how much of an effort was spent on development of a dedicated ASAT system in those two decades, especially separate from the BMD efforts (to a degree such an separation is possible), remains a mystery. In technical terms, the Ground-Based Midcourse Defense system (the number of deployed interceptors is to be

[1] Orbital altitude between 160 and 2000 km. Majority of satellites populate LEO orbits, although significant constellations (navigational, early warning) are located in higher orbits.

[2] CHUN, Clayton S. K. Shooting down a 'Star'. *Airforce University Cadre Paper* [online]. 2000 [cit. 2014-10-15]. Available from: http://fas.org/spp/military/program/asat/ADA377346.pdf; CHUN, Clayton K. S. *Defending Space.* New York: Osprey Publishing, 2006, pp. 32-33

[3] KOPLOW, David A. *Death by Moderation.* Cambridge: Cambridge University Press, 2010, p. 163. ENCYCLOPEDIA ASTRONAUTICA. ASAT. *Encyclopedia Astronautica* [online]. [cit. 2014-10-13]. Available from: http://www.astronautix.com/lvs/asat.htm

[4] DAY, Dwayne A. Killer Birdie. In: *The Space Review* [online]. Mar 31 2008 [cit. 2014-10-15]. Available from: http://www.thespacereview.com/article/1093/1

increased from 26 to 40) does provide the US with an inherent, albeit limited ASAT capability.[5] Such a capability was demonstrated when the other US BMD system - the Aegis - shot down a malfunctioning satellite with a slightly modified SM-3 missile in 2008. After the system gets upgraded with a new generation of interceptors (SM-3 Block IIA/B) in near future, the US will possess additional flexible ship-based ASAT capability threatening most satellites in LEO.[6]

The main **Soviet** efforts in the antisatellite field focused on the IS (Istrebitel Sputnikov) ASAT system and its successors. Developed during the 1960s, it was declared operational in 1973, and upgraded into IS-M in 1976. Its latest iteration designated IS-MU was declared operational in 1991, and although it was reportedly withdrawn from service in 1993. The IS family of ASATs were co-orbital systems which achieved the interception by means of a conventional explosive. The systems were tested extensively and reportedly reached higher degree of flexibility than the early US systems. Naturally, the orbital trajectories they could reach were still limited.[7] Development of a follow up Naryad system capable of intercepting satellites in GEO was tested in the early 1990s. It is unclear whether the work on Naryad continued in secret, or if some residual capability lingers was it truly abandoned.[8] Russian Federation might have revived two other ASAT programs from the 1980s according to recent reports - Kontakt, an air-launched ASAT carried by MiG-31 broadly similar to the US ASM-135, and A-60, the Soviet version of the Airborne Laser.[9]

There is less information in public domain on the **Chinese** ASAT programs. In January 2007 China conducted the infamous test of a direct-ascent kinetic kill ASAT based on modified DF-21 missile. The system was again tested in January 2010 and January 2013. In May 2013 China conducted unusual missile launch that could have been part of another ASAT test. China has been also developing directed energy ASATs - it has repeatedly targeted US satellites with its ground-based laser.[10]

India has not conducted a dedicated ASAT test yet. It probably does have the residual ASAT capability due to advanced ballistic missile and ABM programs. The option of pursuing a dedicated ASAT program has been recently under policy discussion in New Delhi.[11]

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[5] GUBRUD, Mark A. Chinese and US Kinetic Energy Space Weapons and Arms Control. *Asian Perspectives*. 2011, vol. 35, no. 4, pp. 624-625

[6] Ibid. 624

[7] MOWTHORPE, Matthew. *The Militarization and Weaponization of Space*. Lanham: Lexington Books, 2004, pp. 117-124; RUSSIANSPACEWEB. IS Anti-Satellite System. *Russianspaceweb* [online]. [cit. 2014-10-13]. Available from: http://www.russianspaceweb.com/is.html; ENCYCLOPEDIA ASTRONAUTICA. IS-A. *Encyclopedia Astronautica* [online]. [cit. 2014-10-13]. Available from: http://www.astronautix.com/craft/isa.htm

[8] B - RUSSIANSPACEWEB. The Naryad Program. *Russianspaceweb* [online]. [cit. 2014-10-13]. Available from: http://www.russianspaceweb.com/naryad.html; RUSSIAN STRATEGIC NUCLEAR FORCES. Is China repeating the old Soviet and U.S. mistakes? In: *Blogger* [online]. 2007-01-19 [cit. 2014-10-13]. Available from: http://russianforces.org/blog/2007/01/is_china_repeating_the_old_sov.shtml; SIDDIQI, Asif A. Soviet Space Power during the Cold War. In: GILLESPIE, P. G. and G. T. WELLER, eds. *Harnessing the Heavens*. Chicago: Imprint Publications, 2008, p. 145.

