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The limits of Chinese anti-satellite capabilities and the resilience of U.S. space power

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Executive Summary

The U.S. military exploits space capabilities better than any other nation, resulting in an asymmetric advantage to its armed forces on a global scale. Given this advantage, several analysts posit that China might find it prudent to directly attack U.S. satellites—executing a space "pearl harbor" that would cripple U.S. military capabilities for years. Without its eyes and ears in space to provide early warning and real-time intelligence, they argue, the U.S. would be in a painfully awkward situation should China put direct military pressure on Taiwan. However, the argument that U.S. armed forces are vulnerable to disruption from Chinese attacks rests on untested assumptions—primarily that China would find attacking U.S. military satellites both operationally feasible and ultimately desirable. This policy brief challenges those assumptions by critically examining the difficulties involved in executing a direct attack and the limited potential benefits such an action would yield for China. It then provides policy recommendations for the U.S. decision makers to pursue that would dissuade China from pursuing an anti-satellite capability.

Introduction

In May 2013, the Pentagon suggested that a high-altitude Chinese sub-orbital space launch—claimed to be a scientific mission by China—was in reality the first test of an anti-satellite (ASAT) interceptor that could reach all the way to geo-synchronous Earth orbit. Previously, on January 11, 2007, China had successfully launched an ASAT missile against one if its own low-Earth orbit (LEO) weather satellites. Do these launches establish Chinese dominance in space? Do they mean that the United States won't be able to use its satellites in a military engagement with China, say, in the Taiwan Straits? Not necessarily. This brief will show that all U.S. military satellites are not equally vulnerable to a potential Chinese ASAT attack.[1] In addition, it will argue that the benefits of such an attack would be limited and do not confer decisive military advantage. Finally, the brief will offer a combination of policy actions—including both unilateral U.S. military-technical innovations and bilateral cooperative measures—that could dissuade China from pursuing an ASAT capability and demonstrate U.S. resilience against ASAT attacks.

Limits of the possible

The wide range of orbital altitudes—from 1,000 kilometers to 36,000 kilometers—across which satellites operate limits China's ability to attack U.S. military satellites. U.S. intelligence, surveillance, and reconnaissance (ISR) satellites that operate at altitudes lower than 1,000 kilometers are theoretically the satellites most vulnerable to a Chinese ASAT attack by Intermediate Range Ballistic Missiles (IRBMs). The 2007 Chinese ASAT test demonstrated an intercept of this type, yet there is reason to doubt China's ability to conduct additional intercepts consistently. There is no publicly available data on the conditions under which the 2007 test occurred. How long was the target satellite tracked? Was it transmitting telemetry data that provided orbital location information? These conditions matter to both China's ability to target satellites and to others' ability to evade attack.

If the U.S. slightly changed the parameters of a satellite's orbit (for example, its inclination) China would likely be unable to track, target, and intercept the satellite. Unlike the United States, China has limited satellite tracking capabilities, most of which are based in its territory and, possibly, on a few ships.[2] Assuming China cannot pre-determine a point of intercept, it would be extremely difficult for China to successfully execute an ASAT operation without an extensive tracking capability due to the difference between the velocity of the target satellite and the ASAT missile. A satellite with an altitude of, say, 800 kilometers travels at approximately 7.5 kilometers per second. In the approximately three minutes during which an interceptor missile would be travelling to a satellite target, the satellite would travel a distance of 1,350 kilometers. To successfully intercept the satellite, the ASAT missile would have to travel up to the altitude

[1] This assertion is distinct from the possibility that China could disrupt/deny the effects generated by these satellites rather than the hardware itself. The Chinese military, in all probability, possesses the technology capability to use jammers and other electronic countermeasures along with active camouflage and deception techniques to passively (and temporarily) disrupt U.S. GPS, ISR and communication systems. Of course, the U.S. would respond to Chinese countermeasures with its own electronic counter countermeasures. The U.S., for example, operates the Counter Communications System that does this in the communications realm.

