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# Dangerous Space Incidents

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## *INTRODUCTION*

As space systems increasingly perform and support critical operations, a variety of plausible near-term incidents in outer space could precipitate or exacerbate an international crisis. The most grave space contingencies—viewed from the perspective of U.S. interests and international stability—are likely to result from either intentional interference with space systems or the inadvertent effects of irresponsible state behavior in outer space. The threats to U.S. space assets are significant and growing, as potential adversaries continue to pursue and could soon acquire counterspace capabilities. The United States has strategic interests in preventing and mitigating dangerous space incidents, given its high reliance on satellites for a variety of national security missions and unparalleled global security commitments and responsibilities. Like other technology-driven global governance challenges, the longer the United States delays preventive and mitigating efforts, the less dominant its position will be in shaping rules of the road for space.

## *THE CONTINGENCIES*

Based on capabilities, intent, and history of malicious or destabilizing behavior, the state most likely to undertake destabilizing actions is China, followed by North Korea, and Iran. Although Russia has robust counterspace capabilities, it has not recently demonstrated intent to direct malicious and destabilizing actions toward U.S. space assets. Increasingly prevalent types of interference include jamming, hacking, spoofing, and lazing of space- and terrestrial-based sensors, transmitters, and data links. Additionally, interference can entail direct ascent or "co-orbit" anti-satellite tests (ASAT), and intentional or unintentional collisions that create a long-term problem of orbital space debris. An outlier scenario not covered in this report is one that U.S. officials consider unrealistic: an electromagnetic pulse event in space. The three most plausible scenarios that warrant concern are crisis-related interference, intentional peacetime interference, and inadvertent peacetime interference.

### Crisis-Related Interference

China, North Korea, and Iran could conceivably be involved in dangerous space activities—such as a "direct ascent," or vertical launch, ASAT test from a ground-based missile system—during a crisis with the United States or one of its allies to gain bargaining leverage, to deter potential hostile acts, or for defensive reasons in anticipation of imminent conflict. The intent of these activities could be misinterpreted if they cause unintended harm to U.S. and ally satellites, and could thereby exacerbate or inadvertently escalate the crisis.

China has the most active ASAT development program, having conducted at least six direct ascent, or vertical launch, ASAT missile tests since 2005. China has not yet intentionally interfered with U.S. space assets. However, it has conducted ASAT tests without warning and signaled intent to undertake malicious actions. People's Liberation Army (PLA) Air Force publications argue that shooting down U.S. early-warning satellites would be a de-escalatory and stabilizing action in a naval encounter with the United States.

China might be tempted to demonstrate its ASAT capabilities during a major crisis to deter potential U.S. military involvement, such as during a confrontation with Taiwan or other neighboring states over unresolved territorial disputes in the East or South China Seas. The purpose would be to signal its resolve and willingness to escalate militarily and thus gain "escalation dominance."

North Korea's record of provocative military behavior makes it a plausible candidate to conduct dangerous actions in space, possibly by leveraging a crude ASAT demonstration to extract concessions similar to how it has used nuclear and missile testing in the past. North Korea placed its first satellite in orbit in December 2012 using a rocket derived from the Taepodong II missile, which could alternatively be used to destroy an inactive satellite or maliciously target a U.S. satellite. Although less likely, North Korea could use the still untested road-mobile, medium-range Hwasong-13 ballistic missile. Given North Korea's history of confrontational behavior and provocative language, interference with or damage to a U.S. or allied satellite has the potential to escalate into a crisis and elicit a response from the United States.

Iran also has a long history of engaging in military intimidation. In the past two years, there have been an increasing number of near misses in the Persian Gulf between Iranian Revolutionary Guards Corps (IRGC) tactical boats and U.S. Navy ships, and IRGC surveillance drones and navy helicopters, as well as multiple attempts by IRGC fighter jets to shoot down U.S. Predator surveillance drones. Since Iran already views space as a legitimate arena in which to contest U.S. military power, Tehran could use similar tactics against U.S. satellites during a major crisis, especially if it believes war is imminent—an assessment that could have self-fulfilling consequences. Should this significantly limit U.S. situational unawareness of the unfolding crisis, there would most certainly be a military response against the source of that Iranian interference. Additionally, like North Korea, Iran could attempt a direct-ascent ASAT test or co-orbital ASAT test, in which it detonates a conventional explosive near a targeted satellite. Iran's capacity to do this will likely improve if it follows through on its June 2013 announcement of plans to build a space monitoring center designed to track satellites above Iranian territory.

