China and NASA: The Challenges to Collaboration with a Rising Space Power

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Executive Summary:
The People's Republic of China is shifting the contemporary geopolitical landscape with its rise as an economic and military power. This new reality has moved the United States (US) to adjust its domestic and foreign policies to address this emergence, particularly in civilian and defense space activities. China's rise as an international space power brings both challenges and opportunities to the US civilian space operations at the National Aeronautics and Space Administration (NASA) in terms of collaboration with its Chinese counterparts. Currently, the US collaborates with Chinese government entities in the areas of science and research across a variety of civilian agencies, including the National Oceanic and Atmospheric Administration (NOAA) and the Department of Energy (DOE). Until 2011, NASA was one of the agencies that started meeting with its Chinese counterparts at the China National Space Administration (CNSA) to trade scientific knowledge and discuss potential areas of collaboration through working groups. This collaboration stopped following the passage of language in the Department of Defense and Full-Year Appropriations Act that was first passed in a 2011 continuing resolution by Congress that banned bilateral meetings and any collaboration between NASA and Chinese government agencies. The reason behind this ban is founded on concerns over technology theft and human rights violations by China's communist government. However, this policy contradicts the broader science and technology policy outlined in the US-China Agreement on Cooperation in Science and Technology of 1979 that promotes civilian collaboration with the Chinese government within areas of scientific research. While other world space agencies are finding ways to collaborate with China on civilian space exploration, NASA is missing out on opportunities to collaborate with a rising power that has space station and deep space exploration ambitions.

NASA should be allowed to resume bilateral discussions with its Chinese counterparts at CNSA and the Chinese Academy of Sciences to exchange scientific data and explore ways to collaborate on scientific missions. This avoids direct collaboration on human missions, which would require collaboration with the China Manned Space Agency (CMSA), which resides under the People's Liberation Army (PLA). However, working with CNSA and the Chinese Academy of Sciences would

keep NASA informed of CMSA's activities. Despite concerns over technology theft and humanitarian violations, the current collaboration ban is a standalone in US policy rather than a part of a concerted effort to influence Chinese leaders to change state actions. Instead, the Congressional language only ostracizes NASA from the global space community at a time when NASA wants to maintain its leadership role.

I. China's Space History and Bureaucracy

China's space capabilities first began with the implementation of the "863" high-technology program by China's then leader, Deng Xiaoping, in the late 1980s.[1] This program laid a foundation of technology and industrial growth which has given rise to China's modern day economy. The multibillion-dollar program also led to the advent of Chinese space programs in the early 1990s. Unlike NASA, which performs a variety of space missions from human to robotic, China segments its human and robotic activities into two agencies, the China Manned Space Agency (CMSA) and the China National Space Administration (CNSA).[2] CMSA controls human spaceflight and is a branch of the People's Liberation Army (PLA) under its General Armaments Department.[3] CNSA is a civilian agency that performs mainly scientific and robotic missions. Unlike NASA, CNSA is a third tier bureaucratic organization under the State Administration for Science and Technology Industry which functions under the Ministry of Industry and Information Technology. The leadership throughout this bureaucratic system, as with all leadership in the Chinese government, is held by members of the Chinese Communist Party (CCP). Furthermore, CMSA and CNSA are not mutually exclusive. Though led by PLA officers, CMSA leadership does consist of members of the Ministry of Industry and Information Technology and the Chinese Academy of Sciences who are listed as "Deputy Commanders".[4] Even past CNSA administrators have served in CMSA leadership. However, every launch, mission control, and tracking facility is operated through the PLA.[5] Thus, any NASA collaboration with China could include direct involvement with PLA personnel depending on the type of project.