[9] RUSSIAN STRATEGIC NUCLEAR FORCES. Another old anti-satellite system resurfaces. In: *Blogger* [online]. 2013-01-25 [cit. 2014-10-13]. Available from: http://russianforces.org/blog/2013/01/another_old_anti-satellite_sys.shtml; RUSSIAN STRATEGIC NUCLEAR FORCES. Russia to resume work on airborne laser ASAT. In: *Blogger* [online]. 2012-11-13 [cit. 2014-10-13]. Available from: http://russianforces.org/blog/2012/11/russia_to_resume_work_on_airbo.shtml

[10] EASTON, Ian. The Great Game in Space. [online]. 2009 [cit. 2014-10-15]. Available from: http://project2049.net/documents/china_asat_weapons_the_great_game_in_space.pdf

[11] JOHN, Arvind K. India and the ASAT Weapon. *ORF Issue Brief* [online]. 2012 [cit. 2014-10-15]. Available from: http://goo.gl/jvIiLz

STRATEGIC ROLES FOR THE ASAT

Defensive measure against adversary's space-based nuclear weapons

The most basic theoretical purpose of an ASAT in nuclear strategy is to counter the potential threat of enemy's nuclear weapons deployed on orbital platforms. The need to counter this threat was a strong incentive for the US to develop and eventually deploy the first actual operational ASAT. Historically, space-based nuclear weapons went out of vogue relatively quickly in the 1960s both in theory and practice, and were eventually banned by the Outer Space Treaty (OST). The Soviet Fractional Orbital Bombardment System (in service between 1968 and 1983) remained, due to its unusual characteristics, closest to an actual space-based nuclear weapon and the only system of its kind ever deployed by any state. However, its characteristics would considerably stretch the very definition of a space-based nuclear weapon system, making its classification as one highly disputable.

Legal aspects notwithstanding, basing nuclear weapons in space may, at least in theory, hold certain strategic advantages, including a potential for a fast strike, possibly with an advantageous flight geometry vis-a-vis the adversary's early warning and defensive capabilities, as compared to the land-based systems. But in order to fully utilize such comparative advantage, taking into account orbital mechanics and general physics, a state would have to base its nuclear weapons in LEO and maintain relatively dense constellation of orbiting weapon platforms. Enormous expense needed for such an endeavor offsets any theoretical comparative advantage over the traditional basing options. The constellation would be not only extremely costly, but also highly vulnerable to an ASAT attack intended to physically destroy it or to disrupt the constellation's command and control. It is therefore not surprising that, at least as far as open sources reporting goes, there is no indication of any of the current nuclear-weapon states planning to deploy nuclear weapons to orbit. As the underlying strategic logic of nuclear weapons-free orbit remained unchanged after the end of the Cold War and would remain so in the foreseeable future, the relevance of this particular strategic role of ASATs as a proliferation driver has remained and would remain largely nonexistent.

Nuclear first strike force multiplier

The central role of an ASAT in a nuclear exchange, as it was envisaged by the Cold War strategists, is to enhance destructiveness of the state's first strike. ASATs fulfill the role by neutralizing the adversary's early warning satellites, delaying the detection of the incoming strike, and therefore shortening the time available for taking counter-measures and time for the retaliatory second strike. A strategic environment featuring robust deployments of ASATs and a low threshold for their use has been considered particularly unstable, as the degradation of a second strike capability is naturally incompatible with the functioning mutually assured destruction.[12] Indeed, the assumed destabilizing effects of a credible threat against the adversary's early warning satellites have been often regarded a major reason behind the limited US deployment of ASATs during most of the Cold War era. The US actions in the military space domain were guided by the so-called space sanctuary doctrine, which emphasized restraint in order to protect the fleet of vulnerable orbital assets, ultimately strengthening the general logic of the MAD.

