



Recent US and Chinese Antisatellite Activities

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Recent antisatellite (ASAT) activities by the United States and China have revived questions regarding space warfare, the follow-on effects of potential satellite destruction on a massive scale, national accountability, and technological challenges to mitigate offensive threats. Many of these same questions, which emerged during the initial space race and Cold War, have taken on new emphasis in light of growing multinational dependence upon satellites and the freedom to access space. This article briefly reviews the history of US and Soviet ASAT capabilities and testing during the Cold War, examines the recent Chinese shoot-down of its failed Feng Yun-1C satellite and the US shoot-down of the failed USA-193 satellite, and compares and contrasts these two ASAT missions, highlighting the follow-on threats to other nations' satellites. It also presents mitigating strategies that may lessen the threat of future offensive countersatellite operations, including enhanced situational awareness, improved survivability/reduced vulnerability, and increased sustainability; it then offers a brief look at countries capable of offensive countersatellite operations.

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Military Antisatellite Programs during the Cold War

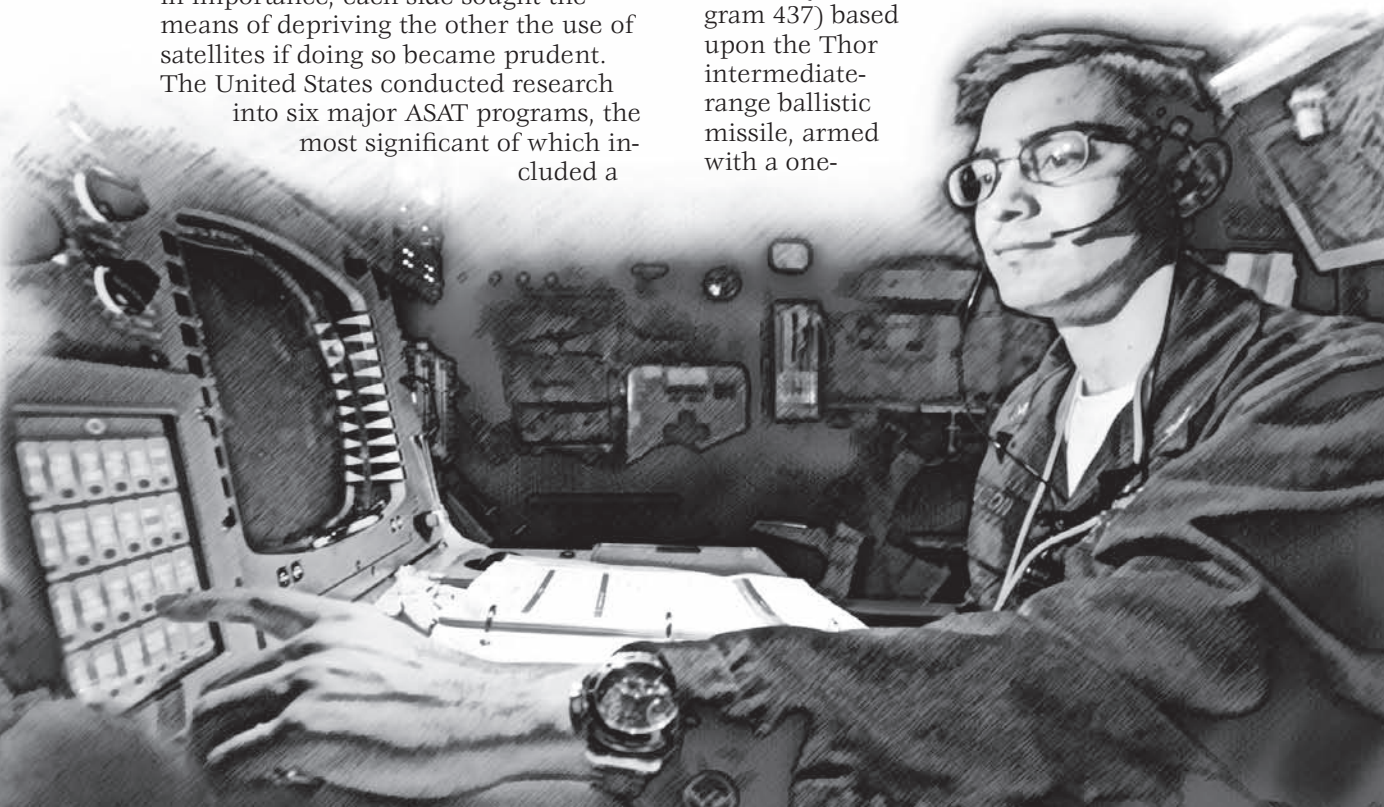
A military presence has accompanied human activity in space from its inception. Nevertheless, despite the intense rivalry between the United States and Soviet Union during the Cold War, space remained a weapons-free region and continues to do so. The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, often called the Outer Space Treaty, put into effect 10 October 1967, codified this concept by calling on the 91 signatories "to refrain from placing in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction or from installing such weapons on celestial bodies."¹ One possible intent of the treaty was to dissuade an arms race in space.