The set policy for CMSA from its inception has been a three-step development strategy.[6] First, achieve human spaceflight capabilities. Second, develop a crewed space laboratory module in low-Earth orbit. Third, develop a space station in low-Earth orbit for a three person crew that remains operational over a ten year lifespan. The first step was achieved with the successful launch of the Shenzhou 5 spacecraft in 2003.[7] The Shenzhou spacecraft is similar in design to the Russian Soyuz and was launched on a Long March launch vehicle to achieve low-Earth orbit. In 2013, the second step was achieved when the Tiangong-1 lab module was successfully launched and placed into low-Earth orbit followed by the Shenzhou X crew of three astronauts who successfully docked with the module.[8] Despite these successes, CMSA Director Wang Zhaoyao noted after the Tiangong-1 mission:

> As we celebrate our success, we also realize the fact that there is still a gap between China and the leading countries in terms of human

> spaceflight technology and capability. Much remains to be done for us to live up to the state's needs and our people's expectations.[9]

In late 2016, China plans to launch a second lab module, Tiangong-2, to low-Earth orbit that will be later occupied by two astronauts.[10] The ultimate goal for CMSA is to complete a low-Earth orbit station by 2022 starting with the launch of a core module in 2018.[11]

For CNSA, their sights are primarily set on the Moon. Proposed in 2000, CNSA set out a three phase approach to lunar exploration.[12] First, launch and orbit a spacecraft to map the Moon's surface. Second, achieve a soft-landing of a lunar rover. Third, perform a lunar sample return mission. The first step was achieved in 2007 with the successful launch and mission of the Chang'e-1 Moon orbiter, which was followed by a second successful orbiter, Chang'e-2, in 2010. The second step was mostly achieved in 2013, with the successful soft-landing of the Chang'e-3 Moon lander and the Yutu rover.[13] However, Yutu experienced malfunctions in its driving unit shortly upon landing.[14] CNSA has pursued other missions outside the Moon, including a failed robotic orbiter mission to Mars, Yinghuo-1, in 2011 after an unsuccessful launch.[15] In 2017, CNSA plans to execute the final phase of strategy with the launch of a robotic spacecraft, Chang'e-5, to the Moon to collect and return lunar samples to Earth.

Another result of the 863 program was a focus on developing China's aerospace industry. This led to the establishment of the China Aerospace Science and Technology Corporation (CASC) and the China Aerospace Science and Industry Corporation (CASIC), government entities under the Ministry of Industry and Information Technology focused on the development of China's industrial base.[16,17] CASC and its subsidiaries are integral to CMSA and CNSA as they are responsible for the development of China's Long March launch vehicles, Shenzhou space capsules, and robotic space probes.[18] However, both of these government owned corporations have been hampered at times by their government ownership, numerous responsibilities, and ancillary product lines.

China's annual space budget has been estimated to be between $1.4-2.2 billion to as high as $8 billion.[19, 20] China's currency practices also provide an added challenge of translating their budget into comparable US dollars. Ultimately, these estimates are difficult to confirm given China's "budget opacity".[21] However, many sources agree that China has been increasing its allocations across various space-related civilian and defense programs to achieve its ambitious space objectives.[22]

II. China's Military Objectives in Space

As with most foreign policy issues around China, it is difficult to ascertain the exact goals of the Chinese space program given the PLA's involvement. Coupled with the overlapping responsibility and influence on decision makers within the Chinese bureaucracy, this makes for a level of uncertainly unlike those experienced in Western space agencies.[23] As with the history of most national space programs, the CCP utilizes CMSA and CNSA as tools both to garner respect internationally and legitimacy internally.[24] Thus, there is incentive to ensure that missions are carefully

orchestrated and executed in a way that minimizes the risk of international and national embarrassment.

PLA officer writings on the topic of space provide various doctrines around the weaponization of space, which range from "no first use" of firing weapons in space unless first fired upon, to writings that consider space weapons a natural evolution of military technology.[25] There are even military teachings that promote the idea of purposefully creating space debris to take out enemy satellites even at the risk of damage to Chinese space assets.[26] Tensions between the U.S. and China came into spotlight with the highly publicized Chinese kinetic anti-satellite test on a defunct Chinese weather satellite in 2007. More recently, a Chinese rocket launched in May 2013, which was reported as a research mission, has come under fire as actually being a test of a new anti-satellite weapon.[27] President Xi Jinping, speaking to the People's Liberation Air Force in April 2014, urged officers "to speed up air and space integration and sharpen their offensive and defensive capabilities."[28] The Pentagon has characterized China's overall military development as part of its agenda to prepare the PLA to "fight and win, short-duration, high-intensity regional military conflicts."[29] However, while space plays a role in that agenda, the Pentagon also views space as an arena for the PLA to project "extended-range power" for global conflicts with countries like the US.[30]

III. Congressional Restrictions on NASA's Interactions with China

The major impediment to NASA's ability to collaborate with CMSA, CNSA, or the Chinese Academy of Sciences is language under the Congressional Department of Defense and Full-Year Appropriations Act that was first passed in a 2011 continuing resolution. Section 1340(a) of this act strictly banned NASA and the Office of Science and Technology Policy from working with Chinese entities.[31] Specifically, no appropriated funds may be used "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."[32] Exceptions to this restriction include hosting Chinese nationals at NASA facilities as long as prior notice and certain assurances are given to Congress that proper security measures are taken.[33] Similar language has continually appeared in subsequent appropriations bills.