The US and the Russian Federation have been the only operators of early warning satellite constellations since the Cold War era. They might be joined by two additional states in the near future - France launched the Spirale early warning system demonstrator in 2009,[13] and the PRC has been lately deploying an experimental constellation that some analysts suspect of having an early warning

[12] STARES, Paul B. *Space and National Security*. Washington D.C.: The Brookings Institution, 1987, pp. 66-70, 138-140; MOWTHORPE, ref. 7, p. 110

[13] France accepts spirale early warning system demonstrator. In: *Defence Talk* [online]. May 20, 2009 [cit. 2014-10-13]. Available from: http://www.defencetalk.com/france-spirale-space-early-warning-system-19033/

capability.[14] In the past, also several non-nuclear-weapon states expressed interest in the early warning satellites - Japan as a part of its BMD system,[15] South Korea,[16] and Turkey[17]. The implementation of these countries' potential plans to develop such capability likely lies in a more distant future.

The early warning satellite constellations are usually composed of satellites deployed in GEO, which play the main role in fulfilling the early warning purpose, and additional, supporting, satellites deployed in HEO or LEO. The numbers of satellites in early warning constellations are generally low.[18] Although the early warning satellites in LEO and HEO are rather vulnerable to the technologically less demanding low-orbit ASATs, the key constellations' components based in GEO are protected to a large extent by their sheer distance from Earth.

The first strike enhancement would be a relevant ASAT proliferation driver for a state which had emphasized preventive or preemptive elements in its nuclear doctrine. Of the current nuclear-weapon-states' nuclear doctrines, the Pakistani one would be, as indicated by open sources, the most likely to adopt such elements. However, India has not so far indicated plans to develop an early warning constellation, as its utility would be considerably limited against Pakistani nuclear strike due to geographical proximity of the two countries.[19] Still, India might at some point develop early warning satellites in response to the evolving Chinese nuclear deterrrent. It remains doubtful that Pakistan would be sufficiently motivated to invest in a costly ASAT capability to counter Indian constellation in light of how small its contribution to the Indian defense vis-a-vis Pakistan would be.

The nature of Sino-Indian strategic nuclear balance, however, might carry a significant potential in terms of motivation for either of the two states to obtain a dedicated ASAT capability. Both the quantitatively limited arsenals of these states, as well as their relative geographic distance make early warning satellites a potentially relevant force-enhancement. It might be argued that if, or when, one of these countries deploy the capability, the other would be motivated to deploy the countermeasure.

It is doubtful that the alleged Chinese ASAT development program, part of which migh have been the high-orbit test noted in the introduction, would be pursued mainly to obtain a capability to threaten specifically the US (or Russian) early warning satellites. It seems significantly more probable that such a program would be driven either by a perceived need to counter the US missile defense capabilities and/or its conventional superiority (see below), by the above mentioned evolving Sino-Indian nuclear balance, or by a combination of all of these factors.

Countermeasure against adversary's anti-ballistic missile defense

The third role of an ASAT in a nuclear strategy is to counter adversary's anti-ballistic missile defense (ABM) capabilities by degrading its orbital components. In foreseeable future, these orbital components would be limited to sensors. In essence, ASAT in this role serves as a bolster to credibility

[14] China Seen Readying Space-Based Warning Sensor, In: *NTI* [online]. Jul 25 2013 [cit. 2014-10-15]. Available from: http://www.nti.org/gsn/article/china-seen-readying-space-based-warning-sensor/; China launches another secretive Shijian-11 mission. In: *NASA Spaceflight* [online]. Sep 28 2014 [cit. 2014]. Available from: http://www.nasaspaceflight.com/2014/09/china-launches-secretive-shijian-11-mission/

[15] HUGHES, Christopher W. Japan, Ballistic Missile Defence and Remilitarisation. *Space Policy*. 2013, vol. 29, no. 2, p. 132

[16] S. Korea pushes for deployment of military spy satellites. In: *Yonhap News* [online]. Feb 06, 2013 [cit. 2014-10-13]. Available from: http://english.yonhapnews.co.kr/national/2013/02/06/80/0301000000AEN20130206006000315F.HTML

[17] Turkey paves the way for large satellites plan. In: *Hurryiet Daily News Online* [online]. Jan 27, 2012 [cit. 2014-10-13]. Available from: http://www.hurriyetdailynews.com/turkey-paves-the-way-for-large-satellites-plan.aspx?pageID=238&nid=12376

[18] Both the US and Russian Federation have been modernizing their early warning constellations, progress has been slow, however.