During the Cold War, as satellites grew in importance, each side sought the means of depriving the other the use of satellites if doing so became prudent. The United States conducted research

into six major ASAT programs, the most significant of which included a

satellite interceptor, later renamed satellite inspector; an aircraft-launched two-stage interceptor missile; a Navy sea-based interceptor missile; and an Army ground-based interceptor missile.² Many of the early systems relied on nuclear warheads or those with very high explosive yield due to the inherent inability to precisely target satellites moving at high relative speeds. Other means for attacking enemy satellites included kinetic kills; destruction of ground-based radar and command, control, and communications facilities; and jamming of communications links.

As the threat of Soviet intercontinental ballistic missiles began to grow, Secretary of Defense Robert McNamara approved the testing of an antiballistic missile system based on the Nike-Zeus rocket (known as Program 505) as an ASAT system limited to a maximum altitude of 200 miles.³ Following promising results, the Air Force solicited a more robust capability (known as Program 437) based upon the Thor intermediate-range ballistic missile, armed with a one-



megaton nuclear warhead and providing a range of 700 miles with a kill radius of five miles in orbit. Testing of Program 437 began in February 1964 and terminated on 1 April 1975.⁴

Launching from combat aircraft would offer a more flexible ASAT capability. Attempts to employ aircraftborne ASAT missiles began in the late 1950s, highlighted by the launch of a Bold Orion missile from a B-47 bomber. Pres. Gerald R. Ford's directive of 1975 allowed exploration of air-launched ASAT missiles, resulting in creation of an ASAT program that year which employed a modified standard antiradiation homing missile fired from an F-15 fighter. This system represented a significant improvement over earlier ones insofar as it employed a kinetic-kill minivehicle to directly impact the targeted satellite versus an area weapon such as nuclear or high-explosive warheads. On 13 September 1985, a "full-up" test resulted in the destruction of the P78-1 Solwind satellite, but in 1988 Congress canceled the program.⁵ Further US ASAT tests focused on denial of use rather than absolute destruction of enemy satellites, as in a 1997 test in which a laser temporarily blinded an Air Force MSTI-3 satellite at 300 miles altitude.⁶

The Chinese Antisatellite Program

China's military has undergone tremendous change over the last 15–20 years, accelerating the pace over the last 10 years in a quest to revolutionize its military forces by reducing personnel numbers and focusing on a massive modernization program that emphasizes quality over quantity. Current military theory in China is partially based on capitalizing on its own resources to mitigate the advantages of potential high-technology opponents. This thinking is evident in China's self-described "Assassin's Mace" programs, a war-fighting strategy of the People's Liberation Army designed to

give a technologically inferior military advantages over technologically superior adversaries and thus change the direction of a war.⁷

