GLOBAL CHINA
ASSESSING CHINA'S GROWING ROLE IN THE WORLD

# MANAGING CHINA'S RISE IN OUTER SPACE

FRANK A. ROSE

APRIL 2020

## EXECUTIVE SUMMARY

Access to outer space is critical to modern everyday life on Earth. The utilization of outer space helps us warn of natural disasters, facilitate navigation and transportation globally, expand our scientific frontiers, monitor compliance with arms control treaties and agreements, provide global access to financial operations, and scores of other activities worldwide.

However, today's outer space environment is evolving rapidly, presenting the United States and the entire international community with several key challenges to the sustainability, safety, stability, and security of the outer space environment. Some of these key challenges include the growth of orbital debris, which represents an ever-increasing threat to both human and robotic space flight, the emergence of mega constellations of small satellites, and the development and deployment of anti-satellite (or ASAT) capabilities.

China's increasing activities in outer space lie at the heart of these challenges. Over the past several decades, China has rapidly expanded its presence in outer space in both the civil and military arenas. Given the increasing role that China is playing in the space domain in the future, the United States will need to develop a strategy that deters China's increasing ASAT capabilities, while at the same time finds ways to work with China cooperatively on sustainability and safety issues like orbital debris, space traffic management, and the rise of mega satellite constellations. Elements of such a strategy should include: enhancing deterrence and increasing resiliency against Chinese ASAT threats; reinvigorating the U.S.-China bilateral dialogue on space security issues; continuing the U.S.-China Civil Space Dialogue; developing bilateral and multilateral norms of behavior for outer space; identifying ways to cooperate with China on pragmatic civil space projects; and reviewing current congressional limitations on civil space cooperation with China.

## INTRODUCTION[1]

Access to outer space is critical to modern everyday life on Earth. The utilization of outer space helps us warn of natural disasters, facilitate navigation and transportation globally, expand our scientific frontiers, monitor compliance with arms control treaties and agreements, provide global access to financial operations, and scores of other activities worldwide. However, today's outer space environment is evolving rapidly, presenting the United States and the entire international community with several key challenges to the sustainability, safety, stability, and security of the outer space environment. Some of these key challenges include the growth of orbital debris, which represents an ever-increasing threat to both human and robotic space flight, the emergence of mega constellations of small satellites, and the development and deployment of anti-satellite (or ASAT) capabilities.

China's increasing activities in outer space lie at the heart of these challenges. Over the past several decades, China has rapidly expanded its presence in outer space in both the civil and military arenas. As a January 2019 report by the U.S. Defense Intelligence Agency noted, "China has devoted significant economic and political resources to growing all aspects of its space program, from improving military space applications to developing human spaceflight and lunar exploration programs."[2]

Given the increasing role that China is playing in the space domain, the United States will need to develop a strategy that deters China's increasing ASAT capabilities, while at the same time finds ways to work with China cooperatively on sustainability and safety issues like orbital debris, space traffic management, and the rise of mega satellite constellations. This paper seeks to provide an outline of the key elements of such a strategy. Specifically, the paper will discuss the key challenges facing the outer space environment; provide an overview of Chinese civil and military space programs; outline recent bilateral interactions between the United States and China in space; and provide pragmatic recommendations on how the United States can effectively manage China's rise in outer space.

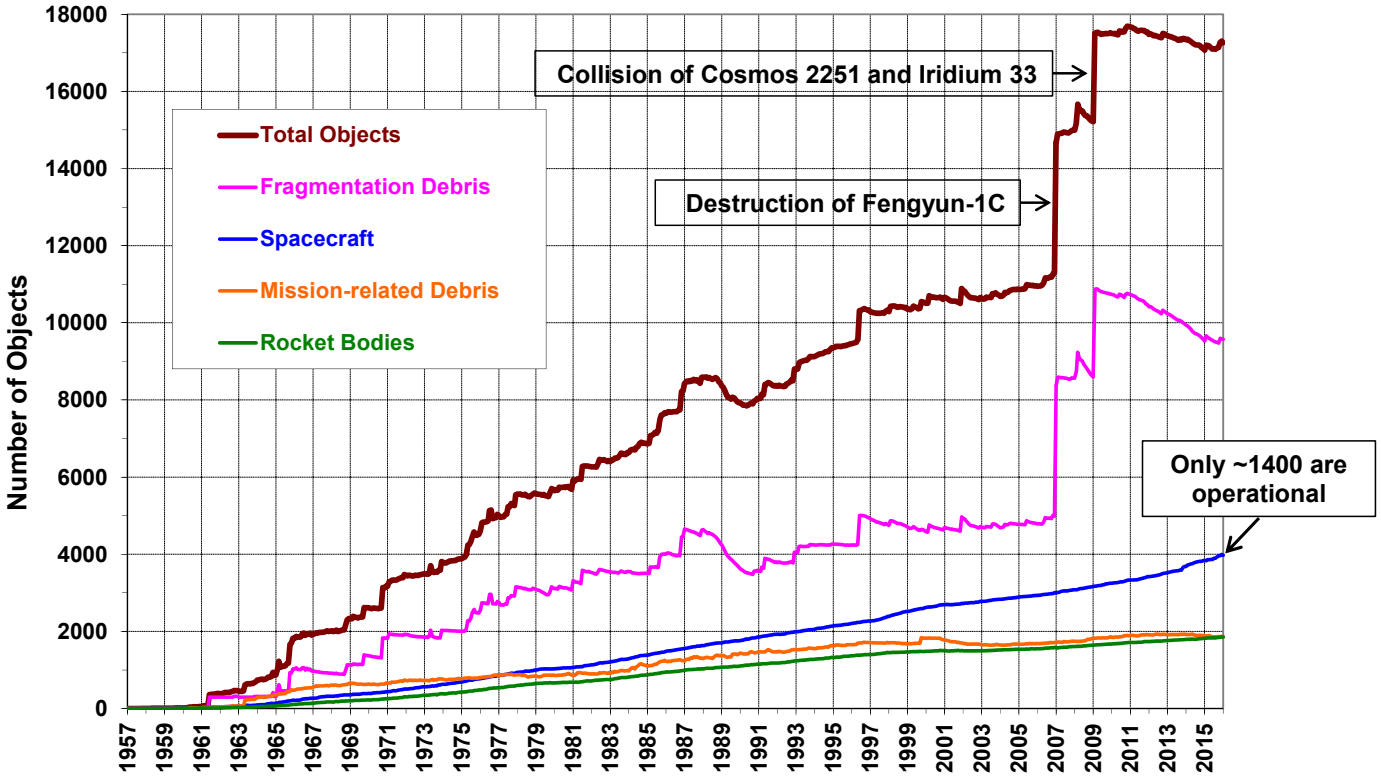
## CHALLENGES TO THE OUTER SPACE ENVIRONMENT