[19] As Mian et al.demonstrate, an early warning satellite would "buy" India only an extra period of minute or two to respond to Pakistani attack, as compared to conventional ground-based radars. - MIAN, Zia, et al. Early Warning in South Asia - Constraints and Implications. *Science and Global Security*. 2003, vol. 10, no. 2-3, pp. 109-150.

of the nation's nuclear deterrent by denying the adversary's defensive measures. A nuclear-weapon-state that adopted a minimal or limited deterrence doctrine with the associated force structure might thus be driven to develop the ASAT, if the credibility of its weak deterrent was further threatened by a nuclear-armed adversary developing a strategic ABM system whose architecture included an orbital component. This calculation naturally depends on particularities of the specific nuclear balance between two hypothetical adversaries. Apart from the US, Russian Federation has possessed a limited degree of national-level ABM capability, while Israel, India, Japan, and the People's Republic of China are all in various stages of building such a capability.

The massive US and Russian nuclear arsenals are not, in theory, particularly vulnerable to limited ABM systems and it seems that both countries in question would barely require the residual (based on the previously deployed systems in the Russian case, or provided by the BMD in the US case) ASAT capability to retain credible deterrence postures against each other and against any other nuclear power, despite the vocal opposition that Moscow has been expressing for many years against the US missile defense projects. Nevertheless, it is possible that Russian strategists truly do perceive the development of the US BMD as threatening, which could ultimately result in a renewed ASAT proliferation drive. Such a motivation would be even more logical in the Chinese case - both as a counter to the US and potentially Japanese as well as Indian ABM capabilities (if the latter two countries truly develop and deploy orbital sensors).

Asymmetric counter to a technologically superior adversary

The combat support and force enhancement provided by orbital-based systems, including communication, reconnaissance, navigation, meteorological and geodetic satellites, became a critical part of the US (and to a lesser degree other NATO countries')[20] conventional combat operations during the First Gulf War, and their importance has been rising steadily since then.[21] Indeed, Mowthorpe considers the RMA to be "underpinned" by space-based systems.[22] Other seasoned analyst notes: "...[successful post-Cold War military campaigns]...*illustrate a new American way of War empowered by a space-enabled global reconnaissance, precision-strike complex*."[23] Naturally, the resultant ever-increasing dependence of the First world militaries on the space-based force enhancement also creates potential for a dangerous strategic weakness exploitable by cunning adversaries.[24]

States may thus be motivated to acquire ASATs as an asymmetric capability increasing their chances in conventional conflicts with the US, or any other nation highly reliant upon space-based assets. The severity of the weakness this dependence created is currently very much unclear. According to the "space Pearl Harbor" group of analysts and (mainly the US) government officials, the threat is a grave one. They emphasize the deepness of the dependency, inherent vulnerability of the space assets, and potentially crippling lack of redundancy of these capabilities. Although the vulnerability of satellites is a known fact, the overall effect the complete denial of space-based force enhancement would have on a modern fighting force is yet to be seen. So far, at least based on open source reporting, no modern forces were denied the space assets, except for a very limited and crude GPS jamming. Perhaps the basic technological and material requirements of an ASAT as well as the space-based force enhancement assets limit this scenario to a very narrow niche of conflict in terms of its actors - one must be at least advanced enough to have the ASAT capability, while the other must be advanced enough to have the orbital capacities to be reliant upon. The pool of available actors for such a conflict is simply small at present, but it will increase as the military satellites proliferate.

[20] MOWTHORPE, ref. 7, p. 172

[21] SHEEHAN, Michael. *The International Politics of Space.* New York: Routledge, 2007, pp. 91-108; HAYS, Peter L. Space and the military. In: COLETTA, Damon and Frances T. PILCH, eds. *Space and Defense Policy*. New York: Routledge, 2009, pp. 160-170; JOHNSON-FREESE, Joan. *Space as a Strategic Asset.* New York: Columbia University Press, 2007, pp. 90-91