[2] China has attempted to establish a global optical satellite tracking network. In 2005, China formed the Asia-Pacific Space Cooperation Organization (APSCO) with Bangladesh, Indonesia, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey. APSCO countries agreed to develop a project, the Asia-Pacific Ground Based Optical Space Objects Observation System (APOSOS), as part of which member states would host Chinese-built observation sites. The project has not progressed beyond the planning stages, yet if such a system would be built China would have a far greater ability to track satellites.

of the satellite and, at the same time, compensate for the 1,350 kilometers that the satellite traverses using its lateral acceleration forces. The ASAT missile must accomplish this while starting from a standstill and flying at an average velocity of approximately 5.42 kilometers per second, much slower than a satellite in low-Earth orbit.

Unlike ISR satellites, U.S. GPS and military communication satellites are completely invulnerable to current Chinese missiles. Even China's most powerful missiles, its solid-fueled inter-continental ballistic missiles (ICBMs), would be unable to reach an altitude of 20,000 kilometers, where GPS satellites operate, or 36,000 kilometers, where U.S. military communications satellites operate in geostationary orbit. For instance, when launched straight up, a Chinese ICBM with a reduced payload of 500 kilograms would reach a maximum altitude of only 10,500 kilometers. Reducing the payload to 250 kilograms would increase the approximate maximum altitude to 15,000 kilometers.

In order to reach higher orbit satellites, China would have to build new, more powerful ICBMs. Even if China managed to develop such an ICBM, it would be expensive and time-consuming to build large numbers of them. Alternatively, China could use its liquid-fueled space launch vehicles to target satellites, but this option is problematic as well. Even if Chinese space launch vehicles could reach these higher orbits in time to intercept U.S. satellites, executing multiple launches of these vehicles, in quick succession is close to impossible due to infrastructure limitations. For example, the total number of annual Chinese space launches to orbits higher than LEO was nine in 2012, nine in 2011, eight in 2010, two in 2009 (with one failure), and four in 2008. In the last five years, the two quickest back-to-back launches to orbits higher than LEO occurred 15 days apart. To date, China has also only used one space launch facility, the Xichang space launch center with three launch pads, for higher than LEO launches.

Another limit on China's liquid-fueled vehicles is their vulnerability to attack. Unlike ICBMs which can be quickly fired, liquid-fueled space launch vehicles take time to fuel, and these preparations are visible. If the U.S. anticipates and observes preparations for an ASAT attack, it could destroy the launch vehicles during preparation.

Alternate platforms and redundancies

Even if China were capable of developing a viable ASAT capability, it is unclear what advantage China would gain by employing it. The presence of alternate platforms and built-in redundancies substantially limit the advantages that China could obtain from anti-satellite operations against the United States.

In the case of ISR satellites, the U.S. has an extensive array of airborne platforms (e.g., U-2, E-8C Joint Surveillance and Target Attack Radar System [JSTARS], RC-135 Rivet Joint, EP-3 [Aries II], E-3 Sentry, and E-2C Hawkeye) that could duplicate and likely outperform many missions that are also performed by satellites. In addition, unmanned aerial vehicles, such as the RQ-4 Global Hawk, MQ-1 Predator, MQ-SX, MQ-9 Reaper, MQ-1C Grey Eagle, MQ-5 Hunter, MQ-8 Firescout, and RQ-7 Shadow, also perform a range of reconnaissance, signal intelligence, communications relay, wide-area full-motion video surveillance, and jamming missions. All recent U.S. military operations have extensively employed these airborne ISR systems, and future U.S. military operations would assumedly do so, too.

These airborne platforms also have standoff capability and would likely be able to operate safely outside of China's inland air defense systems in a hypothetical conflict in the 180-kilometer-long Taiwan Straits. In such a conflict, why would China attack ISR satellites when airborne platforms probably pose a much greater threat and would be easier to attack?