### *The growth of orbital debris*

Decades of space activity have littered Earth's orbit with defunct satellites and pieces of orbital debris. As activities in outer space continue to grow, the chances of a collision increase. The United States is currently tracking approximately 26,000 pieces of orbital debris 10 centimeters or larger in various Earth orbits. Approximately 2,218 of these objects are active satellites.[3] Other objects in orbit include: spent rocket bodies, inactive satellites, a wrench, and even a toothbrush! Additionally, as many as 600,000 pieces of orbital debris smaller than 10 centimeters exist that we currently don't have the capability to track but could still cause significant damage if a collision occurred. Experts warn that the current quantity and density of man-made debris significantly increases the odds of future collisions either as debris damages space systems or as colliding debris creates more debris.

Because of the high speeds in which these objects travel in space — 17,500 miles per hour — even a sub-millimeter piece of debris could cause a problem for human or robotic missions. This serious problem is continually growing as more debris is generated by routine operations as well as by accidents and mishaps such as the 2009 collision between a Russian Cosmos satellite and a commercially-operated Iridium satellite. Other debris is a result of deliberate acts, like China's 2007 destructive test against one of its own satellites. That single test created over 3,000 pieces of debris larger than 10 centimeters that will stay in low Earth orbit for potentially hundreds of years, presenting an ongoing threat to the space systems of all nations, including China itself. Over the past several years there have been hundreds of occasions when debris from China's 2007 anti-satellite test has come close to their own satellites. Indeed, these two events alone are responsible for approximately one-third of all the debris in low Earth orbit. The chart below illustrates the dramatic growth in the amount of orbital debris since the dawn of the Space Age in 1957.

**FIGURE 1: GROWTH OF ORBITAL DEBRIS 1957-2015**




*Source: National Aeronautics and Space Administration*[4]

The United States is working to address the orbital debris challenge in several ways. First and foremost, it is improving space situation awareness capabilities (or SSA), which allow us to track, characterize, and catalogue objects in outer space. This mission is currently performed by the U.S. Department of Defense (DOD) through the U.S. Air Force's 18th Space Control Squadron, based at Vandenberg Air Force Base in California.[5] The 18th Space Control Squadron currently publishes a catalog of space objects and warns global space operators, including foreign governments and commercial operators, of potential collisions free of charge.[6] However, at some point in the future, this mission will transfer to a civilian agency to allow the Pentagon to focus more on its traditional warfighting mission. The Trump administration has proposed transferring the mission to the U.S. Department of Commerce, but Congress has not approved the request, and there remains disagreement in Congress as to whether Commerce is the right agency with which to place the mission.[7]

Over the last several decades, the United States has also worked within several international forums like the Interagency Debris Coordination Committee (IADC), which consists of representatives from the world's major space agencies, and the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), to develop international guidelines to improve the safety and sustainability of the outer space environment. Since 2007 these groups have developed and approved several important agreements such as the UN Debris Mitigation Guidelines (2007) and the UNCOPUS Long-Term Sustainability Guidelines (2016 and 2019), designed to address the orbital debris challenge.

According to data from Space-Track.Org,[8] United States and Russia are responsible for the largest number of objects in Earth orbit, which includes active satellites, spent rocket bodies, and orbital debris. This is primarily due to their long history of outer space operations dating back to the 1950s. However, China

is quickly catching up, and is now the country with the third-largest number of objects in orbit. Some of these objects are satellites and spent rocket bodies, but the majority is debris from China's 2007 ASAT test. And as Chinese activities in outer space continue to grow, the number of its objects in space are almost certain to increase, making it critical that we find a way to constructively engage China on orbital debris.

### *Managing mega constellations*

The second key challenge facing the outer space environment is the development of "mega constellations" of small satellites. According to press reports, several U.S. and European entities have plans to launch mega constellations in the coming years. The Federal Communications Commission (FCC) approved a request by SpaceX to construct, deploy, and operate a new very low Earth orbit[9] constellation of more than 12,000 Starlink satellites using V-band frequencies.[10] These satellites will be used to improve broadband communications globally. And SpaceX has asked the FCC to approve an additional 30,000 satellites for a total of 42,000.[11] Other companies, such as OneWeb, have begun to deploy similar constellations, though not as large as Starlink.[12] While these mega constellations will improve space-based capabilities, they will also contribute significantly to the congestion of low Earth orbit.