[22] MOWTHORPE, ref. 7, p. 172

[23] HAYS, ref. 21, p. 150

[24] KOPLOW, ref. 2, pp. 156-157

The most frequently discussed scenario in this context is that of a US - China armed confrontation.[25] An ASAT capability is an important part of the Chinese conventional Anti-access / Area-denial (A2/AD) strategy, aiming "*to wedge an asymmetrical dagger in the heart of America's seemingly insurmountable military edge*".[26] In other words, ASATs would in this case play the role of conventional "equalizer". However, as Geoffrey Forden demonstrated in his wargame thought experiment in 2008, the best possible theoretical application (according to his opinion) of near-term Chinese ASAT capabilities would essentially cause only little more than a perfectly manageable nuisance to the massive US war-machine.[27] Forden's conclusion was contested by Weeden,[28] but only after the recourse to the potential use of nuclear-tipped ASAT, which somewhat weakens the latter's argument. Furthermore, Forden did not consider the Chinese use of directed energy ASATs. The US military establishment reflected the growing threat of the A2/AD in the new air-sea battle concept. One of the three main components of defeating the A2/AD strategy according to the air-sea battle doctrine is destruction of C4ISR.[29] In the context of fighting China this naturally also means suppression/destruction of the orbital assets. Particularly worrisome problem for the US planners has been the Chinese anti-ship ballistic missile, which requires reconnaissance satellite support systems in order to be a credible threat.[30] An important stage of a Sino-US conflict would be therefore fought in space.

Counter-value weapon

Another potential role for ASATs is the intentional destruction of an adversary's civilian orbital infrastructure either as a tool of compellence or punishment. A rising number of states operate satellites for commercial or scientific purposes. Although the space sector is not an economic "center of gravity" even for the United States, not to mention other countries,[31] in some cases orbital assets can indeed be of extraordinary material and symbolic value beyond the simple commercial one - India with its extensive use of satellites for a range of development-oriented missions is a good example.[32] The US, Russian and Chinese manned missions, in addition to the International Space Station, also fall within this sector. All these can serve as suitable targets for "terrorist" compellence or punishment strikes. After all, one of the few imaginable (state) terrorist acts that could surpass the symbolic power of the 9/11 attack would be the interception of the International Space Station. It seems, however, highly unlikely that a state actor would develop a dedicated ASAT system solely for these purposes, so the relevance of this role as a motivation for proliferation is not very credible. Nevertheless, the residual capability of a slightly modified (potentially nuclear-armed) MRBM,[33] would be the worrisome aspect in this case. The possibility of an apocalyptic EMP "cleansing" of the skies is also a potential scenario.

[25] See for example O'HANLON, Michael E. *Neither Star Wars Nor Sanctuary. Constraining the Military Uses of Space*. Washington D.C.: Brookings Institution Press, 2004, pp. 91-117; SAUNDERS, Phillip C. a Charles D. LUTES. China's ASAT Test: Motivations and Implications. *INSS Special Report* [online]. 2007 [cit. 2014-10-15]. Available from: http://goo.gl/E3dZrt

[26] Kazianis, Harry. America's Anti-Access Nightmare Coming True. In: *Real Clear Defense* [online]. 2013 [cit. 2014-10-15]. Available from: http://www.realcleardefense.com/articles/2013/05/21/americas_anti-access_nightmare_coming_true_106609.html

[27] FORDEN, Geoffrey. How China Loses the Coming Space War. In: *Wired* [online]. 2008 [cit. 2014-10-15]. Available from: http://www.wired.com/2008/01/inside-the-chin/

[28] WEEDEN, Brian. How China "Wins" a Space War. *China Security*. 2008, vol. 4, no. 1, pp. 137-150.

[29] DEPARTMENT OF DEFENSE. *Air-Sea Battle: Service Collaboration to Address Anti-Access & Area Denial Challenges*. 2013. Available from: http://www.defense.gov/pubs/ASB-ConceptImplementation-Summary-May-2013.pdf

[30] STOKES, Mark. China's Evolving Conventional Strategic Strike Capability. [online]. 2009 [cit. 2014-10-15]. Available from: http://project2049.net/documents/chinese_anti_ship_ballistic_missile_asbm.pdf

[31] HAYS, ref. 21, pp. 157-159

[32] SHEEHAN, ref. 21, pp. 142-151

[33] DEBLOIS, Bruce L., et al. Space Weapons. Crossing the U.S. Rubicon. *International Security*. 2004, vol. 29, no. 2, p. 60.