In the case of GPS satellites, the redundancy of the U.S. constellation limits what China can achieve by attacking it. The GPS constellation consists of around 30 satellites in six orbital planes. This orbital arrangement guarantees that the navigation signals of at least four satellites can be received at any time all over the world. To meaningfully impact U.S. performance—for example, force U.S. ships to operate without access to accurate GPS navigation signals in the Taiwan Straits region—China would have to successfully attack and disable at least six GPS satellites. Even if six GPS satellites were destroyed in an elaborate ASAT operation, the degradation in navigation signals lasts only for 95 minutes. China would gain little from such a short period of GPS degradation. U.S. ships and aircraft have accurate inertial navigation systems that would still permit them to operate in the region. If the United States was temporarily unable to use GPS-guided bombs with normal accuracy, the U.S. could shift to laser-guided bombs. In fact, between Operations Enduring Freedom and Iraqi Freedom, the U.S. Defense Department decreased the use of GPS-guided bombs by about 13 percent and increased the use of laser-guided bombs by about 10 percent.

Finally, in the case of communication satellites, a Chinese ASAT operation would pose escalation control problems, as it would most severely affect communications between command authorities and forward-deployed battle groups. For instance, the Naval Telecommunications System (NTS), which supports the U.S. Navy in a conflict, is composed of three elements: (1) tactical communications among afloat units around a battle group, (2) long-haul communications between the shore-based forward Naval Communications Stations (NAVCOMSTAs) and forward-deployed afloat units, and (3) strategic communication connecting NAVCOMSTAs with National Command Authorities (NCA). "Line-of-sight" and "extended line-of-sight" radio systems are used for communication between close formations (25-30 kilometers) of ships and with picket ships and between formed groups (300-500 kilometers). Only the third element, strategic naval communications, is largely dependent on satellites.

Thus, if China were to target U.S. communication satellites it would most severely affect communications between NCAs and forward-deployed battle groups. This poses a unique problem, as China would likely prefer to disable communications *within* a forward-deployed battle group and to then negotiate to have that battle group withdrawn or stand down. By using ASATs, however, China could cut off a forward-deployed battle group from its NCA but not significantly disrupt the battle group's ability to execute its naval mission. While an ASAT attack might force a battle group to stand down, it could also lead a battle group commander to act rashly in the absence of direct guidance from the NCA, particularly if combat maneuvers have been initiated. It would not be in China's self-interest to trigger a situation with such escalatory potential.

Policy recommendations

The arguments presented above paint a more detailed and nuanced picture of American vulnerabilities in space and the potential for China to exploit them than is typically discussed publicly. U.S. armed forces do rely on satellites more than any other military in the world, but that does not make U.S. military satellites immediate, obvious, and easy targets. Convincing Chinese policy makers that this is the case might be the best way to dissuade their anti-satellite activities. U.S. policy makers can take a number of steps to do that. For example, they could:

- emphasize the presence of alternate systems that give a large measure of operational security to U.S. forces—enabling them to operate in an environment with degraded satellite services—and integrate such systems should more effectively into U.S. military operations;

- demonstrate U.S. ability to use technical measures, such as satellite sensor shielding and collision avoidance maneuvers, that would dilute an adversary's ASAT potential; and

- prioritize the development and deployment of monitoring systems that provide long warning times and possess the ability to definitively identify an attacker (e.g., the ground based Rapid Attack, Identification, Detection, and Reporting System [RAIDRS] used to identify, characterize and geo-locate attacks against U.S. satellites and the upcoming Geosynchronous Space Situational Awareness (SSA) that would provide a continuous monitoring of satellites).

While these military-technical solutions might provide some relief, it is also important for U.S. officials to acknowledge and address legitimate Chinese concerns about U.S. weapons programs, including missile defenses, in order dissuade Chinese ASAT development. China perceives an incongruence in the capabilities of U.S. forces and the People's Liberation Army, which has spurred a search for effective asymmetric capabilities. While it may not be politically possible to address all Chinese concerns about this incongruence, addressing some of them could help to build a more stable and cooperative regime in space.

A useful first step in that direction should consider integrating China more deeply into the global space community. To do this, U.S. policy makers could make available to Chinese officials U.S. data on satellite traffic and collisions that would help China streamline its space operations. Such a gesture would demonstrate good will, which could spur further cooperation. To date, the United States has been more forthcoming and willing to set up data-sharing arrangements with its traditional allies than with China. While there may be security reasons such as preventing the revelation of specific operational details of U.S. space tracking assets behind this preference, U.S. and global space operations have much to gain from engaging China in the peaceful development of space.

About the Author

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