NASA orbital debris experts have highlighted this concern in a recent study on the potential impact of large satellite constellations. According to Jer-Chyi Liou, NASA's chief scientist for orbital debris, "Because of the number of spacecraft involved, [these companies] need to pay attention to certain areas to make sure they do not pollute the near-Earth space environment with significant orbital debris."[13] To address this challenge, NASA experts have recommended ensuring that satellites in the constellations are de-orbited at the end of their respective service lives.[14]

As these mega constellations begin to be deployed it will be important that this deployment is done in a way that is fully consistent with debris mitigation policy and standards. The good news is that U.S. regulators are beginning to think through the implications of mega-constellations of satellites on the long-term sustainability of the outer space environment. In their decision approving the SpaceX constellation, the FCC required the company to come back to the commission with an updated plan for debris mitigation.[15] The FCC further noted that:

> "Across the board, we need to prepare for the proliferation of satellites in our higher altitudes… Today, the risk of debris-generating collusions is reasonably low. But they've already happened — and as more actors participate in the space industry and as more satellites of smaller size that are harder to track are launched, the frequency of these accidents is bound to increase. Unchecked, growing debris in orbit could make some regions of space unusable for decades to come. That is why we need to develop a comprehensive policy to mitigate collision risks and ensure space sustainability."[16]

Another concern about mega constellations is that they could potentially interfere with astronomy. According to press reports, several astronomers have noted that the initial batch of Starlink satellites have "shone surprisingly bright in the night sky at dawn and dusk, and by some calculations, these satellites, in addition to OneWeb and Amazon's proposals, could hamper observations."[17]

But U.S. and European entities aren't the only ones who are developing mega constellations: several Chinese entities are also developing similar systems. For example, in December 2018, Aerospace Dongfanhong, a Chinese state-owned satellite manufacturing company, launched the first demonstration satellite for the Hongyan communications constellation of small satellites.[18] The Hongyan constellation will ultimately consist of 320 satellites, and is expected to be fully operational by 2025.[19] Though this constellation is significantly smaller than the Starlink constellation proposed by SpaceX, it is likely only a matter of time before China's approach to mega constellations becomes more ambitious, making it imperative that the United States begin a discussion with China on this important issue.

### *The growing anti-satellite threat*

A third key challenge to the outer space environment is the growing threat from ASAT weapons. Throughout the Cold War, both the United States and the Soviet Union developed limited numbers of ASAT weapons, but never moved forward with largescale deployment

of these weapons given concerns about the damage ASAT weapons could do to the sustainability of the outer space environment.[20] With the end of the Cold War, development of ASAT weapons declined significantly, but that changed in 2007 when China conducted a direct assent ASAT test "deliberately hitting and destroying one of its own aging weather satellites at an altitude of 865 kilometers."[21] Since 2007, several other nations have conducted direct ascent engagements of their own satellites in Earth orbit, including the United States and India.[22]

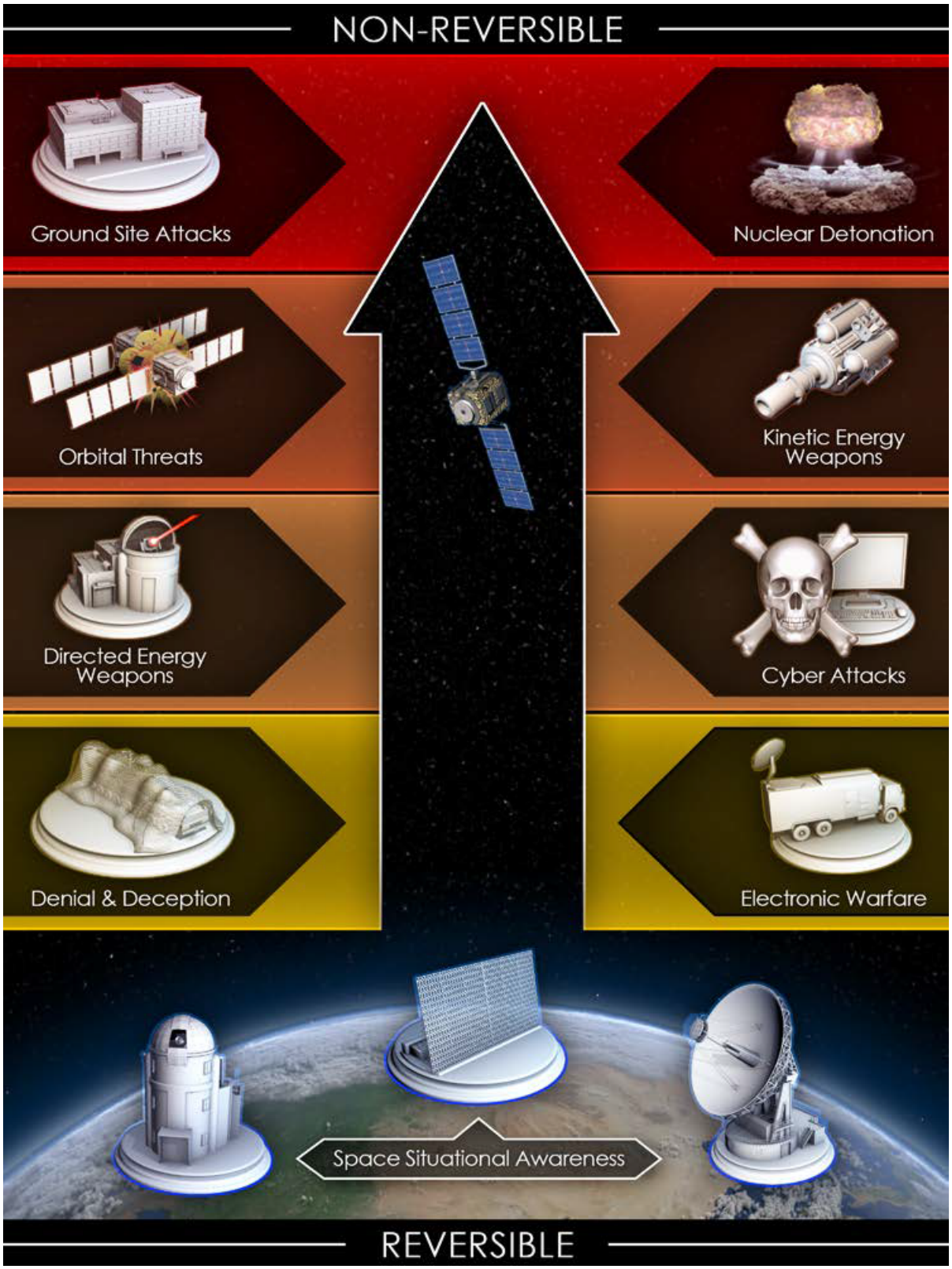
What prompted this renewed interest in ASAT capabilities by China and other countries? From my perspective, interest is driven by the increasing importance that space-based systems play in military operations. This applies particularly to military operations conducted by the United States. Potential U.S. adversaries understand that space-based assets are key to the United States' ability to project power globally. For example, satellites enable the U.S. military to detect and target adversaries, as well as provide command and control for its own forces. Denying the United States access to space-derived data would provide potential adversaries significant military advantage.