The primary author of this language comes from former House Representative Frank Wolf who previously chaired the House Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies that oversees NASA's funding.[34] As co-chairman of the House bipartisan Human Rights Commission, Chairman Wolf opposed the CCP due to its history of human rights violations.[35] From his perspective, collaboration with the CCP's authoritarian government in something as highly visible as space may be perceived as a "moral compromise" that damages the US's international standing on human rights issues.[36] In a 2013 letter to NASA Administrator Charles Bolden, Chairman Wolf reiterated China's human rights violations and stated that Chinese citizens "long for the U.S. government to find a common cause with the Chinese people not with those who persecute them."[37] His successor to the appropriations subcommittee, John Culberson, continues to include similar language in NASA appropriations bills.

Another concern that has been prevalent among Congressional attitudes like those of Chairmen Wolf and Culberson on China is security. Chinese nationals stealing US technology to enhance PLA defense systems or provide economic advantages to Chinese companies pose challenges to collaboration with Chinese entities. Much of these concerns have been reinforced by several espionage incidents. In 2013, NASA contractor and Chinese national, Bo Jiang, tried to fly to China with a NASA laptop containing sensitive government materials before being arrested.[38] While the laptop did not contain classified material and Jiang was allowed to return to China after a misdemeanor conviction, two NASA supervisors were indicted in late 2015 as part of the case.[39] In response to the indictment, Chairman Culberson reiterated the importance of continued Congressional restrictions and oversight on NASA in regards to security stating, "[the] indictment is further proof of widespread negligence at NASA and throughout the Obama Administration when it comes to protecting U.S. intellectual property and sensitive information."[40]

This incident follows other Chinese espionage activities within the aerospace industry. In 2010, a Chinese-born Boeing engineer named Dongfan Chung was convicted on six counts of espionage for the theft and passage of aerospace technical documents to China that were collected over the course of 30 years.[41] The stolen documents included information on a phased-array antenna designed for the Space Shuttle and on a Delta IV booster rocket fueling mechanism.[42] This followed the 2009 conviction of another Chinese-born US national, Shu Quan-Sheng, who as head of a US manufacturing company helped China design and develop a cryogenic fueling system for space launch vehicles.[43] Additionally, Chinese entities have also undertaken espionage activities in cyberspace against US companies and federal agencies.[44] Both the National Security Agency and the Federal Bureau of Investigations have repeatedly warned US companies and fellow government agencies about the security threat that Chinese hackers present.[45]

Contention around US-China relations in the area of space technology has its roots in a series of controversies in the 1990s during which Congress investigated possible violations of US export control regulations between US and Chinese companies.[46] The investigation and subsequent report were developed and led by the Cox Committee that was established by Congress in 1998. The Cox Committee declared that US satellite manufacturers had transferred technology to Chinese engineers during their assistance with launch vehicle failure investigations in the 1990s, which violated export control laws. Legislation as a result of the Cox Committee's findings led to the transfer of all satellite-related items from the Department of Commerce to the jurisdiction of the Department of State's International Traffics in Arms Regulations, which is much more restrictive of these technologies and lists China as a country where items under regulation are strictly prohibited.[47] Originally, the law denied the President the discretionary authority to pick and choose which satellite technologies should fall under the Department of State regulations; however, the 2013 defense authorization bill returned this authority.[48] The Obama Administration put in place new rules that shifted some space-related technologies back under the less restrictive jurisdiction of the

Department of Commerce.[49] This could lead to a major boost in business for both US satellite manufactures and CASC. According to CASC, China purchased more than $1 billion in US manufactured satellites in the 1990s prior to the regulatory restrictions.[50]