Although China has not published an official document on space warfare, it is incorporating space-based support systems into all aspects of its military operations. This tactic includes denying adversaries the use of their space-based systems through kinetic-kill capabilities, jamming, and blinding. China continues to build up its organic space-based systems, seeking to develop into a modern military power capable of force projection and high-intensity military operations.⁸ China pursues research into other nonkinetic weapons for use in satellite targeting, including high-powered lasers, microwaves, particle beams, and electromagnetic-pulse devices, all intended to render enemy satellites inoperable without the debris field associated with kinetic-killing weapons.⁹ Investment in such weapons technology fits China's asymmetric approach and desire to provide a credible threat. In *Joint Space War Campaigns*, Col Yuan Zelu loudly echoes this approach, declaring that the "goal of a space shock and awe strike is to deter the enemy, not to provoke the enemy into combat."¹⁰

On 11 January 2007, China became the third known country with a proven ASAT capability when it conducted an unannounced launch of a Deng Fong-21 / Kai Tuo Zhe-1 (DF-21/KT-1) against its own defunct Feng Yun-1C meteorology satellite.¹¹ This event confirmed intelligence estimates of Chinese ASAT developments. Given the secretive nature of the Chinese government, most of the details remain hidden from the public, with most of what is known based upon observation and established Chinese capabilities. (This article draws upon publicly available sources for its references to technical data and capabilities.)

The Chinese launched the Feng Yun-1C ("Feng Yun" is Chinese for "wind and cloud"), a polar-orbiting meteorological satellite, on 10 May 1999 from the Taiyuan

Launch Complex, located in Shanxi province. Since 1985 that complex has served as a launch point for polar-orbiting satellites, primarily of the Earth monitoring, science, and meteorological type.¹² Feng Yun-1C was in sun-synchronous orbit ranging between 845 and 865 kilometers above Earth, with an inclination of approximately 99 degrees.¹³ Comparable American satellites include the defense meteorological satellites and the National

The world will continue to feel the consequences of this action for decades. Specifically, the intercept produced a massive debris field estimated at 20,000 to 40,000 fragments, each of them one centimeter or greater in size.¹⁵ This single event resulted in a 20 percent increase in the number of trackable objects in low Earth orbit (LEO). Because the interception was coplanar, much of the debris field resides in close proximity to the

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Oceanic and Atmospheric Administration's polar-orbiting satellites.

A kinetic-kill vehicle launched by a modified DF-21 intermediate-range ballistic missile known as the KT-1 space-launch vehicle, in essence a modified DF-21, destroyed Feng Yun-1C.¹⁴ The exact technical characteristics and specific capabilities of the missile are not publicly known and are probably unique. Expert review of available information and testimony from civilian monitors and modelers indicate that the missile carried a kinetic-kill vehicle of approximately 600 kilograms.

A simplistic evaluation of the kinetic energy provides some insight into the level of effectiveness of the kill. Given the mass of the Feng Yun-1C at 880 kilograms, an estimated kinetic-kill-vehicle mass of 600 kilograms and closure speed of 32,400 kilometers per hour yield a maximum kinetic energy of approximately 40.9 gigajoules. To put this into perspective, one ton of standard TNT explosives yields approximately 4.184 gigajoules of kinetic energy. Thus, the combined kinetic energy of the satellite and interceptor amounts to approximately nine times the explosive yield of one ton of TNT.

original altitude of the Feng Yun-1C at the time of the interception; however, some fragments may be as high as 3,500 kilometers in orbit.¹⁶

These fragments pose a significant threat to satellites from many nations. A review of the database maintained by the Union of Concerned Scientists indicates well over 50 satellites in LEO near the altitude of the debris field from Feng Yun-1C. A further review reveals 16 satellites with an apogee/perigee within 825 to 900 kilometers and an inclination angle of 98 to 99 degrees (table 1).