As then-U.S. Director of National Intelligence Daniel Coats noted in testimony before Congress in 2019, the U.S. Intelligence Community assesses that:

> "China and Russia are training and equipping their military space forces and fielding new antisatellite weapons to hold U.S. and allied space services at risk… Both countries recognize the world's growing reliance on space and view the capability to attack space services as a part of their broader effort to deter an adversary from or defeat one in combat."[23]

The chart below shows the broad spectrum of anti-satellite weapons. On one end of the spectrum you have "reversable" weapons, which includes things like jammers, lasers, and offensive cyber-attack capabilities that are designed to disable or degrade a satellite for a temporary period. The opposite end of the spectrum consists of the "non-reversable" systems designed to do permanent damage or destroy a satellite. The most prominent of these "non-reversable" systems are kinetic interceptors designed to destroy satellites in Earth orbit. With this as background, let's now examine China's national security space programs.

**FIGURE 2: SPECTRUM OF ANTI-SATELLITE THREATS**




*Source: National Air and Space Intelligence Center*[24]

## CHINA'S NATIONAL SECURITY SPACE PROGRAMS

In recent years, China has embarked on a major expansion of its national security space programs. The most concerning of these programs has been its development of a robust set of ASAT capabilities designed to target satellites in orbit and disrupt the flow of space-derived information. According to several U.S. government and other open source reports, China is developing and deploying a full spectrum of ASAT capabilities.[25] These include a network of space situational awareness sensors "capable of searching, tracking, and characterizing satellites in all Earth orbits;" electronic warfare capabilities designed to jam satellite transmissions; laser weapons to "disrupt, degrade, or damage satellites and their sensors;" offensive cyber capabilities to target computer networks; sophisticated in-orbit satellite attack capabilities; and ground-based missiles designed to destroy satellites kinetically.[26]

In addition to its ASAT capabilities, China is improving and expanding its other national security space-related capabilities. For example, China possesses a robust constellation of intelligence, reconnaissance, and surveillance (ISR) satellites that allow it to monitor political and military developments around the world.[27] China currently operates over 120 ISR and remote sensing satellites, second only to the United States. And it is continuing to improve those capabilities as demonstrated by the July 2018 launch of the Gaofen-11, its highest resolution imagery satellite to date.[28] Since then, China has launched 14 Gaofen satellites into orbit.[29] China also operates approximately 34 communication satellites, of which about four are dedicated exclusively for military uses.[30] Finally, China is continuing to expand its BeiDou precision, navigation, and timing (PNT) system, which is similar to the U.S. Global Positioning Systems (GPS), and is on track to achieve global coverage with the system this year.[31] The expansion of the system will likely improve its ability to target precision-guided munitions, and lessen China's dependence on GPS, which the Chinese government fears the United States might deny access to during a crisis.[32]

In addition to the development of national security space capabilities, the Chinese People's Liberation Army (PLA) has conducted a major reorganization to better integrate space, cyberspace, and electronic warfare systems with its other military capabilities. The most significant of these reforms was the establishment of the PLA Strategic Support Force (SSF) in 2015. According to the U.S. Defense Intelligence Agency, "The SSF forms the core of China's information warfare force, supports the entire PLA, and reports directly to the Central Military Commission."[33] Furthermore, as a RAND Corporation report on the SSF notes, "the creation of the SSF suggests that information warfare, including space warfare, long identified by PLA analysts as a critical element of future military operations, appears to have entered a new phase of development in the PLA."[34]

## CHINA'S CIVIL SPACE PROGRAMS AND PROSPECTS FOR BILATERAL COOPERATION

China has also emerged as a major international actor in the civil space arena. For example, last year, China became the first country to land a space probe on the far side of the moon. China's civil space activities are certain to grow in the coming years. According to a December 2018 report by the National Air and Space Intelligence Center:

> "China plans to become an international leader in lunar research and exploration with goals to assemble a lunar research station beginning in 2025, perform a crewed Moon landing mission in 2036, and establish a Lunar Research and Development Base around 2050."[35]

China also plans to deploy a rover to Mars by 2020, probe asteroids around 2022, and send a mission to Jupiter around 2029.[36] It has also deployed several deep space ground stations around the world, including in Argentina,[37] and is developing its own space station, the Tiangong, which is scheduled to become fully operationally around 2022. China's civil space activities are certainly impressive and present multiple opportunities for collaboration with international partners, including the United States.