However, the interpretation of appropriations language around Chinese nationals at NASA facilities has led to some controversy. During a 2013 Kepler Science Conference at NASA's Ames center, Chinese nationals were initially turned away as a result of NASA's interpretation of the provision.[51] This led to a public uproar within the scientific community and later led to a rebuke from Congress on NASA's interpretation of the law. Then Congressmen Wolf stated that the Chinese nationals should be allowed to participate because they are not part of an official Chinese delegation.[52] Furthermore, according to Wolf, the provisions around China and NASA in appropriation's language still "allow opportunities for limited engagement."[53] These opportunities include multilateral venues and exceptions for direct engagement as long the President can certify to Congress that none of the Chinese participants are known human rights violators and that there is no risk of technology transfer.[54]

IV. Past and Present NASA-China Interactions

Before the bilateral engagement restrictions with China appeared in the 2011 appropriations bill, NASA and CNSA had taken some small collaborative measures. The first was Administrator Sean O'Keefe's hosting of the CNSA Administrator at NASA Headquarters in 2004. This was simply labeled as a courtesy visit and no official business was discussed or proposed.[55] Later in 2006, however, Administrator Mike Griffin became the first acting NASA administrator to visit China to meet with CNSA leaders and Chinese Academy of Sciences members, as well as to tour some of China's space facilities.[56] During this trip, there were initial discussions on possible collaborative efforts around science and robotic missions.[57] China even issued a four-point proposal to establish ongoing dialogue between the two agencies with annual exchanges and confidence building measures following this visit.[58] However, no plans for cooperation in human spaceflight were discussed during this visit because of the amount of transparency NASA requires to collaborate on these types of missions.[59]

Shortly after Griffin's visit, engagement with Chinese counterparts was halted in January 2007 following the Chinese anti-satellite weapon test, which destroyed a decommissioned Feng Yun weather satellite.[60] However, engagement activities resumed in 2008 due to the convening of bilateral working groups on the topics of Earth and space science with representatives from CNSA and NASA.[61] The tagline from NASA was that these working group meetings were "based on the principles of mutual benefit, reciprocity, and transparency."[62] NASA also stated that any proposals for specific projects between NASA and CNSA that resulted from these working group sessions would undergo a careful review process within the US government before any action could occur.[63]

These working groups in 2008 achieved a format for discussion around possible bilateral agreements for future missions. Additionally, they allowed for the opportunity to understand China's objectives in space and

led to data exchanges between NASA and CNSA.[64] The benefit of the scientific data exchanges was that NASA gave CNSA what was already publicly available data, while CNSA in exchange provided non-publically available data to NASA.[65] NASA was careful to ensure that these discussions were in line with US policy and had the blessing of the White House.[66]

These bilateral working groups were permanently suspended upon the passage of Congress's restrictions on collaboration with China entities in 2011. Currently, NASA only interacts with its Chinese counterparts through multilateral discussions and events. One forum for multilateral discussion is the International Space Exploration Coordination Group (ISECG). The ISECG is a mechanism formed by 14 international space agencies, including CNSA and NASA, to discuss exploration efforts and strategy.[67] ISECG is both voluntary and non-binding to allow for exchanges in visions and opportunities to strengthen national programs and global collective efforts without the political burdens of formal diplomatic negotiations. At times, the exact status of CNSA's involvement in the ISECG has been somewhat convoluted. A CNSA representative stated at a September 2013 multilateral panel in Beijing that CNSA was still waiting on an invitation to become a full member of the ISECG.[68] Conversely, other agencies have stated that CNSA is already an observer to the ISECG, and NASA Administrator Charles Bolden also stated that China is part of the ISECG.[69] Despite the confusion, in November 2013, CNSA presented and shared plans for its Chang'e-3 mission, future robotic missions, and the CMSA space station program at an ISECG meeting.[70] This presentation also included plans for a new robotics mission to Mars, which would include an orbiter and rover within a 2019 to 2021 timeframe.[71] In January 2014, a Chinese delegation consisting of CNSA and CMSA officials attended an International Space Exploration Forum and a Heads of Space Agencies Summit in Washington, DC.[72] During this event, Administrator Bolden met with his CNSA counterpart, Administrator Xu, but not with CMSA Director General Wang Zhaoyao, a PLA officer.[73]