The threat from the debris is not limited to any single satellite. With velocities in the range of eight kilometers per second, debris colliding with any of these 16 satellites could have a dramatic cascading effect, leading to uncontrollable and/or inoperable satellites threatening other satellites in nearby orbits and dramatically increasing the amount of hazardous debris in LEO, as recently occurred with the collision between Iridium and Russian military satellites. Additionally, the Union of Concerned Scientists' satellite database lists a number of satellites that pass through the debris field's altitude during their Molnyia (highly elliptical) orbits. Given the na-

Table 1. Threatened satellites

<i>Name of Satellite, Alternate Names</i>	<i>Country of Operator/ Owner</i>	<i>Users</i>	<i>Purpose</i>	<i>Perigee (km)</i>	<i>Apogee (km)</i>	<i>Inclination (degrees)</i>
IRS-P6	India	Gov't	Remote sensing	802	875	98.7
Met Op-A Met Op Sat	Multinational	Gov't/Civil	Earth Science / Meteorology	813	830	98.73
Cute-1 Cubical Titech Eng Sat, Oscar 55	Japan	Civil	Technology Development	819	831	98.7
Cubesat XI-IV Oscar 57	Japan	Civil	Technology Development	822	828	98.7
Spot 2	France/Belgium/Sweden	Comm	Earth Observation	824	825	98.7
Spot 4	France/Belgium/Sweden	Comm	Earth Observation	824	825	98.7
Feng Yun-3A (FY-3A)	China (PR)	Gov't	Earth Science	825	829	98.8
MOST	Canada	Civil	Astrophysics	831	855	98.7
DMSP 5D-3 F15, USA 147	USA	Military	Earth Science / Meteorology	837	851	98.9
DMSP 5D-2 F14, USA 131	USA	Military	Earth Science / Meteorology	842	855	98.9
DMSP 5D-3 F17, USA 191	USA	Military	Earth Science / Meteorology	842	855	98.79
DMSP 5D-3 F16, USA 172	USA	Military	Earth Science / Meteorology	843	852	98.9
DMSP 5D-2 F13, USA 109	USA	Military	Earth Science / Meteorology	845	855	98.8
NOAA-18 (NOAA-N, COSPAS-SARSAT)	USA	Gov't	Meteorology	847	866	98.7
NOAA-16 (NOAA-L)	USA	Gov't	Earth Science / Meteorology	848	863	98.7
Feng Yun-1D (FY-1D)	China (PR)	Gov't	Earth Science	851	871	98.8

Source: "UCS Satellite Database," Union of Concerned Scientists, 6 October 2008, http://www.ucsusa.org/nuclear_weapons_and_global_security/space_weapons/technical_issues/ucs-satellite-database.html.

ture of such orbits and the associated increase in speed while at perigee, these satellites would hit the debris at a higher speed, with catastrophic results. Under the Convention on International Liability for Damage Caused by Space Objects, China may be accountable if such an incident were to occur.¹⁷

China's ability to strike a relatively small satellite with a kinetic-kill vehicle at a significant altitude clearly demonstrates technological prowess. What could motivate such a dramatic action? Kenneth S. Blazejewski proposes several possible interpretations of Chinese space-weapons activity. First, it signals a strong concern regarding the United States' continuing development of a ballistic missile defense shield and that country's possible weaponization of space. He points to the leveraging effect that such a system could impose on Chinese missiles in the event of an attack on Taiwan. Blazejewski further states that

such an obvious ASAT test, in Chinese eyes, could lead to a negotiation to de-weaponize space. Alternatively, as James Oberg stipulates, destruction of the Feng Yun might encourage the US Congress to sign a treaty banning the use of ASAT weapons, which would clearly follow Chinese strategy of employing an asymmetric approach to negate a US advantage.¹⁸ Second, according to Blazejewski, China may perceive that the United States seeks to deny it the use of space and is therefore pursuing ASAT capabilities to meet that challenge. Third, he suggests that China simply seeks to establish parity with US and Russian ASAT capabilities.¹⁹

US Destruction of USA-193

In January 2008, the United States began public planning for a similar ASAT test that would target a failing National

Reconnaissance Office (NRO) satellite (USA-193). (See table 2 for a comparison of this satellite and the Feng Yun-1C.) Conducted under the auspices of the Missile Defense Agency, the test used readily available systems, modified in rapid fashion to provide a seaborne satellite-intercept capability. The more open nature of American society, the preannounced intentions of this ASAT test, and the media focus made a good bit of information available; however, many details remain classified.