However, one of the key challenges faced when cooperating with China in more robust civil space cooperation is the fact that the Chinese civil space program, led by the China National Space Administration, is controlled by the Chinese military. As a result, there is a real possibility that any bilateral cooperation could contribute to China's military space programs. But this is not the first time the United States has faced a challenge from a peer competitor in space and found a way to cooperate with that country on civil space projects. In 1972, the United States and the Soviet Union agreed to an Apollo-Soyuz docking mission, which occurred in 1975. As Michael Krepon of the Stimson Center has written,

> "Some feared that this mission would compromise the U.S. space program while providing further rewards to the Soviet program. These anxieties proved to be overdrawn... The Apollo-Soyuz mission established practices of cooperation in space between Washington and Moscow that continue to this day on the international space station."[38]

The United States currently conducts limited bilateral cooperation with China in the civil space arena, primarily focused on aeronautics and Earth science. However, cooperation is severely limited by restrictions put in place by the U.S. Congress due to human rights and national security-related concerns.[39] Section 526 of the Consolidated Appropriations Act for 2020 states:

> "None of the funds made available by this Act may be used for the National Aeronautics and Space Administration (NASA), the Office of Science and Technology Policy (OSTP), or the National Space Council (NSC) to develop, design, plan, promulgate, implement, or execute a bilateral policy, program, order, or contract of any kind to participate, collaborate, or coordinate bilaterally in any way with China or any Chinese-owned company unless such activities are specifically authorized by a law enacted after the date of enactment of this Act."[40]

That said, the law does allow for cooperation if NASA, OSTP, and the NSC, after consultation with the Federal Bureau of Investigation (FBI), certifies that the cooperation will not harm U.S. national or economic security, and will not involve knowing interactions with any Chinese officials who have been determined by the United States to have direct involvement with violations of human rights. The law requires that any certifications be made to the House and Senate appropriations committees, and the FBI, 30 days prior to initiation of the activity.[41]

However, several experts have raised questions as to whether the current language limiting civil cooperation with China is too restrictive. In a recent press interview, Charles Bolden, former administrator of NASA, described the current prohibitions as a "significant legal constraint" and hindrance that should be relaxed or reversed.[42] In the same interview, he argued that the United States should also work to integrate China into the International Space Station.

The key question that the United States must answer regarding civil space cooperation with China is how does the U.S. develop a strategy that allows it to cooperate with China on civil space projects, while at the same time safeguarding U.S. national security?

## BILATERAL U.S.-CHINA DIPLOMATIC ENGAGEMENTS

During the last two years of the Obama administration, the United States worked to advance a pragmatic discussion with China on space security and sustainability issues.[43] For example, in 2015, the United States established a direct link between the U.S. Joint Space Operations Center (JSPOC) and the Beijing Institute for Telecommunications and Tracking (BITT) to provide China more timely conjunction assessments and collision avoidance notifications.[44] Prior to that, all notifications were sent to China via the Chinese Ministry of Foreign Affairs, which was not the most effective way to share these types of notifications.

Furthermore, in May 2016, the United States and China convened the first ever U.S.-China Space Security Talks.[45] A second meeting of the group was held in December 2016 in Beijing. In addition to the orbital debris issue, the talks addressed measures to build mutual confidence and reduce the risk of miscalculation in outer space. The two sides also established a complementary Civil Space Dialogue, focused on exploring options for increasing bilateral and multilateral civil space cooperation.[46]

During President Barack Obama's September 2016 visit to China, the White House released a jointly negotiated fact sheet noting the commitment of China and the United States to work together to reduce orbital debris. The fact sheet states:

> "The United States and China recognized that space debris can be catastrophic to satellite and human spaceflight, and that, due to the global dependence on space-based capabilities, the creation of space debris can seriously affect all nations. Therefore, as two Permanent Members of the UN Security Council with major space programs, the United States and China committed to intensify cooperation to address the common challenge of the creation of space debris and to promote cooperation on this issue in the international community."[47]

While the production of a fact sheet is not a major development, it is an example of a certain level of bilateral progress that had been made to address space sustainability issues, especially orbital debris.

To date, the Trump administration has conducted limited bilateral engagements with China on outer space issues. On the positive side, the United States and China held the third U.S.-China Civil Space Dialogue on November 30, 2017,[48] and have agreed to meet again in the spring of 2020.[49] Additionally, NASA Administrator James Bridenstine met with Chinese National Space Administrator Zhang Kejian during the International Astronautical Congress in Bremen, Germany on October 1, 2018, to discuss future bilateral cooperation.[50] However, based on publicly available information, it does not appear the United States and China have continued the bilateral Space Security Talks that were established in 2016, though a senior U.S. State Department official did visit Beijing in June 2019 to discuss space security and other issues.[51]

## RECOMMENDATIONS

The United States faces a fundamental dilemma as it attempts to effectively manage China's rise as a major actor in outer space. On one hand, China's development of anti-satellite weapons represents a direct threat to U.S. and allied space systems. On the other hand, it is difficult to see how the United States and the international community will be able to address the key challenges facing the outer space environment — i.e., the growth of orbital debris and the rise of mega constellations — without engaging with China. Recognizing this dilemma, below are several recommendations that could serve as an outline for a potential U.S. strategy for managing China's rise in outer space.

- *Enhance deterrence and increase resiliency against Chinese ASAT threats.* The threat to U.S. and allied satellites from Chinese and other nations anti-satellite weapons is growing. In response, the United States, under both the Obama and Trump administrations, has taken actions to expand deterrence in space, and increase the resiliency of U.S. space systems. For example, in 2015, the Obama administration increased funding for the DOD's budget for space security initiatives by $5 billion over five years. These funding increases were focused on enhancing deterrence, assuring access to outer space and space-derived data, and improving the resiliency of U.S. and allied space systems.[52] The Trump administration's initiatives to establish the U.S. Space Force and re-establish U.S. Space Command are primarily focused on achieving similar objectives. China and other nations are developing anti-satellite weapons because they believe that the current vulnerability of satellites is an "asymmetric vulnerability" or "Achilles' heel" for the United States. Therefore, it is imperative the United States continue to take the necessary operational and technical actions to close these vulnerabilities.
- *Reinvigorate the U.S.-China bilateral dialogue on space security issues.* After a robust period of dialogue during the Obama administration, the bilateral U.S.-China dialogue on space security has been largely neglected in the Trump administration. While I largely support many of the military-focused space security initiatives the Trump administration has proposed, such as the creation of U.S. Space Command,[53] military solutions alone will not be enough to address the pressing challenges China presents to space security. Bilateral diplomatic engagements with China also need to be part of the strategy. There are several straightforward steps the United