**Intentional Peacetime Interference**

Intentional acts of interference during peacetime include: probing the technical capabilities of U.S. space systems or ground-based sensors; spying on the location and capabilities of U.S. satellites; and denying or limiting U.S. intelligence collection from space satellites through electronic jamming, blinding optical systems, and issuing false instructions, known as "spoofing." These space disruptions are distinct from computer hacking—i.e., the unauthorized access to a network, or the manipulation of software source code, the originating source of which can be hidden through dummy IP addresses or server rerouting. These interferences are usually stand-alone demonstrations of national power, and are similar to the interferences that routinely affect air and sea systems

on earth. However, no established "rules of the road," comparable to the UN Convention on the Law of the Sea, exist to regulate space operations.

According to U.S. officials, Iran undertakes more purposeful interference with U.S. military and commercial space systems using lasers and jammers than any other country. Although these actions have not resulted in irreparable damage to U.S. assets, this practice increases the possibility that the United States will misinterpret unintended harm caused by such interference. In the worst-case scenario, a routine lasing or jamming attack could cause unintended damage to U.S. or allied space assets—primarily due to untested and less advanced capabilities—precipitating a crisis with China, North Korea, or Iran at an acutely sensitive time, amid ongoing efforts to prevent Iran from acquiring nuclear weapons.

Unlike in the cyber domain, attributing the source of intentional space interference is relatively easy to date. It requires identifying the source of a disruption to a datalink, or to space-based and terrestrial transmitters and receivers. Those sources provide a return address and usually offer a distinct signature. However, interference in space, particularly that which does not result in sustained damage to satellites, is less likely to arouse suspicion due to the distant nature of the domain, which can also encourage deliberate interference and shrouding of military purposes as civilian or scientific.

**Inadvertent Peacetime Interference**

The main form of inadvertent peacetime interference is the testing of ASAT systems that create space debris, which already threatens U.S. space assets and assured access to the domain. China's demonstrated disregard for the consequences of ASAT tests is the greatest threat to international space security.

A January 2007 direct ascent ASAT test carried out by China against its defunct Fengyun-1C weather satellite instantly increased the amount of space debris in low earth orbit (LEO) by 40 percent. Debris is especially problematic in LEO, where half of the world's 1,100 active satellites operate. Space objects—even flecks of paint—travel as fast as eighteen thousand miles per hour and can cause catastrophic damage to manned and unmanned spacecraft—creating even more debris in the process. The U.S. National Research Council estimates that portions of LEO have reached a "tipping point," with hundreds of thousands of space debris larger than one centimeter stuck in orbit that will collide with other pieces of debris or spacecraft, thus creating exponentially more debris. Significant growth in the quantity or density of space debris could render certain high-demand portions of outer space unnavigable and inutile. Currently, there are no legal or internationally accepted means for removing existing debris.

China could also test co-orbital antisatellite systems in which an interceptor spacecraft destroys its target by exploding in close proximity, creating even more debris. For several years, Beijing has conducted a series of close proximity maneuvers with its satellites in LEO; the most recent occurred after a July 20, 2013, launch of three satellites on the same rocket, which have since conducted sudden maneuvers toward other Chinese satellites. Human or operating errors during these maneuvers could inadvertently result in a collision that produces harmful debris. While these maneuvers could eventually be used for civilian purposes, most U.S. officials believe these experiments are primarily intended to demonstrate latent ASAT capabilities.

An ASAT test that causes unintended damage to U.S. and ally satellites or an accident in space caused by debris could trigger a major international crisis between the United States and China.

The risk is heightened by the fact that both countries have no pre–space-launch notification arrangements, similar to the U.S.-Russia agreement on notifications of intercontinental ballistic missile (ICBM) and submarine-launched ballistic missile (SLBM) launches. Management of such a crisis could also be hindered by a lack of direct communication between U.S. authorities and the PLA agency that oversees Chinese military space launches.