OTHER FACTORS DETERMINING ASAT PROLIFERATION

Legal constraints

The legal control of development or use of ASAT weapons is notably weak, although not completely non-existent. The Outer Space Treaty forbids the deployment of nuclear weapons to Earth orbit, celestial bodies, or other regions of space, while the relevant article of The Limited Test Ban Treaty prohibits parties from conducting any nuclear explosions in outer space - the use and deployment of nuclear-tipped ASATs in space is thus essentially prohibited.[34] While it is certainly a valuable achievement, it is not particularly relevant in curbing near-term future proliferation of ASATs. There have not been any openly known plans to further utilize this kind of ASAT by any country since the Cold War due to its well-known indiscriminate nature. Nevertheless, it is notable that China and Iran are not parties to the Limited Test Ban Treaty, and the latter has not ratified the LTBT.

Dean, commenting on numerous resolutions adopted by the UN General Assembly with overwhelming majorities, observes "*...existence of a norm against the weaponization of space* ...[and]... *widespread desire to expand existing multilateral agreements...*"[35] Attempts to bring about this expansion, however, have not been successful so far. Reasons for the striking lack of success include major differences between space capabilities (and therefore interests) of states, and the sensitive nature of already thoroughly militarized (even if not weaponized) space domain.[36] The issue that complicated the original US-USSR negotiations on the banning of ASATs in 1970s, that is the need for intrusive verification,[37] remains actual to this day, because the effective verification would probably still require on-ground inspections and elaborate space surveillance.[38] Meanwhile, the credibility of one of the main supporters of regulation - China - arguably suffered due to its contradictory ASAT testing in January 2007. The significant negative international response that followed the test supports the argument that the international norm does exist (and none of the follow-up Chinese test generated additional debris). Whether such a norm can further restrain proliferation of ASAT weapons is mainly a question of whether we see the international arena through a liberal or realist perspective. The legal framework currently in place, however, is definitely lacking.

Outer space environment degradation

The issue of ASAT weapons proliferation must be seen not only in the context of their utility in terms of the fulfillment of preset strategic roles and corresponding legal and/or technical limits, but also in the context of the degradation of the near outer space. ASAT weapons, even when used in a very limited manner, can quickly degrade space environment through the generation of orbital debris and also the destructive radiation effects.

The orbital space, especially in low Earth orbits, is polluted with massive amounts of particles varying in size, which have high kinetic energies due to their travelling at extreme orbital velocities, and, therefore, can damage or destroy a satellite despite their small size. Debris can remain in orbit for

[34] GRAHAM, Thomas. The law and the military use of outer space. In: *Safeguarding Space for All: Security and Peaceful Uses.* Geneva: UNIDIR, 2004, pp. 88-91

[35] DEAN, Jonathan. The current legal regime governing the use of outer space. In: *Safeguarding Space for All: Security and Peaceful Uses.* Geneva: UNIDIR, 2004, pp. 39-40

[36] SETSUKO, Aoki. A Proxy to Space Security Measures: Possibility of Soft Law Rules in International Space Law. In: LELE, A. a SINGH, G., eds. *Space Security and Global Cooperation*. New Delhi: Academic Foundation, 2009, p. 214

[37] MOLTZ, James Clays. *The Politics of Space Security. Strategic Restraint and the Pursuit of National Interest.* Stanford: Stanford University Press, 2008, p. 186.

[38] HAGEN, Regina and Jürgen S CHEFFRAN. Is a space weapons ban feasible? Thoughts on technology and verification of arms control in space. [online]. 2003 [cit. 2014-10-15]. Available from: http://www.peacepalacelibrary.nl/ebooks/files/UNIDIR_pdf-art1886.pdf

decades, depending on its altitude. Kinetic energy ASATs, co-orbital or direct-ascent, are one of the largest polluters, potentially increasing amount of the orbital debris by tens of percent.[39]

During the Cold War, ASAT tests conducted by the Soviet Union and the United States generated significant amounts of such debris, despite a low number of tests.[40] All the previous tests were overshadowed by the single most polluting event[41] in the history of spaceflight - the Chinese direct-ascent ASAT test in January 2007. Two years after the event, NASA estimated that the resultant debris accounted for 25% of the total amount present in low Earth orbit.[42] Subsequently, two US satellites had to evade this debris in 2008,[43] in addition two other satellites and possibly others the following year.[44] If such an increase in orbital debris was caused by a single event, it is easy to imagine how quickly (and for all practical purposes irreversibly) the orbital environment would deteriorate after a mere small skirmish involving less than ten satellites, not to mention a major conflict involving several tens of them, as in the above-mentioned Forden's scenario. Even though the use of a directed energy ASAT generally guarantees less orbital debris, its efficiency might be less than sufficient due to its limitations, and destruction of the target by assured kinetic means might be still preferable, especially during a high-intensity conflict.[45] Furthermore, even a satellite destroyed by directed energy is not completely debris-free (as it becomes an uncontrollable flying target for other debris).

