Statement of Dr. Namrata Goswami
Independent Senior Analyst and Author
2016-2017 Minerva Grantee
Before the U.S.-China Economic and Security Review Commission
Hearing on "China in Space: A Strategic Competition?"
April 25, 2019

This statement is submitted to the U.S.-China Economic and Security Review Commission (Commission), based on my decades old research on China as a major power in international politics and specifically of studying China's space program. My focus today is on China's space program and its long-term ambitions and goals. I would like to thank the Commission for this opportunity to appear before it. The Commission posed a few broad questions to me. I aim to answer them in the following order: a) What are the current status and future goals of China's space exploration programs, including asteroid mining, a lunar base, and on-site resource exploitation? How capable is China of achieving these goals? b) To what degree are China's civilian space programs guided by dual-use aims rather than purely civilian scientific research purposes? Related to that: how does China's international sharing of the outcomes of its space scientific research reflect the primary aims of these programs? c) What access agreement terms China is offering prospective partners for its planned space station, and how successful has China been in attracting partners? d) policy recommendations.

Current Status of China's Space Program. China's capability to launch, establish presence and conduct deep space exploration and resource utilization has undergone significant shifts in the last few decades.[1] In 2018, China achieved the world's largest number of space launches (39), compared to the U.S. (31) and Russia (20).[2] As of November 30, 2018, China has the second largest number of operating satellites (284), compared to the U.S. (849).[3] In early 2019, China landed a lander and rover on the far side of the Moon (*Chang'e 4*), registering a first for humanity.[4] On March 10, 2019, China achieved another milestone with its *Long March 3B* rocket when it successfully launched for the 300th time. The *Long March* carrier rockets are developed by the China Aerospace Science and Technology Corporation (CASC).[5] This July, China will attempt to launch the *Long March 5 Y3*,[6] its heavy lift rocket (25 metric tons to Low Earth Orbit). Its payload capacity is more than double of any other Chinese rocket.[7] The *Long*

[1] The author conducted interviews with Chinese space and security experts in Beijing and Shanghai, China, November 2016.
[2] Ivan Couronne, "In Space, the US Sees a Rival in China", Phys.org, January 6, 2019 at https://phys.org/news/2019-01-space-rival-china.html (Accessed on April 13, 2019).
[3] Union of Concerned Scientists, "UCS Satellite Database", November 30, 2018 at https://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database (Accessed on April 19, 2019).
[4] "China Moon Mission Lands Chang'e 4 Spacecraft on Far Side", BBC, January 3, 2019 at https://www.bbc.com/news/science-environment-46724727 (Accessed on April 17, 2019).
[5] "China Long March Rocket Completes 300 Launches", China Aerospace Science and Technology Corporation," March 13, 2019 at http://english.spacechina.com/n16421/n17212/c2516621/content.html (Accessed on April 13, 2019).
[6] Andrew Jones, "China will attempt 30-plus Launches in 2019, including crucial Long March 5 Missions", SpaceNews, January 29, 2019 at https://spacenews.com/china-will-attempt-30-plus-launches-in-2019-including-crucial-long-march-5-missions/ (Accessed on April 13, 2019).
[7] Zhao Lei, "Scientists Find Solutions to Keep Rockets Working", *China Daily*, April 17, 2018 http://www.chinadaily.com.cn/a/201804/17/WS5ad52fb0a3105cdcf65189c1.html (Accessed on April 19, 2019).