States could take to advance this dialogue. First and foremost, it could simply restart the U.S.-China Space Security Talks last held in 2016. Alternatively, it could seek to incorporate space security on the agenda of the broader strategic stability dialogue the U.S. State Department proposed in December 2019.[54]

- *Continue the U.S.-China Civil Space Dialogue.* In addition to the space security talks, the United States and China should continue the complementary U.S.-China Civil Space Dialogue, which has continued to meet during the Trump administration. This dialogue serves as a useful bilateral forum to discuss space sustainability issues and could also serve as a forum to explore additional areas for enhanced bilateral civil space cooperation. The two sides should also use this forum to increase bilateral coordination in multilateral space sustainability forums like UNCOPUS.
- *Develop bilateral and multilateral norms of behavior for outer space.* The United States should develop bilateral norms of behavior or confidence building measures with China focused on reducing the risks of misperception and miscalculation in outer space. One area where the two countries might work together is on developing mechanisms to further reduce the growth of orbital debris. As noted previously, the United States and China made some progress on this issue during the 2015-2016 timeframe with the negotiation of the direct link between the U.S. Department of Defense and a Chinese entity to pass conjunction assessment notifications, and efforts to develop a joint statement on reducing the growth of orbital debris.[55] In addition to developing bilateral norms, the United States should also work to develop multilateral norms. One option could be for the United States to propose some type of ban or limitation on further debris-generating events in outer space.[56]
- *Identify ways to cooperate with China on pragmatic civil space projects.* The United States will need both carrots and sticks if it is to find a way to effectively manage China's rise in outer space. The prospect of increasing bilateral civil space cooperation is a potential carrot that the United States could deploy. But since the Chinese civil space program is controlled by the military, any cooperation will need to be carefully calibrated to ensure that bilateral cooperation does not contribute to China's military space programs. However, if the United States was ultimately able to find a way to cooperate with the Soviet Union on civil space programs during the Cold War without undermining national security, it should be able to find a way to cooperate pragmatically with China.
- *Review current congressional limitations on civil space cooperation with China.* If the United States ultimately seeks to expand civil cooperation with China, Congress will likely need to modify or remove the current legislative restrictions on that cooperation. However, Congress is unlikely to make any significant changes to the legislation unless it is part of a larger strategy that seeks to balance civil cooperation with broader nation security concerns.
- *Develop a comprehensive U.S. strategy for engaging China on space.* For a variety of reasons articulated in this paper, civil space cooperation with China cannot be separated from larger national security concerns. Given these facts, the United States should develop a comprehensive strategy for engaging China that connects cooperation on civil space and sustainability issues with broader national security concerns. Establishing such a strategy will be critical if the United States is to effectively manage China's rise in outer space in a way that ensures the long-term safety, security, stability, and sustainability of the outer space environment.

# CONCLUSION

As the 2017 U.S. National Security Strategy notes,[57] the United States has returned to an era of renewed great power competition with Russia and China. But as my Brookings Institution colleague Thomas Wright has argued:

> "As the United States competes with Russia and China it cannot lose sight of the many areas in which the United States must cooperate with its rivals out of shared interest... The issue is whether it is possible to cooperate on these problems while competing on others."[58]

This is the essential balance that the United States will need to strike regarding outer space: finding a way to work with states like Russia and China on space sustainability and safety issues, while at the same time pushing back on security issues when necessary.

# REFERENCES


1 This paper draws extensively from my recent congressional testimony for the House Committee on Science, Space, and Technology. See Frank A. Rose, "America in space: Future visions, current issues," The Brookings Institution, March 14, 2019 https://www.brookings.edu/testimonies/america-in-space-future-visions-current-issues/.

2 "Challenges to Security in Space," (Washington, DC: U.S. Defense Intelligence Agency, January 2019), 13, https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/Space_Threat_V14_020119_sm.pdf.

3 "UCS Satellite Database," Union of Concerned Scientists, https://www.ucsusa.org/resources/satellite-database.

4 Jer-Chyi Liou, "Orbital Debris Challenges for Space Operations," (presentation, ICAO/UNOOSA Symposium, Abu Dhabi, March 15-17, 2016), https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20160002047.pdf.

5 "18th Space Control Squadron," Peterson Air Force Base, August 6, 2018, https://www.peterson.af.mil/About/Fact-Sheets/Display/Article/1060346/18th-space-control-squadron/.

6 John E. Hyten, "Statement Before for the Joint Hearing of the House Strategic Forces Subcommittee and House Space Subcommittee," (Washington, DC: U.S. House of Representatives, June 22, 2018), https://science.house.gov/imo/media/doc/Hyten%20Testimony.pdf.

7 Theresa Hitchens, "The Hill Nixes Trump Space Tracking Plan," Breaking Defense, December 19, 2019, https://breakingdefense.com/2019/12/hill-nixes-trump-space-tracking-plan/.

8 Ibid.

9 According to the Interagency Space Debris Coordinating Committee, low Earth orbit or LEO is spherical region that extends from the Earth's surface up to an altitude of 2,000 km. For more information, see "IADC Debris Mitigation Guidelines," (Interagency Space Debris Coordinating Committee, September 2007), http://www.unoosa.org/documents/pdf/spacelaw/sd/IADC-2002-01-IADC-Space_Debris-Guidelines-Revision1.pdf.

10 "FCC Boosts Satellite Broadband Connectivity and Competition in the United States," U.S. Federal Communications Commission, November 15, 2018, https://www.fcc.gov/document/fcc-boosts-satellite-broadband-connectivity-competition.