bated about which agency within the department could best carry out the ASAT mission. The Missile Defense Agency's expertise and previous experience made it the logical choice. That agency's senior leadership concluded that the test community within the organization had the disciplined approach necessary to conduct such an operation.²¹ Because the primary aiming point was the main hydrazine tank, which weighed 450 kilograms, targeting of USA-193 would center on that portion of the satellite.²²

Table 2. Satellite comparison

<i>Satellite Characteristics</i>	<i>United States USA-193</i>	<i>China Feng Yun-1C</i>
Satellite Type	Reconnaissance	Meteorological
Satellite Mass	2,450 kg	880 kg
Satellite Apoapsis	257 km	865 km
Satellite Periapsis	242 km	845 km
Satellite Inclination	58.48 degrees	98.8 degrees

Source: "FY-1," *Encyclopedia Astronautica*, <http://www.astronautix.com/craft/fy1.htm> (accessed 11 November 2008); and David A. Fulghum and Amy Butler, "U.S. to Shoot Down Satellite," *Aviation Week*, 17 February 2008, http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=awst&id=news/aw021808p2.xml&headline=U.S.%20To%20Shoot%20Down%20Satellite (accessed 30 October 2008).

The Air Force launched NRO satellite USA-193 on 14 December 2008 from Vandenberg AFB, California. The 21st in the NRO series and most likely carrying very-high-resolution photo-imaging systems, the satellite failed after one day in a deteriorating polar orbit ranging between 257 and 242 kilometers. Because the satellite retained a significant amount of hydrazine fuel—a highly reactive and toxic chemical, exposure to which can be extremely hazardous—that could possibly survive reentry, the US government announced that it would shoot down the 2,450-kilogram USA-193, destroying the hydrazine fuel tank in the process, before it could plummet to Earth and possibly cause fatalities.²⁰

After finalizing the decision to conduct the shoot-down, senior leadership within the Department of Defense de-

The intercept would employ a modified Standard Missile-3 (SM-3) fired from the Aegis-system-equipped USS *Lake Erie*, one of three such cruisers in the US Navy that carry the SM-3 and part of the sea-based Aegis ballistic missile defense system.²³ These warships are designed to provide midcourse-intercept capabilities against short- and intermediate-range ballistic missiles.²⁴

The SM-3's kinetic warhead, which uses a high-resolution long-wave-infrared sensor for target detection, is vectored into intercept by the Solid Divert and Attitude Control System.²⁵ The warhead incorporates advances from earlier designs, including a large-aperture field of view that enables target acquisition at 300 kilometers. Additionally, data-stream encryption ensures secure communica-

tions and telemetry supporting confirmation of missile performance.²⁶

For the shoot-down of USA-193, modifications to the USS *Lake Erie*'s systems included the AN/SPY-1 radar system and SM-3 missiles, the former tasked to report the satellite as engageable, identify it as a valid target, determine intercept points, and provide revised aiming-point information.²⁷ In an effort to maximize successful target engagement, the Missile Defense Agency's team augmented Aegis tracking by integrating data from the US space-surveillance network, in-

shot when the sun angle would maximize optical tracking. The shoot-down of USA-193, which included each military service, offered a good indication of the level of jointness within the Department of Defense.²⁹

Comparisons

Both the American and Chinese ASAT missions relied upon kinetic-kill vehicles. The absence of either a conventional or nuclear warhead reflects the significantly improved accuracy and precision of to-

Tremendous political pressure sought to ensure that the mission went as projected during planning for the shoot-down . . . minimizing the debris field.

cluding X-band radars and other Aegis radar systems. Tracking data from these sources enhanced situational awareness, provided precision data, and created a real-time, accurate track-enabling computation of a firing solution.²⁸