Possible use of a nuclear-tipped ASAT (and any high-altitude nuclear explosion in general) could potentially disrupt satellites in the LEO both by direct X-ray emissions and by temporarily increasing the environmental hostility (due to "excited" radiation belts) of orbits for months, gradually damaging any passing satellites, regardless of the owner.[46]

The presented risk of ASAT use can, to some extent, induce restraint in terms of ASAT proliferation. This can be true because of two causal effects. Firstly, as the orbital space constitutes a global commons its intentional degradation inevitably generates negative diplomatic feedback, as has been demonstrated by the Chinese case, and also increases pressure to prevent its further abuse through legal means. Secondly, since even the limited use of kinetic ASAT systems leads to orbital environment degradation which in turn threatens attacker's own orbital systems, the action seems to be somewhat self-defeating. As Weeden puts it "*The concept of 'winning' in the* [ASAT warfare] *should be understood only in the most Pyrrhic sense*."[47] The second point, naturally, applies only to the nations that value present or planned orbital capacities, which was the case with both superpowers during the Cold War. Moltz considers the environmental factor and its reflection in political/military circles to be an important basis of the strategic restraint in deployment of ASATs that both superpowers displayed during the Cold War.[48]

Technical aspects

Numerous factors of a technical nature have had a profound impact on ASAT proliferation, both stimulatory and inhibitory, and their importance will inevitably remain significant in the future.

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[39] WRIGHT, David. Orbital debris produced by kinetic-energy anti-satellite weapons. In: UNIDIR, ed. *Celebrating the Space Age: 50 Years of Space Technology, 40 Years of the Outer Space Treaty.* Geneva: UNIDIR, 2007, pp. 155-164; LIOU, J.-C. and N. L. JOHNSON. Risks in Space from Orbiting Debris. *Science*. 2006, vol. 311, no. 5759, pp. 340-341

[40] PORTREE, David S. F. and Joseph P. Jr. LOFTUS. Orbital Debris: A Chronology. [online]. 1999 [cit. 2014-10-15]. Available from: http://ston.jsc.nasa.gov/collections/TRS/_techrep/TP-1999-208856.pdf

[41] *Orbital Debris Quarterly News* [online]. NASA [cit. 2014-10-15]. Available from: http://orbitaldebris.jsc.nasa.gov/newsletter/newsletter.html

[42] NASA, ref. 41

[43] U.S. satellites dodge Chinese missile debris. In: *The Washington Post* [online]. Jan 11, 2008 [cit. 2014-10-13]. Available from: http://www.washingtontimes.com/news/2008/jan/11/us-satellites-dodge-chinese-missile-debris/

[44] Ibid.

[45] WRIGHT, ref. 39, p. 158

[46] HAYS, ref. 21, pp. 178-180; O'HANLON, ref. 25, pp. 67-70

[47] WEEDEN, ref. 28, p. 145

[48] MOLTZ, ref. 37, pp. 42-66, quotation p. 62

The technology required to produce an ASAT system is, to a certain degree, dual-use, a fact which applies to all types of these systems. Especially missile defense systems (those capable of extra-atmospheric interception), but also ballistic missiles (capable of reaching certain ranges), common satellites, and even the Space Shuttle, are considered to have residual ASAT capabilities.[49] This has two main implications: on the one hand, a complete, credible, and verifiable regulation of an ASAT capability is extremely unlikely (or impossible), which is one of the reasons its regulation is actually so weak,[50] enabling states to freely pursue its development, perhaps also because the "fog" of residual assets makes the exact status of other states' ASAT capabilities unclear; on the other hand, the availability of many residual systems can make the need to actually develop and deploy dedicated ASAT systems seem unnecessary.

Every state capable of sending a satellite into orbit can, with sufficient tracking technologies, deploy a crude co-orbital ASAT system similar to that tested by the Soviet Union during the Cold War. But as the Soviet experience demonstrated, co-orbital systems, in general, tend to be slow and inflexible due to inability to attack systems in full range of orbit inclinations,[51] thus limiting the attractiveness of these systems to contemporary potential proliferators.