11 Caleb Henry, "SpaceX submits paperwork for 30,000 more Starlink satellites," Space News, October 15, 2019, https://spacenews.com/spacex-submits-paperwork-for-30000-more-starlink-satellites/.

12 Caleb Henry, "OneWeb's first large batch of satellites launch on Arianespace Soyuz rocket," Space News, February 6, 2020, https://spacenews.com/arianespace-launches-first-large-batch-of-oneweb-satellites-on-soyuz-rocket/.

13 Loren Grush, "As Satellite Constellations Grow Larger, NASA is Worried About Orbital Debris," The Verge, September 28, 2018, https://www.theverge.com/2018/9/28/17906158/nasa-spacex-oneweb-satellite-large-constellations-orbital-debris.

14 Ibid.

15 "In the Matter of Space Exploration Holdings, LLC... Memorandum Opinion, Order and Authorization," U.S. Federal Communications Commission, March 29, 2018, https://transition.fcc.gov/Daily_Releases/Daily_Business/2018/db0329/FCC-18-38A1.pdf.

16 Ibid.

17 Johnathan O'Callaghan, "The Risky Rush for Mega Constellations," *Scientific American*, October 31, 2019, https://www.scientificamerican.com/article/the-risky-rush-for-mega-constellations/.

18 Deyana Goh," China launches first Hongyan LEO comms satellites," Space Tech Asia, December 22, 2018, https://www.spacetechasia.com/china-launches-first-hongyan-leo-comms-satellite/.

19 John Sheldon, "China's new space race: First satellite of CASC's Hongyan LEO SATCOM constellation to launch by end of 2018," Spacewatch Asia Pacific, November 23, 2018, https://spacewatch.global/2018/11/chinas-new-space-race-first-satellite-of-cascs-hongyan-leo-satcom-constellation-to-launch-by-end-of-2018/.

20 For a good discussion of the history of space security issues, see James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests* (Stanford, CA: Stanford University Press, 2008).

21 Brian Weeden, "Anti-satellite Tests in Space — The Case of China," Secure World Foundation, May 18, 2015, https://swfound.org/media/115643/china_asat_fact_sheet_may2015.pdf.

22 On February 20, 2008, the United States successfully engaged and destroyed a defunct U.S. satellite (USA-193) with a modified SM-3 missile defense interceptor. U.S. officials stated that this action was taken to mitigate the risk of the satellite falling on a populated area and was not an ASAT test. However, the Russian government and some outside experts claimed this was an ASAT test. For further information see "US spy satellite plan a cover," BBC News, February 17, 2008, http://news.bbc.co.uk/2/hi/americas/7248995.stm, and Jeremy Hsu, "Military's Motives Questioned in Shooting at Satellite," Space.com, February 20, 2008, https://www.space.com/5003-military-motives-questioned-shooting-satellite.html. On March 27, 2019, Indian Prime Minister Narendra Modi announced that India had successfully tested a destructive anti-satellite weapon against one of its own satellites at around 300 kilometers in outer space. For more information on this test see, Frank A. Rose, "India's anti-satellite test presents a window of opportunity for the Trump administration. Will it take advantage?" The Brookings Institution, May 10, 2019, https://www.brookings.edu/blog/order-from-chaos/2019/05/10/indias-anti-satellite-test-presents-a-window-of-opportunity-for-the-trump-administration/.

23 Daniel R. Coats, "Statement for the Record: Worldwide Threat Assessment of the U.S. Intelligence Community," (Washington, DC: Office of the Director of National Intelligence, January 29, 2019), p. 17, https://www.dni.gov/files/ODNI/documents/2019-ATA-SFR---SSCI.pdf.

24 "Competing in Space," (Wright-Patterson AFB, OH: National Air and Space Intelligence Center, December 2018), 14, https://media.defense.gov/2019/Jan/16/2002080386/-1/-1/1/190115-F-NV711-0002.PDF.

25 In addition to the government reports on the threat to outer space systems cited in this paper, the Center for Strategic and International Studies and the Secure World Foundation have both published excellent reports on the counterspace threat. See Todd Harrison, Kaitlyn Johnson, and Thomas G. Roberts, "Space Threat Assessment 2019," (Washington, DC: Center for Strategic and International Studies, April 4, 2019), https://www.csis.org/analysis/space-threat-assessment-2019; Brian Weeden and Victoria Samson, eds., "Global Counterspace Capabilities: An Open Source Assessment," (Broomfield, CO: Secure World Foundation, April 2019), https://swfound.org/counterspace/.

26 "Challenges to Security in Space," U.S. Defense Intelligence Agency, 20-21.

27 Ibid., 19.

28 Daniel R. Coats, "Statement for the Record," 17.

29 Andrew Jones, "China tests grid fins with launch of Gaofen-7 imaging satellite," Space News, November 4, 2019, https://spacenews.com/china-tests-grid-fins-with-launch-of-gaofen-7-imaging-satellite/.

30 "Challenges to Security in Space," U.S. Defense Intelligence Agency, 19.

31 Pratik Jakhar, "How China's GPS 'rival' Beidou is plotting to go global," BBC News, September 20, 2018, https://www.bbc.com/news/technology-45471959.

32 Ibid.

33 "Challenges to Security in Space," U.S. Defense Intelligence Agency, 15.

34 Kevin L. Pollpeter, Michael S. Chase, and Eric Heginbotham, *The Creation of the PLA Strategic Support Force and Its Implications for Chinese Military Space Operations* (Santa Monica, CA: RAND Corporation, 2017), p. X.

35 "Competing in Space," (Wright-Patterson AFB, OH: National Air and Space Intelligence Center, December 2018), https://media.defense.gov/2019/Jan/16/2002080386/-1/-1/1/190115-F-NV711-0002.PDF.