## *WARNING INDICATORS*

As China, North Korea, and Iran's space capabilities continue to grow, the following strategic and tactical warning indicators would suggest that a dangerous space event is forthcoming.

Strategic warning indicators include statements of intention to interfere with or develop the capability to interfere with space operations of other powers during a crisis or wartime; evidence of such intent, including research and development or budget indicators, organizational changes, or intelligence collection; noticeably increased efforts to disrupt space communications using lasers or jammers against satellites or ground-based transmitters; or the sudden and unexplained launch of additional satellites into LEO, accompanied by an increase in aggressive or potentially hostile maneuvers.

Certain indicators are suggestive of potential military escalation or onset of conflict. These include a heightened diplomatic crisis involving the United States and China, North Korea, or Iran that could result in terrestrial military escalation and trigger a crisis-related interference in space; militarized tensions or direct conflict between one of the three countries and the United States, a U.S. treaty ally, or a non-U.S. ally with known space capabilities, such as India or Russia; or an internal power struggle among governing elites in China, North Korea, or Iran, prompting space activities intended to consolidate domestic power or stoke nationalism.

Tactical warning indicators tend to be more overt. They include significant changes in the alert status or operational readiness of military units associated with China, North Korea, or Iran's missile or space programs; the unexpected announcement of the closure of airspace to civilian aircraft over the territory of previous space launches; or preparations for missile tests from satellite launching stations which are usually detectable days, if not weeks, in advance. Space launches from road-mobile missile units, although closely monitored, would likely occur with less warning, if any. Additional indicators include specific space-related warnings or rhetoric, or the declaration of an antisatellite or ballistic missile defense test, although no warning would be issued. The 2007 Chinese ASAT test that destroyed an LEO satellite was not preceded by any specific warnings.

## *IMPLICATIONS FOR U.S. INTERESTS*

The United States has three primary national interests in preventing or mitigating the dangerous space contingencies detailed above, which would threaten U.S. or allied space assets and produce mass space debris, imperiling assured access to space.

First, the United States depends on space systems more than any other country, which is unlikely to change in the future. No other state spends as much on its space activity (75 percent of global space funding is by the United States), or has a greater stake in a safe and secure space (43 percent of all active satellites are U.S. owned). Threats to U.S. satellites would reduce the country's ability to attack suspected terrorists with precision-guided munitions and conduct imagery analysis of

nuclear weapons programs, and could interrupt non-cash economic activity depending on the severity of the attack and number of satellites disrupted. Moreover, although space debris threatens all international space assets, the United States depends especially on satellites in the portions of LEO where the greatest debris is found for encrypted communications, reconnaissance over Afghanistan, missile defense, and other missions critical to national security.

Second, as the most active global security manager with unmatched commitments, the United States would be more affected by an unstable or insecure space commons than any other country. In January 2012, the Obama administration announced its commitment to help broker an International Code of Conduct on Outer Space Activities, which would be an informal arrangement based on freedom of access to space for peaceful purposes, preservation of the security and integrity of space objects in orbit, and due consideration for the legitimate defense interests of states.

Third, as the primary guarantor of space access, the United States has a strong interest in promoting responsible behavior in space or at least preventing space activities that have the potential to become a source of international instability or potential conflict, in space or on the ground. Intentional or crisis-related interference in space would undermine the norm of equal access to space for all by introducing space as a domain for crisis bargaining, as well as prompting its further militarization—both of which would be highly destabilizing to international political dynamics. The U.S. Strategic Command's Joint Space Operations Center (JSpOC) helps to protect the space domain by providing conjunction assessment notifications to government and commercial space operators when their satellites are predicted to collide with other satellites or space debris. JSpOC gathers this information with its "space fence" of ground-based radars and optical sensors located throughout the world.

Threats to military or civilian satellites could limit the timely and accurate information available to civilian decision-makers and military commanders during crisis situations. This is compounded by how difficult it would be for officials to quickly interpret whether a satellite malfunction was caused intentionally or inadvertently by humans, a damaging space phenomenon (such as solar flares), or routine mechanical failure. Attributing who or what is responsible for such a disruption in space is usually possible, but requires equipment, analysts, and time—all of which may be in short supply during a crisis. This situation could also create a first-strike incentive for U.S. decision-makers seeking to act before its understanding of a terrestrial dispute or its space situational awareness—the ability to view, characterize, and predict the location of manmade objects in space—is interrupted or further degraded.