A direct-ascent kinetic kill ASAT tends to create orbital debris, unless attacking a satellite in very low orbit, providing a capability attractive only for last-resort strikes, as has been mentioned above. In addition, its potential to attack targets in higher orbits in a timely manner is low.[52]

Technology of ground-based directed energy ASATs has not matured enough to make these systems efficient.[53] The current level of directed energy technology would likely constrain their use to dazzling (blinding) attacks against targets in the LEO. Although useful, strategic utility of such capability is limited. The positioning of such ASAT assets in space is even more technologically challenging and would expose them to attacks from much cheaper ground-based ASATs.

The emerging prospect of cyberwarfare methods applied against satellites may be perhaps regarded as another factor inhibiting the proliferation of non-cybernetic, "traditional", ASATs. The cyber-attacks against satellites do have several significant advantages over the conventional methods. They are difficult to attribute to a particular actor and enable countries with less developed aerospace sector to target the satellites. Cyberwarfare allows for a more controlled, nuanced, approach in attacking satellites when compared to the binary nature of the conventional methods (operational-destroyed), although some directed energy ASATs have such potential as well. Finally, cyber-attacks against satellites carry less risk of generating space debris. These advantages may potentially make cyberwarfare a preferred method of states' anti-satellite activities, decreasing the attractiveness of the older methods. Nevertheless, it is hard to estimate the balance between the attack and defense in cyberwarfare at any one point. Therefore, states may still wish to seek conventional ASATs as more reliable capability, or as a backup.

Future technologies, involving sufficiently matured ground-based directed energy systems and cheap, fast-deployable micro-satellites[54], can become significant capability enablers in the future, and, therefore, might stimulate ASAT proliferation.

[49] STARES, ref. 12, pp. 111-113

[50] Ibid.

[51] BULKELEY, Rip and Graham SPINARDI. *Space Weapons: Deterrence or Delusion?* New Jersey: Barnes and Noble Books, 1986, pp. 47-49; MOWTHORPE, ref. 7, p. 120

[52] WRIGHT, David, Laura GREGO and Lisbeth GRONLUND. *The Physics of Space Security: A Reference Manual* [online]. Cambridge: American Academy of Arts and Sciences, 2005 [cit. 2014-10-15], p. 135. Available from: http://www.amacad.org/publications/Physics_of_Space_Security.pdf

[53] O'HANLON, ref. 25, p. 72

[54] WEBB, Dave. Space weapons: dream, nightmare or reality. In: BORMANN, Natalie and Michael SHEEHAN, eds., *Securing Outer Space*. New York: Routledge, 2009, p. 37; WEEDEN, Brian. China's BX-1 microsatellite: a litmus test for space weaponization. In: *The Space Review* [online]. Oct 20 2008 [cit. 2014-10-15]. Available from: http://www.thespacereview.com/article/1235/1; O'Hanlon (2004), O'HANLON, ref. 25, pp. 85-89

CONCLUSION

The proliferation of dedicated ASATs will remain limited in the near future, especially in terms of their actual deployment. The residual capabilities of number of dual-use systems (as described above) will continue to provide established space powers with means for hedging - dedicated ASAT systems might be rapidly developed if and when needed. The strongest proliferation driver for dedicated ASATs in near future will be its potential utility as a counter against proliferating BMD capabilities. Demand might arise for an ASAT system in Islamabad and perhaps in Teheran as well, depending on the future expansion of Israeli military space architecture in the latter case. China will likely strengthen its ASAT capabilities both as a counter against the US and Japanese (perhaps also South Korean in more distant future) BMD, and also due to its utility as a tool of asymmetric degradation of an adversary's superior conventional space-enabled capability. Other states, for which such a role can be a sufficient driver, might obtain crude dedicated ASAT capabilities as well. The residual ASAT capacities will increase globally as the numbers of nations with access to space rise. In the near future, operational efficiency of all but the direct-ascent kinetic kill systems will remain low due to technical difficulties, generally lowering perceived attractiveness of ASAT proliferation. Permanent problem of space environment degradation magnified by the direct-ascent kinetic kill weapons will, however, make even those controversial, as a norm regarding this issue has emerged in the most basic and embryonic form. Future advances in "soft kill" ASAT technologies (predominantly directed energy based approaches) could increase the perceived attractiveness of ASAT proliferation.