V. China's Expansion of Space Partnerships

While China has asserted its space power credentials with the 2007 anti-satellite weapon test and its recent successes in both its human and robotic programs, China has also actively worked to collaborate bilaterally with other space powers beyond the US to establish itself as a major space power. China has ratified four of the five major international space treaties: the 1967 Outer Space Treaty, the 1968 Rescue and Return Agreement, the 1972 Liability Convention, and the 1975 Registration Convention.[74] Despite controversy around the debris created from the 2007 weapon test, China was also a partner in the development of the Space Debris Mitigation Guidelines that was adopted by the United Nations Committee on the Peaceful Uses of Outer Space in 2002 and updated in 2007.[75] China has also claimed that it has contributed to space debris mitigation efforts through enhancements in its Long March rockets and the removal of aging satellites from geostationary orbit.[76]

In March of 2014, France's spacy agency, Centre National d'Etudes Spatiales, and CNSA agreed to a joint ocean-surface research satellite called the China-French Oceanic Satellite.[77] The satellite is scheduled to launch in 2018 on a Long March rocket with a

Chinese made wind-measurement scatterometer and a French made wave-scatterometer/spectrometer. The French also have plans to perform cardiovascular studies in the China's Tiangong lab module and agreed to investigate a possible joint venture in 2020 in the area of space-based astronomy.[78]

Beyond France, China has also sought further collaboration within Europe. The European Union and China have had a collaborative framework for space activities established since 1998.[79] In 2011, European Space Agency Director of Human Spaceflight and Operations Thomas Reiter even stated that "Cooperation with China offers great potential and there are great perspectives for it."[80] European astronauts have already begun visiting training sites in China in preparation for future collaboration.[81]

China is also active in collaborating with developing countries, including emerging space powers, as part of a larger effort to boost its international presence. In late 2015, China pledged $2 billion in foreign aid to developing countries and initiated debt forgiveness programs for least-developed countries.[82] In the space industry, China offers numerous services, including construction, launch, insurance and financing for telecommunications satellites for Bolivia, Laos, Nigeria, and Venezuela.[83] China also has a strong history of space and science cooperation with Brazil.[84] Since 1999, the two nations have developed and jointly operated Earth observation satellites under the China-Brazil Earth Resources Satellite program. These satellites are launched from China on Long March vehicles.[85]

VI. Possible Opportunities and Templates for Future Collaboration

Lei Fanpei, vice president of CASC, stated in 2011 that CASC sees three areas where the US and China can find future collaboration.[86] First is open commercial access to each nation's satellites and launch vehicles. Second is collaboration in science and human spaceflight. Third is collaboration around satellite disaster monitoring and management. There are US agencies that have had major collaboration efforts with China that may provide a template for future collaborations. These agencies include the National Oceanic and Atmospheric Administration (NOAA) and the Department of Energy (DOE). NOAA has had ties to the China Meteorological Administration for over 30 years.[87] In 2015, NOAA and the China Meteorological Administration completed their 19th joint working group session to promote disaster preparedness and meteorological modernization.[88] NOAA has also looked to incorporate weather data from Chinese Feng Yun satellites into US weather forecast models to fill a projected gap in NOAA's polar satellite coverage.[89] DOE's cooperation with China also extends over 30 years with joint studies into nuclear physics and fossil energy. DOE even recently collaborated with China civilian agencies and 14 other countries to build and sponsor the first magnetic spectrometer to be placed in orbit on the International Space Station (ISS) to search for evidence of dark matter.[90] NASA was also a partner in this effort. However, it only worked directly with the DOE and had no interaction with any Chinese agency.[91] The Chinese contribution to this effort has sometimes been used to classify China as a nation that "participate[s]" in ISS activities.[92]

These examples by other civilian agencies demonstrate that collaboration in space-related activities is possible and is ongoing at other agencies today. While there are misgivings in Congress over NASA and Chinese collaboration, it is also important to note that funding for NOAA falls under the jurisdiction of the same appropriations subcommittees as NASA, which has allowed NOAA the flexibility to collaborate with their Chinese counterparts. If the provisions prohibiting bilateral cooperation in the appropriations bill were to be removed, then NASA would probably first resume the working groups established in 2008, which is similar to how NOAA operates with its Chinese counterparts.[93] Reportedly, Administrator Bolden met with the president of the Chinese Academy of Sciences at an International Astronautical Congress hosted in Beijing in fall of 2013. At this discussion, Bolden was reported to have stated interest in cooperation with China, particularly in the area of Earth science.[94] However, between space and earth science, space science may be easiest area to find collaboration as the Chinese may shy away from Earth science on the basis of the potential negative publicity that pollution research may bring to the CCP.[95]