March 5 Y2 heavy lift rocket suffered a failure during launch in 2017.[8] The *Long March 5 Y3* launch was announced by CASC Vice President, Yang Baohua in a press conference in Beijing on January 29.[9] This launch will test the *Dong Fang Hong* 5 (DFH-5) satellite platform, constructed to support satellites from 6,500kgs to 9,000kgs.[10] The success of the *Long March 5 Y3* is critical as China's *Chang'e 5* lunar sample return mission depends on its success for launch later this year, on the *Long March 5 Y4*.[11] That mission aims to collect two kilograms of lunar rocks and regolith, from an area near the Mons Rümker in Oceanus Procellarum on the lunar near side. Other missions planned for 2019 include the launch of its *Long March 11*, which will attempt the first sea-based launch from the Yellow Sea. According to Jin Xin, Deputy Commander-in-Chief of CASC's Department of Astronautics, "picking the country's Yellow Sea waters for the first sea launch attempt is to reduce launch technical difficulties and the launch service will expand to cover potential users from countries along the routes of the Belt and Road initiative as the technology matures".[12] In connection to the Belt and Road Initiative (BRI), China launched two *Beidou* (BDS)-3 satellites in November 2018, and started providing basic GPS services to countries along BRI.[13] In 2018, China sent up 18 satellites connected to the BDS-3. Wang Jingang, the chief deputy designer of the BDS-3 satellites specifies, "It's a rare chance to devote my intelligence to a symbolic national project…people still mainly depend on navigation by GPS, supplemented by BDS. I hope that in a few years, people can be navigated mainly by BDS".[14] In January 2019, China established its first state funded Space-Based Solar Power (SBSP) plant in Chongqing, a concept supported by Li Ming, the Vice President of the China Academy of Space Technology (CAST).[15] The Chinese state funded space program is currently estimated to be about $8 billion.[16] Euroconsult estimated the size of the Chinese space value chain to be $16 billion in 2017.[17] In 2018 alone, the Chinese commercial space industry received new investment totaling

---

[8] Jeff Foust, "China's Powerful Long March 5 Rocket Fails on Second Launch", *Space.com*, July 03, 2017 at https://www.space.com/37376-china-long-march-5-rocket-failure.html (Accessed on April 17, 2019).
[9] "China to Send over 50 Spacecraft into Space via over 30 Launches in 2019", *Xinhuanet*, January 30, 2019 at http://eng.chinamil.com.cn/view/2019-01/30/content_9417217.htm (Accessed on April 13, 2019).
[10] Andrew Jones, "China will attempt 30-plus Launches in 2019, including crucial Long March 5 Missions", n.13.
[11] Deng Xiaoci, "China's Long March 5 Rocket to Resume Flight in July", *Global Times*, January 29, 2019 at http://www.globaltimes.cn/content/1137449.shtml (Accessed on April 18, 2019).
[12] Ibid.
[13] "China Focus: China's BeiDou Navigation System Starts Global Service", *Xinhua*, December 27, 2018 at http://www.xinhuanet.com/english/2018-12/27/c_137702707.htm (Accessed on April 18, 2019).
[14] "From Compass to BeiDou: Chinese Wisdom Help Navigate Belt & Road", *China Daily*,
[15] "China Starts to Build World's First Space-Based Solar Power Plant", CGTN, February 18, 2019 at http://www.ecns.cn/news/economy/2019-02-18/detail-ifzeratr8870758.shtml (Accessed on April 18, 2019).
[16] "China Dream :The First Solar Power Station in Space, *The Hindu Business Line*, February 18, 2019 at https://www.thehindubusinessline.com/news/science/chinas-dream-the-first-solar-power-station-in-space/article26304887.ece (Accessed on April 19, 2019).
[17] Euroconsult, "China Space Industry 2018", at http://euroconsult-ec.com/research/China-space-industry-2018-brochure.pdf (Accessed on April 19, 2019).

$2 billion.[18] In 2019, there are no less than 11 Chinese private startups focused on space launch.[19]

China's Future Space Goals.

In light of that, what does the Commission need to know about the Chinese Space Program's future goals?