Tremendous political pressure sought to ensure that the mission went as projected during planning for the shoot-down, a significant portion of that pressure focusing on minimizing the debris field since the US intercept would yield a kinetic energy greater than that for the Chinese intercept. (The mass of USA-193, estimated as 2,450 kilograms, combined with a closure speed of intercept of 28,000 kilometers per hour yields a maximum estimated kinetic energy of 74.2 gigajoules—approximately 17 times greater than the explosive yield of one ton of TNT.) Meaningful debate within the team emphasized limiting any possible secondary effects following a successful intercept (e.g., an errant, dysfunctional satellite or an underforecasted debris field). Therefore, the team included a plan to mitigate these factors by taking such actions as conducting the

day's systems compared to those proposed in the early part of the Cold War. The use of a kinetic kill mitigates the danger of damage to friendly satellites caused by electromagnetic pulse—a crucial difference, given the fact that we have many more satellites today than we did 30 years ago. Other similarities between the ASAT tests include the use of solid-fueled boosters and mobile launch platforms. (Although capable of mobile launch, the Chinese mission probably launched from a fixed position.)

Several notable differences distinguished the ASAT missions as well—for example, the altitudes of the satellites. Only a few days away from reentry into the atmosphere and potential impact with the surface, USA-193 orbited at a relatively low 247 kilometers at the time of its destruction, whereas Feng Yun-1C orbited at the significantly higher altitude of 864 kilometers. This 617-kilometer difference is important because of the time that the residual debris field will remain in orbit, posing a threat to other satellites. According to Geoffrey Forden, even residual segments from the USA-193 in-

tercept that acquired a greater speed due to the collision will have an orbital perigee of 210 kilometers and should degrade in altitude, burning up in reentry far more rapidly than the remnants of Feng Yun-1C.³⁰ Estimates for the debris from USA-193 indicate no remaining pieces in orbit after 40 days; meanwhile, modeling suggests that debris from Feng Yun may stay in orbit for up to 100 years.³¹

In an interview prior to the USA-193 shoot-down, Gen James Cartwright (USMC), vice-chairman of the Joint Chiefs of Staff, avowed that the US test launch differed from the Chinese launch, pointing out that the United States was providing the world advance notification of its launch and that the US intercept would occur at a very low orbital altitude to assure that no residual debris remained in long-term orbit.³² This difference in altitude also drove the size of the launch vehicle. Given the estimated six times greater mass of the Chinese kinetic-kill vehicle and the higher altitude, the DF-21/KT-1 had a launch mass 20 times

greater than that of the SM-3. Furthermore, the US missile relied upon the global positioning system (GPS) and inertial navigation system with radar guidance, whereas the DF-21/KT-1 employed an inertial navigation system with terminal radar guidance (table 3).

Mitigating the Antisatellite Threat

During a speech at the 2007 Air Warfare Symposium, Secretary of the Air Force Michael Wynne stated that “space is no longer a sanctuary.”³³ These remarks underscored the fact that China had demonstrated its ability to strike US satellites and that several other countries possessed or were seeking similar capabilities. In light of the potential threat posed by ASAT systems, how can the United States mitigate or reduce it? In his paper *Does the United States Need Space-Based Weapons?* Maj William L. Spacy gives some indication of how such

Table 3. Comparison of missile-intercept systems

	<i>United States SM-3</i>	<i>Chinese Deng Fong-21</i>
Length	6.55 m	10.7 m
Diameter	0.34 m	1.4 m
Launch mass	708 kg	14,700 kg
Estimated kinetic vehicle mass	102 kg	600 kg
Configuration	Three-stage solid propellant	Two-stage solid propellant
Guidance	GPS/INS and radar guidance	Inertial plus terminal radar guidance
Interceptor / Target Closing Speed	28,000 km*hr ⁻¹	32,400 km*hr ⁻¹
Interceptor Launch (Ground/Sea)	Shipborne	Ground based
Interceptor Launch Point (estimated)	163.3 degrees West, 23.5 degrees North	102.0 degrees East, 28.2 degrees North
Interceptor Launch Facility	USS <i>Lake Erie</i>	Xichang Space Center
Interceptor Type	Modified Standard Missile-3	Modified Dong Feng-21 / KT-1 Space-Lift Vehicle
Estimated Debris Pieces in Orbit	None after 40 days	2,200 (for 20–100 years)
Intercept Altitude	247 km	864 km