VII. Recommendations

Concerns and ambiguity around the PLA's involvement, space objectives, and desires to steal US technology require close scrutiny in any US civilian collaboration. However, any future space mission between the two nations could serve as a diplomatic goal towards defusing potential military conflicts. In fact, the Council on Foreign Relations has suggested civilian space cooperation with China as a confidence building measure as part of its policy recommendations to address space security issues.[96] Even in the midst of the Cold War, NASA and its Russian counterparts successful planned and executed a joint human spaceflight mission, the Apollo-Soyuz mission in 1975. Astronaut Vance Brand, a US crew member on that mission, stated that "We were a little of a spark or a foot in the door that started better communications."[97] As US – Russia relations normalized, those communications would eventually culminate in the success of over 15 years of scientific partnership onboard the ISS today. Even while US – Russia relations have deteriorated in recent years, this has yet to have a major impact on ISS activities as both nations continue to see mutual benefits from collaboration on an asset that required significant investment and work to complete. As former NASA Administrator Mike Griffin has argued in regards to possible future NASA collaboration efforts with China, "It is never wrong for the US to try to figure out ways to engage with other societies, whether or not they are friends or adversaries. If you are talking, you are not fighting."[98] If NASA can successfully collaborate on civilian space missions with Russia today and other US agencies like NOAA regularly interact with their Chinese counterparts, then Congress' ban on NASA and China collaboration is at odds with broader US science and technology policy. While the origins of this ban are based on important security and humanitarian issues, the ban seems to have little influence over CCP leadership. However, the ban does hamper the ability of NASA and Chinese scientists to share important scientific information and to explore ideas on possible joint scientific ventures. Therefore, the first action Congress should take is to remove this appropriations language. NASA should then create formal relations with civilian Chinese entities through renewed working groups to

explore collaboration possibilities. Next, there needs to be the creation and passage of a new NASA Authorization Act that lays out a direction for NASA priorities, with an emphasis on international negotiations and collaboration. This is prudent as there has not been a new authorization act instituted since 2010. That act only lays out appropriations authorization language up to fiscal year 2013. Based on the priorities defined in a new authorization act and the outcomes of working groups, NASA should evaluate what areas CNSA and the Chinese Academy of Sciences could be valuable partners. Congress and appropriate regulatory bodies shall continue to provide oversight over NASA's security of intellectual property just as it does for all NASA activities today.

CNSA and the Chinese Academy of Sciences are the most logical potential partners for NASA interaction and collaboration because they are civilian agencies not under the PLA. Additionally, there is a precedent of collaboration already established with these two entities from the suspended 2008 NASA working groups. Of potential areas of cooperation and interaction for NASA and CNSA or the Chinese Academy of Sciences, focus should be placed on space science, which offers the least amount of political risk and a logical first step in establishing a working relationship. Examples like the internationally developed spectrometer for the ISS and science data sharing programs provide mutual benefit through shared costs and scientific advancement. China's scientific and space agreements with other Western space powers could also serve as a template of future multilateral or bilateral collaboration activities for NASA as well.

VIII. Conclusions

Ultimately, collaboration with China comes down to what NASA's objectives are for the next ten to twenty years. A "Moon first" or "Asteroid first" approach for human spaceflight as a precursor to an ultimate mission to Mars and the future of the ISS affects NASA's long-term considerations in regards to China as a potential space partner. Mutual benefit of any collaborative effort is just as important as transparency and reciprocity when dealing with such expensive and risky endeavors. Through its own successes and international agreements, China has demonstrated that its future in space is not dependent on US assistance. Therefore, China will only likely join a collaborative effort where it sees itself as an equal party and perceives definitive benefits. The next US presidential administration and Congress will have to decide on a clear, long-term path for NASA through new NASA authorization and appropriations language that is cognizant of the looming security challenges and indicates to potential international partners the requirements and opportunities for involvement.

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