1. China intends to be the #1 space power by 2045. At the highest levels of PRC policy, China has set itself a goal to exceed all others by 2045 in time for its 100-year celebration of the establishment of the People's Republic of China (PRC). This goal is comprehensive in scope: Industrial, Logistic, Diplomatic, Economic.[20] The goals, articulated by the China Academy of Launch Vehicle Technology (CALVT) was published in the front pages of the *People's Daily* in November 2017. [21] Li Hong, Director of CALVT specified that by 2045, China will possess advanced space transportation in the world. The way to achieve this is to develop nuclear-propelled spacecrafts by 2040. Wang Changhui, Associate Professor of aerospace propulsion at the School of Astronautics at Beihang University in Beijing specified, "The nuclear vessels are built to colonise the solar system and beyond,".[22] The idea is to build a transport hub, that orbits Earth; the nuclear shuttles will be docked permanently there, and reusable spacecrafts would be utilized to transport humans and cargo to and from the nuclear shuttles.[23] These space goals have been repeated and supported by China's top space policy-making body, the CNSA and CAST.[24] To call this a space exploration program is misleading; this is a program for industrial and economic dominance of the Cis-Lunar System.

2. China's 2040 Grand Design. By 2040, China has a grand design of its space infrastructure and activities that will make it a comprehensive space power, which includes:

---

[18] Micheal Sheetz, "China Increases Investment in Emerging Private Space Industry", CNBC, October 10, 2018 at https://www.cnbc.com/2018/10/10/china-increases-investment-in-emerging-private-space-industry.html (Accessed on April 19, 2019).

[19] Jean Deville, , "The Technical Choices of China's New Space Launcher Companies in 2019", *The China Aerospace Blog*, April 14, 2019 at https://china-aerospace.blog/2019/04/14/the-technical-choices-of-chinas-newspace-launcher-companies-in-2019/ (Accessed on April 19, 2019).

[20] See Stacey Solomone, *China's Strategy in Space* (Springer, 2013). Also see Brian Harvey, *China's Space Program-From Conception to Manned Spaceflight* (Springer Praxis Books, 2004). Also see Michael Pillsbury, *The Hundred-Year Marathon China's Secret Strategy to Replace America as the Global Superpower* (New York: St Martin's Griffin, 2016).

[21] Stephen Chen, "China's Nuclear Spaceships will be 'Mining Asteroids and Flying Tourists' as it aims to overtake the US in a Space Race," *South China Morning Post*, November 17, 2017 at https://www.scmp.com/news/china/policies-politics/article/2120425/chinas-nuclear-spaceships-will-be-mining-asteroids (Accessed on April 13, 2019).

[22] Ibid.

[23] Ibid.

[24] "China Outlines Roadmap for Deep Space Exploration", *Space Daily*, April 26, 2018 at http://www.spacedaily.com/reports/China_outlines_roadmap_for_deep_space_exploration_999.html (Accessed on April 17, 2019).

a. Full conversion to re-usable launch vehicles.[25]According to Bao Weimin, Director of the Science and Technology Commission at CASC and an academician at the China Academy of Sciences (CAS), "China's reusable carrier vehicle will use technologies different from those of U.S. commercial space firm SpaceX".[26] This was reiterated by Long Lehao, the Chief Designer of carrier rockets at the CALVT, who stated, "As the current Long March 2, 3, 4 series rockets are fueled by toxic propellants, they cannot be recycled. But we are developing technologies to precisely control the fall of the rocket remains to ensure safety".[27]
b. Operation of nuclear power shuttles for the purposes of asteroid mining, settlement and exploration.[28]
c. An operational Solar Power Satellite in Geo Stationary Orbit (GEO), weighing 300 MT collecting 24 Megawatt (MW) and beaming one MW back to Earth.[29]
d. A permanent industrial facility on the Moon[30] and to be industrializing the moon with the purpose of building solar power satellites.[31]

3. With regard to Space Based Solar Power,[32] as mentioned earlier, China became the first country in the world to establish a state funded SBSP base plant in Chongqing's Bishan district, early this year.[33] The base plant is being constructed under the guidance of the Chongqing Collaborative Innovation Research Institute for Civil-Military Integration (CCIRICMI) in Southwestern China in partnerships with researchers from Chongqing University, CAST's Xi'an Branch in Shaanxi province, and Xidian University. The initial investment for the SBSP plant of $15 million has been made by the Bishan district government. Technologies being tested include the construction of SBSP satellites in GEO using automated assembly and the wireless transmission of power.[34] Li Ming, senior vice president of CAST, asserted that China will lead the world in this critical renewable energy source.[35] The key challenges that the plant will be testing are:

---

[25] "China Developing Reusable Space Rocket", *Xinhua*, April 30, 2018 at http://www.xinhuanet.com/english/2018-04/30/c_137147249.htm (Accessed on April 17, 2019). Also see Tim Fernholz, *Rocket Billionaires: Elon Musk, Jeff Bezos, and the New Space Race* (Houghton Mifflin Harcourt, 2018).
[26] "China Developing Reusable Space Rocket", ibid. Also see Tai Ming Cheung, ed., *Forging China's Military Might: A New Framework for Assessing Innovation* (Washington D.C: John Hopkins University Press, 2014).
[27] Ibid.
[28] "China to Achieve "major breakthrough" in Nuclear-Powered Space Shuttle Around 2040: Report", Xinhuanet, November 16, 2017 at http://www.xinhuanet.com/english/2017-11/16/c_136757737.htm (Accessed on April 17, 2019).
[29] Xinbin Hou and Li Wang, "Recent SPS Activities in China", Qian Xuesen Laboratory of Space Technology, China Academy of Space Technology, 2nd Space Solar Power Satellite (SSPS) Workshop, February 13, 2019, Seoul, Korea.
[30] Hannah Devlin, "Battlefield Moon: How China Plans to Win the Lunar Space Race", *The Guardian*, January 21, 2019 at https://www.theguardian.com/science/2019/jan/21/china-steps-up-bid-to-win-the-lunar-space-race (Accessed on April 17, 2019). Morris Jones, *The New Moon Race* (Rosenberg Publishing, 2009).
[31] "Exploiting Earth-Moon Space: Chinese Ambitions after Space Station", Xinhua, March 08, 2016 at http://m.chinadaily.com.cn/en//2016-03/08/content_23775949.htm (Accessed on April 17, 2019).
[32] On SBSP, see John Mankins, *The Case for Space Solar Power* (Houston: Virginia Edition Publications, 2014).
[33] Zhao Lei, "Scientists Envision Solar Power Station in Space", *China Daily*, February 27, 2019 at http://www.chinadaily.com.cn/a/201902/27/WS5c75c8b3a3106c65c34eb8e3.html (Accessed on April 13, 2019). For more on SBSP, see Brain O'Leary, Construction of Satellite Solar Power Stations from Non-Terrestrial Material", *Journal of Energy*, 1/3, 1977, pp. 155-158.
[34] Pan Zhaoyi, "China Starts to Build World's First Space Based Solar Power Plant", CGTN, February 18, 2019 at https://news.cgtn.com/news/3d3d514f34597a4e32457a6333566d54/index.html (Accessed on April 17, 2019).
[35] Ibid.

a. Microwave transmission of electricity,
b. In-space manufacturing of SBSP satellites.

Xie Gengxin, who is the Deputy Head of CCIRICMI stated that:

> We plan to launch four to six tethered balloons from the testing base and connect them with each other to set up a network at an altitude of around 1,000 meters… these balloons will collect sunlight and convert solar energy to microwave before beaming it back to Earth. Receiving stations on the ground will convert such microwaves to electricity and distribute it to a grid… if everything goes well, a Chinese solar power station will be put into orbit about 36,000 kilometers above Earth and start generating power before 2040.[36]

Pang Zhihou, from CAST, laid out the rationale for why SBSP is a critical investment focus for China's space program. First, it is available 24 hours; it is not susceptible to weather variations like ground solar; it can be utilized to power China's lunar base as well as spacecrafts; and increase efficiency "by freeing spacecraft from huge solar cell wings and greatly increasing power levels and control accuracy. It can also be used as a candidate for deep space exploration energy systems, and it can also be used for space fuel production and space processing manufacturing in the future to realize space industry development."[37] The push for SBSP in China in not new. In 2010, the CAST published a roadmap in which it detailed the following: -