36 Mike Ives, "As America Looks Inward, China Looks to Outer Space," *The New York Times*, May 23, 2018, https://www.nytimes.com/2018/05/23/world/asia/china-space-moon.html.

37 Lara Seligman, "U.S. Military Warns of Threat From Chinese-Run Space Station in Argentina," *Foreign Policy*, February 9, 2019, https://foreignpolicy.com/2019/02/08/us-military-warns-of-threat-from-chinese-run-space-station-in-argentina/#.

38 Michael Krepon, "Apollo-Soyuz Redux," Space News, January 7, 2013, https://spacenews.com/apollo-soyuz-redux/.

39 The origins of this provision go back to an amendment authored by former U.S. Representative Frank Wolf (R-VA) in 2011. For a good discussion of the Wolf Amendment and its implications, see Jeff Foust, "Defanging the Wolf Amendment," The Space Review, June 3, 2019, https://www.thespacereview.com/article/3725/1.

40 "Consolidated Appropriations Act, 2020: Public Law No: 116-93," (Washington, DC: U.S. Government Publishing Office, December 20, 2019), https://www.congress.gov/bill/116th-congress/house-bill/1158/text.

41 Ibid.

42 Zhao Huanxin, "Former chief of NASA urges lifting of China ban," *China Daily*, January 14, 2019, http://www.chinadaily.com.cn/a/201901/14/WS5c3bc831a3106c65c34e422f.html.

43 Frank A. Rose, "Safeguarding the Heavens: The United States and the Future of Norms of Behavior in Outer Space," (Washington, DC: The Brookings Institution, June 2018), https://www.brookings.edu/research/safeguarding-the-heavens-the-united-states-and-the-future-of-norms-of-behavior-in-outer-space/.

44 Sam Jones, "U.S. and China set up space hotline," *Financial Times*, November 20, 2015, https://www.ft.com/content/900870f4-8f9f-11e5-a549-b89a1dfede9b.

45 Mike Gruss, "U.S., China will meet this year to talk space debris," Space News, September 22, 2016, http://spacenews.com/u-s-china-will-meet-this-year-to-talk-space-debris/.

46 "The Second Meeting of the U.S.-China Space Dialogue," U.S. Department of State, October 24, 2016, https://2009-2017.state.gov/r/pa/prs/ps/2016/10/263499.htm.

47 "U.S. Fact Sheet for President Obama's Bilateral Meeting with President Xi Jinping," The White House, September 3, 2016, https://obamawhitehouse.archives.gov/the-press-office/2016/09/03/us-fact-sheet-president-obamas-bilateral-meeting-president-xi-jinping.

48 Andrew Jones, "China and US quietly hold third Civil Space Dialogue, discuss exploration plans and cooperation, GBTimes, December 11, 2017, https://gbtimes.com/china-and-us-quietly-hold-third-civil-space-dialogue-discuss-exploration-plans-and-cooperation.

49 Andrew Jones, "U.S., China set for spring Civil Space Dialogue on exploration, science," Space News, January 20, 2020, https://spacenews.com/u-s-china-set-for-spring-civil-space-dialogue-on-exploration-science/.

50 Jeff Foust, "The challenges to Chinese space cooperation," Space News, October 29, 2018, https://spacenews.com/foust-forward-the-challenges-to-chinese-space-cooperation/.

51 "Deputy Assistant Secretary Thomas DiNanno to Travel to China," U.S. Department of State, June 17, 2019, https://www.state.gov/deputy-assistant-secretary-thomas-dinanno-to-travel-to-china/.

52 Douglas Loverro, "Statement of Douglas Loverro before the House Committee on Armed Services and Subcommittee on Strategic Forces on Fiscal Year 2016 National Defense Authorization Budget Request for National Security Space Activities," (Washington, DC: House Armed Services Committee, Subcommittee on Strategic Forces, March 22, 2015) https://docs.house.gov/meetings/AS/AS29/20150325/103106/HHRG-114-AS29-Wstate-LoverroD-20150325.pdf.

53 Frank A. Rose, "Re-establishing U.S. Space Command is a great idea," The Brookings Institution, January 7, 2019, https://www.brookings.edu/blog/order-from-chaos/2019/01/07/re-establishing-u-s-space-command-is-a-great-idea/.

54 Michael Gordon, "U.S. Invites China for Talks on Nuclear Arms," *The Wall Street Journal*, December 20, 2019, https://www.wsj.com/articles/u-s-invites-china-for-talks-on-nuclear-arms-11576890374.

55 Frank A. Rose, "Safeguarding the Heavens."

56 For a greater discussion of potential options, see Frank A. Rose, "India's anti-satellite test presents a window of opportunity for the Trump administration. Will it take advantage?"

57 "National Security Strategy of the United States of America," (Washington, DC: The White House, December 2017), https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf.

58 Thomas J. Wright, *All Measures Short of War: The Contest for the 21st Century and the Future of American Power* (New Haven, CT: Yale University Press, 2017), 218.

## ABOUT THE AUTHOR

**Frank A. Rose** is a senior fellow for security and strategy in the Foreign Policy program at the Brookings Institution. He focuses on nuclear strategy and deterrence, arms control, strategic stability, missile defense, outer space, and emerging security challenges. Prior to joining Brookings, Rose served as U.S. assistant secretary of state for arms control, verification, and compliance from 2014-17. From 2009-14, Rose served as the U.S. deputy assistant secretary of state for space and defense policy. He has also held positions at the U.S. Department of Defense, in the U.S. Congress, and the private sector. Rose received his bachelor's degree in history from American University in 1994 and a master's degree in war studies from King's College, University of London in 1999.

## ACKNOWLEDGEMENTS

The author would like to thank the following individuals for their assistance in the preparation of this paper and comments on drafts: Kristen BelleIsle, Michael O'Hanlon, Ted Reinert, Rachel Slattery, Mallory Stewart, and an anonymous reviewer.