Source: Geoff Forden, “A Preliminary Analysis of the Chinese ASAT Test,” 9, <http://web.mit.edu/stgs/pdfs/A%20Preliminary%20Analysis%20of%20the%20Chinese%20ASAT%20Test%20handout.pdf> (accessed 1 November 2008); and Geoffrey Forden, “A Preliminary Analysis of the USA-193 Shoot-Down,” 12 March 2008, http://mit.edu/stgs/pdfs/Forden_Preliminary_analysis_USA_193_Shoot_down.pdf (accessed 14 November 2008).

counter-ASAT systems might work, highlighting three potential methods: bodyguard satellites, ground-based directed-energy weapons, and space-based anti-ASAT missiles.³⁴

Assigned to high-value satellites, bodyguard satellites would place themselves between the protected satellite and the attacking weapon system, thus performing much the same service for other satellites as fighter escorts did for bombers in World War II (i.e., providing both active and passive defense).³⁵ Bodyguard satellites would need some autonomy in order to discern when an attack is imminent and take protective measures to maneuver into the correct position. Ground-based directed-energy weapons could

maneuver capacity coupled with sensors capable of detecting approaching hostile bodies will enable critical satellites to evade attacking bodies or debris fields; therefore, designs for such satellites should include robust and sustainable thrust capability.

Moreover, building such satellites with separate, redundant systems would increase their ability to function after attack. A similar and potentially more resilient approach involves the use of clustered satellite constellations, which could be widely dispersed or could orbit in close proximity.

The Defense Advanced Research Projects Agency recently proposed designing and fielding satellites that are serviceable

Methods for improving satellites' chances of surviving both natural and man-made hazards include the ability to track threats, add redundancy, and develop serviceable systems.

intercept attacking direct-ascent, kinetic-energy weapons/missiles, rendering them ineffective prior to their reaching friendly satellites. Due to their fixed position on the planet, these counter-ASAT weapons would have an inherently limited line-of-sight striking range. However, by possessing nearly instantaneous striking capability, they would prove very timely if called upon. Lastly, space-based anti-ASAT platforms or kinetic-kill systems, more technologically feasible than surface-based directed-energy weapons, would intercept an attacking ASAT system and destroy it prior to its reaching the targeted satellite.

Methods for improving satellites' chances of surviving both natural and man-made hazards include the ability to track threats, add redundancy, and develop serviceable systems.³⁶ Enhancing the United States' ability to track satellites and significant debris represents the first step in avoiding dangers. Extended

while in orbit. In March 2007, the agency launched Orbital Express—an advanced technology demonstration system consisting of the Autonomous Space Transport Robotic Operations (ASTRO) prototype servicing satellite and the NextSat, a serviceable next-generation satellite designed to serve as a surrogate to ASTRO. Equipped with a robotic arm, ASTRO is designed to evaluate the feasibility of autonomously refueling satellites and robotically changing their components in orbit.³⁷ Successful testing of Orbital Express will decrease current service-life restrictions on satellites based on fuel availability. In addition, the ability to replace components will enable a return to service for satellites damaged by hostile action.

Other means of protecting satellites include enhanced situational awareness, employment of stealth/radar-absorbing technologies, and better design techniques.³⁸ Differentiating between man-

made and natural threats, such as purposeful directed-energy attacks and secondary effects from solar storms, is crucial in ascertaining whether an actual attack is in progress. Additionally, if a hostile force attacks a satellite, determining the source of the attack and taking evasive action or counterattacking are time critical. Multiple satellites working in concert to determine the source and nature of any satellite attack will provide operators the level of enhanced awareness to enable decision makers to act quickly and appropriately in response to threats.³⁹

Given the costs of launching satellites into orbit, present satellite design has focused on squeezing the most utility out of each kilogram, and very little thought has gone into applying stealth technologies to satellites. Exploiting current radar-absorbing technology by incorporating such materials onto sensitive satellites could produce a successful passive defense. Research into active “cloaking” technologies shows promise in hiding satellites—enabling them to better blend into their background. Integration of these technologies into smaller satellites would decrease their vulnerability by making them harder to detect and strike.