> Establish Research &Design (2010); 2019: Establish prototype of SPS plant; 2020: Finish industrial level testing of in-orbit construction and wireless transmissions; 2025: complete the first 100kW SPS demonstration at LEO; 2030: 1 mW in GEO 2035: the 100mW SPS will have electric generating capacity; and by 2050, the first commercial level SPS system will be in operation in GEO.[38]

One of the biggest advocates within China of SBSP is Wang Xiji, the chief designer of China's first rocket, the *Long March 1*. Wang believes that "The world will panic when the fossil fuels can no longer sustain human development. We must acquire space solar power technology before then…Whoever obtains the technology first could occupy the future energy market. So it's of great strategic significance."[39] Xiji further specified that "Once completed, the solar station, with a capacity of 100MW, would span at least one square kilometre, dwarfing the International Space Station and becoming the biggest man-made object in space".[40] Xiji believed that if China did not act quickly on an SBSP program, countries like the U.S. and Japan will take the lead and occupy strategically important locations in space.[41] According to Duan Baoyan,

---

[36] Ibid.
[37] "China is Expected to take the Lead in Building a Space Solar Power Station", *Science and Technology Daily.com*, February 14, 2019 at http://www.stdaily.com/index/kejixinwen/2019-02/14/content_750019.shtml (Accessed on April 7, 2019).
[38] Gao Ji, et.al., "Solar Power Satellite Research in China", *Online Journal of Space Communications*, Winter 2010 at https://spacejournal.ohio.edu/issue16/ji.html (Accessed on April 17, 2019). Don M. Flourney, *Solar Power Satellites* (New York: Springer, 2012).
[39] Chinese Scientists Mull Power Station in Space", *Space Daily*, March 31, 2015 at http://www.spacedaily.com/reports/Chinese_scientists_mull_power_station_in_space_999.html (Accessed on April 17, 2019).
[40] Ibid.
[41] Ibid.

from the Chinese Academy of Engineering (CAE), "If we have space solar power technology, hopefull [sic] we could solve the energy crisis on Earth."[42] Baoyan was earlier a leading member of the satellite payload expert group within the PLA, and member of the advanced manufacturing technique group of China Electronics Group Corporation (CETC). According to Gao Ji, Hou Xinbin and Wang Li, of CAST:

> Since SPS development will be a huge project, it will be considered the equivalent of an Apollo program for energy. In the last century, America's leading position in science and technology worldwide was inextricably linked with technological advances associated with implementation of the Apollo program. Likewise, as China's current achievements in aerospace technology are built upon with its successive generations of satellite projects in space, China will use its capabilities in space science to assure sustainable development of energy from space.[43]

4. China's Lunar Exploration Program (CLEP) has offered a roadmap from 2019 to 2036 specifying its aims and future missions. Right after the successful landing of the *Chang'e 4* on the far side of the moon on January 3 (10.26 Beijing time), Wu Yanhua, Deputy head of CNSA announced on January 14 that by 2019 year-end, China will launch *Chang'e-5*, to bring lunar samples back to Earth; this will be followed by *Chang'e-6*, aimed at bringing samples from the South Pole; *Chang'e-7* will survey the South Pole for evaluating its composition. The *Chang'e-8* will test key technologies like 3D printing to lay groundwork for the construction of a scientific base on the moon.[44] Critically, scientists at the Technology and Engineering Center for Space Utilization of the Chinese Academy of Sciences (CAS) tested 3D printing technology in micro-gravity by successfully completing a ceramic testing technology in 2018.[45] According to Wang Gong, Director of the CAS Key Laboratory of Space Manufacturing Technology, this evaluated Chinese capability to build bases on the moon and Mars, as well as in-situ resource utilization and space manufacturing with space based resources.[46] Using ceramics is instructive as it is similar in composition to lunar silicate particles. As Wang put it, "Elon Musk and SpaceX are developing technologies to take people to other planets, and we are developing technologies to help them survive.".[47]According to Paul D. Spudis, in his book, *The Value of the Moon*, the moon's "greatest value is its capacity to create new spacefaring capabilities through the exploitation of its material and resources."[48] Spudis recommended the use of small robotic rovers to traverse the lunar poles to measure for ice and other contents. In September 2018, Li Guoping, director of the Department of System Engineering at CNSA, stated that China will be sending