## *PREVENTIVE OPTIONS*

The United States has several unilateral, bilateral, and multilateral options for preventing dangerous space events most detrimental to U.S. interests.

In addition to taking further steps to improve the survivability and redundancy of U.S. space assets and enhance its ability to detect dangerous space activities and debris, the United States could undertake other unilateral measures, such as declaring a moratorium on all ASAT testing to pressure other states to do the same. The United States could also promote a nontreaty prohibition of direct ascent ASAT tests. However, given that this would limit the operational requirements of mid-range U.S. ballistic missile defenses, such an agreement would be infeasible because of intense domestic political opposition. Moreover, while an ASAT and direct ascent ASAT ban would be

beneficial to U.S. security, it is unlikely that China, North Korea, or Iran would agree to, let alone abide by, such agreements. Additionally, emerging space powers, such as Russia and India, may prioritize the development of space capabilities in an effort to match those of other space powers.

The United States could issue clear and specific public warnings to deter malicious activity in space. As of yet, U.S. deterrent threats are confined to Pentagon planning documents, or have been applied with little specificity to cyber and space domains contemporaneously. If the space event was detected during the planning stage by the U.S. intelligence community, or it became clear that a country developing space capabilities intended to use them maliciously and the resultant space debris could be predicted by JSpOC, the United States could publicize the costs that such debris would pose to the world's satellites in an attempt to marshal international condemnation to prevent it.

Military options to deter impending actions, or respond if necessary, include deploying naval assets toward a potential adversary, placing regionally based bombers on high-alert status, attempting to intercept a space launch with the sea-based Aegis ballistic missile defense system (a near impossibility for far inland China launches), or attempting to preemptively strike the space launch platform with long-range bombers or conventionally armed ballistic missiles. Though the United States possesses advanced direct ascent ASAT capabilities, employing them against Chinese, North Korean, or Iranian space systems would signal that such acts were normal behavior and create space debris threatening to U.S. space assets.

Beyond these unilateral options, the United States could issue private demarches to warn and educate China, North Korea, or Iran of the consequences of a direct ascent or co-orbital ASAT test. The United States could initiate trust-building measures with specific countries to reduce the risk of inadvertent conflict. For example, U.S. officials could work with Chinese military leaders to establish rules of the road for space, such as announcing space launches and implementing emerging industry standards for debris mitigation, which could be included as part of the U.S.-China military discussions on common understandings for international airspace, the open seas, and cyberspace. Currently, no legal or nonbinding instruments governing outer space exist other than the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space. U.S. diplomats could also request greater clarity from North Korea and Iran about the intent of their space activities.

Multilaterally, the United States could continue to develop and promote bilateral and multilateral transparency and confidence-building measures in outer space, expanding on the UN Group of Governmental Experts' roadmap published in July 2013. This would include information exchanges and notifications, consultative mechanisms, shared space situational awareness, and the publication of national space policies. Likewise, the United States could seek to advance discussions in the UN Committee on the Peaceful Uses of Outer Space, which is developing best practices for space debris and collaborative space situational awareness.

### *MITIGATING OPTIONS*

The United States has several options to mitigate the consequences of a dangerous space event.

If JSpOC characterized the space debris threat accurately in advance, high-demand U.S. satellites could undertake debris avoidance maneuvers to relocate to safer orbital slots. Predictive conjunction notices could be provided to all spacefaring nations and satellite operators. In preparation

for such an event, policymakers could develop contingency plans to shift high demand military or civilian satellite communications from threatened U.S. satellites to available commercial satellites. The United States could mandate that government and commercial satellites include enhanced resilience and recovery capacities, such as passive shielding, hardening electrical circuits, and turn-off systems. Additionally, the U.S. military could expand training for operating in GPS-denied or communications-denied environments, in case military or military-dependent satellites are disabled.