Yet another means of increasing the survivability of satellites involves using appropriate geometry in design efforts—applying the proper shaping to diminish exposed satellite surfaces. Reducing the effective head-on surface area would lessen the probability of penetration; moreover, it would serve as a deflecting mechanism, similar to techniques used in the design of main battle tanks.

Any nation with the space-lift capability to place the necessary payload into LEO could theoretically field a rudimentary ASAT program based upon high-explosive warheads or small nuclear warheads. The dual use of civilian and military rockets being developed and placed into operation by several countries (e.g., Israel, Iran, North Korea, and India) opens the door to rapid growth in

the number of potential players in the weaponization of space.

Primary among the Asian countries is China, a proven player in the ASAT arena. China's growing manned space program—witness its recent success with the *Shenzhou* spacecraft—reflects its confidence and technological capabilities.⁴⁰ The pursuit of Chinese unmanned lunar missions, constellations of communications satellites, and plans for a navigational satellite constellation offer further evidence of a developing command and control capability. This series of successes and technological advances fires a sense of national pride and a desire to assert a Chinese presence in space. As China's dependence on satellites grows, so will its vulnerability, forcing senior leaders to pursue a more robust ASAT capability or abandon such efforts entirely. The latter seems unlikely since China considers space one of its five warfare domains.⁴¹

Second to China in Asian space capability is Japan. Though not a nuclear-armed country, Japan has a demonstrated ability to launch satellites and the technological means to field a viable interceptor. In 2007 that country also launched *Kaguya*, its first lunar probe, using its self-produced H-2A rocket, which has lifted payloads weighing over four tons and has placed satellites into orbits well beyond LEO.⁴²

In addition, Japan is a primary partner in the development of the SM-3/Aegis system. It has cooperated recently with the US Missile Defense Agency to design and test the advanced nose cone for the antiballistic missile. The Japanese Defense Force has fielded the SM-3 on its *Kongo*-class warships and has purchased Patriot Advanced Capability-3 antiballistic missiles for stationing on the home islands.⁴³ Clearly, Japan has the technical expertise and operational experience to quickly implement an ASAT system.

India, another country with a growing organic space-launch capability, so far has launched 10 satellites with its Polar

Satellite Launch Vehicle and seeks to produce its Geosynchronous Satellite Launch Vehicle by 2012. This will give India the capacity to place 3.5-ton payloads into geosynchronous orbit.⁴⁴ India also possesses nuclear-capable ballistic missiles, giving it a de facto ASAT capability. Considering India's rivalry with China and the latter's growing use of satellites, ASAT capabilities may suit Indian strategy. Other Asian countries pursuing space-lift capabilities include, primarily, South Korea, as well as Vietnam, Malaysia, Singapore, and Taiwan.⁴⁵

Conclusion

The Cold War saw the development, testing, and fielding of rudimentary ASAT capabilities, leading to the cementing of a space policy in treaties and agreements that forbade weapons of

mass destruction. With its growing economic power and force modernization (including doctrinal changes), China has sought to leverage asymmetrical means of military power projection, including depriving technology-dependent military forces the use of satellites. China clearly demonstrated this asymmetrical capability when it shot down the Feng Yun-1C satellite. Is it possible that the recent Chinese and American ASAT missions mark the beginning of a second space race, this time with a more sinister and destructive component? As more nations join the ranks of the ASAT-capable countries, survivability must be designed into those satellites critical to national security. Designing and building satellites for the future can be accomplished only through a robust test and development program, with emphasis on reducing vulnerability. ☆

Notes

1. United Nations Office for Outer Space Affairs, Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 10 October 1967, <http://www.unoosa.org/oosa/SpaceLaw/outerspt.html> (accessed 24 March 2009).

2. Michael R. Mantz, *The New Sword: A Theory of Space Combat Power*, research report no. AU-ARI-94-6 (Maxwell AFB, AL: Air University Press, May 1995), 99.

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4. *Ibid.*, 61–65.

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