The United States could attempt to establish a dedicated, bilateral crisis communications channel between JSpOC and its equivalent Chinese, North Korean, and Iranian space agencies, to issue warnings and demarcations, and facilitate cooperation in times of crisis to prevent escalation and mitigate damage to space assets. This might be unlikely in the near term, but could be pursued over time. JSpOC already has a time-delayed mechanism to provide this information to China, and the U.S. military and its Iranian counterpart communicate in real time to prevent misunderstandings. This is even less feasible in the case of North Korea, given there is no current direct communications mechanism with the United States.

The United States could work with other spacefaring nations to develop multilateral and international legal agreements, strategies, and plans for safely removing existing or future space debris. The reduction of space debris in orbit would make additional debris-creating space events less of an immediate and long-term threat to all space assets.

## *RECOMMENDATIONS*

Due to its reliance on space and unmatched space situational awareness and demonstrated record of leading global action, the United States has a unique obligation to lead international efforts to prevent or mitigate a dangerous space event by implementing the following recommendations:

- Upgrade the JSpOC space fence radars and sensors, which are aging and strained, and provide limited coverage of the southern hemisphere. This is estimated to cost up to $2 billion.
- Expand the scope of data-sharing agreements with other countries and commercial space operators—beyond the thirty-five current agreements with commercial operators and five with countries (Australia, Canada, France, Japan, and Italy)—to improve overall space situational awareness.
- Establish regulations mandating best practices for space debris mitigation for all U.S. government and commercial space assets, such as requiring that satellites be maneuvered into "graveyard orbits" at the end of their lifespan so they burn up in the atmosphere.
- Test and develop large debris removal techniques through bilateral and multilateral pilot programs with other spacefaring nations.
- Increase transparency and confidence-building by announcing that the United States will not test or deploy antisatellite capabilities. This would be similar to the unilaterally declared U.S. Nuclear Weapons Testing Moratorium of 1992, which the United States has adhered to since. The moratorium was emulated in the Comprehensive Nuclear Test Ban Treaty ratified by 161 states including Russia.

- Publicize growing concerns about China's ASAT capabilities, mirroring what has been done to address Chinese threats to the maritime and cyber domains; no senior U.S. government official has issued a statement on space since January 2012, signaling that threats are not a priority.
- Dedicate more assets to improve intelligence collection and analysis of the command-and-control arrangements for China's, Iran's, and North Korea's space assets to better understand which officials would authorize a dangerous space incident and how they could be influenced.
- Undertake contingency planning for a diplomatic and military response if such a threatening antisatellite test occurred, similar to planning that has been conducted for catastrophic cyberattacks on U.S.-based critical infrastructure; this has yet to be undertaken at a senior level.
- Ask allied and partner countries with stronger diplomatic ties to China, North Korea, and Iran to raise specific U.S. concerns about those countries' potentially destabilizing behaviors in space.
- Begin formal discussions with Chinese government leaders to increase transparency and predictability for both American and Chinese actions in space, as part of the U.S.-China Strategic and Economic Dialogue process.
- Work with Congress to repeal the 2011 provision that prevents Chinese officials or experts from visiting the National Aeronautics and Space Administration's facilities to allow for bilateral civilian space cooperation with China.
- Increase focus on brokering an International Code of Conduct on Outer Space Activities with the largest number of states, to improve stability in space by promoting rules of the road for responsible space behavior.

## *CONCLUSION*

Though the United States has limited leverage over the actions of China, North Korea, and Iran in space, it does have numerous options available to mitigate or prevent dangerous space incidents and limit the multiplication of space debris that threaten U.S. space assets and assured access to the domain. Some policymakers will argue that these recommendations require too much transparency into U.S. space operations and could pose operational constraints. Others will contend that these do not go far enough to address the reality of space threats and that the United States will waste its diminishing lead role if it does not take more proactive and radical steps. But U.S. policy must balance both demands by implementing the practical set of recommendations provided in this report. On the current path, the likelihood of potentially dangerous space incidents will only increase, whereas a renewed focus on preventing and mitigating such events would markedly reduce this threat. If the United States wishes to better guarantee its access to space as China, North Korea, and Iran advance their capabilities and other space powers emerge, it must intensify its efforts to have an impact or forsake its role in shaping rules of the road for space.

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