---

[42] As quoted in Namrata Goswami, "China's Get-Rich Space Program", *The Diplomat*, February 28, 2019 at https://thediplomat.com/2019/02/chinas-get-rich-space-program/ (Accessed on April 18, 2019).
[43] Gao Ji, et.al., "Solar Power Satellite Research in China", n. 38.
[44] "China unveils Follow-Up Lunar Exploration Missions", *Xinhua*, January 14, 2019 at http://www.xinhuanet.com/english/2019-01/14/c_137743015.htm (Accessed on April 18, 2019).
[45] "China Focus: China Pioneers Ceramic 3D Printing in Micro-Gravity", Xinhua, June 19, 2018 at http://www.xinhuanet.com/english/2018-06/19/c_137265536.htm (Accessed on April 17, 2019). Richard P. Appelbaum, et.al., *Innovation in China: Challenging the Global Science and Technology System* (Polity, 2018). George S. Yip and Bruce McKern, *China's Next Strategic Advantage:* From Imitation to Innovation (MIT Press, 2017).
[46] "China Focus: China pioneers Ceramic 3D Printing in Microgravity", n. 45.
[47] Ibid.
[48] Paul Spudis, *The Value of the Moon: How to Explore, Live, and Prosper in Space Using the Moon's Resources* (Washington, D.C: Smithsonian Books, 2016).

robotic probes to the lunar poles by 2030.[49] These probes will explore the South Pole to analyze the lunar soil's age, and the composition of the solar wind's isotopes of hydrogen, carbon, helium, and oxygen. The rover that will explore the North Pole will examine whether ice exists in the permanent shadow area. The lunar poles probe will be the final step before establishing China's scientific research base.

China's CLEP is not only aimed at lunar scientific missions, but is also a long-term space presence development strategy to incrementally build capacity for lunar and asteroid mining. The Moon offers the best chance of a planetary body, not difficult to reach from Earth, to build space-faring capacities. This aspect is recognized by Wu Weiren, the chief scientist of CLEP. He states and I quote, "our short-term goal is to orbit the Moon, and land on the Moon, and take samples back from the Moon…our long term goal is explore, land and settle. We want our manned lunar landing to stay for longer periods and establish a research base".[50] Weiren believes that the critical step forward is to establish a lunar palace especially on the South Pole by 2030, given the presence of sunlight and water-ice there. Beihang University in China has experimented with a simulated lunar module in 2018, in which eight students lived in a Moon lab for 370 days, to study how a regenerative life support system might work.[51] Significantly, the *Chang'e 4* carried a 3 kg, (0.8 liters) aluminum alloy cylinder, containing seeds of cotton, potatoes and Arabidopsis, a plant related to cabbage as well as eggs of silk worms.[52] The idea was to experiment if potatoes (food for Moon settlers), and silk worms can flourish on the Moon in a simulated mini biosphere. This was exciting, by itself, as it is the first time that such an experiment was carried out 380,000 kms from Earth, many times further than similar experiments carried out on the International Space Station (ISS) and *Tiangong 2*, in Low Earth Orbit (LEO), just 400 kms above earth.[53] According to the mission chief, Liu Hanlong, the idea was to study the process of developing food for space travelers on the lunar surface. Liu specified, "Our experiment might help accumulate knowledge for building a lunar base and long-term residence on the Moon."[54] What makes this experiment unique is that it is the first step in analyzing whether humans can create Earth-like conditions on the Moon to survive on the long term and is directly connected to China's stated ambition of establishing permanent presence on the Moon. The mini biosphere experiment on *Chang'e 4* is a collaborative effort of 28 Chinese universities led by Chongqing University. Its chief designer, Xie Gengxin, who is also leading

---

[49] "China Aims to Explore Polar Regions of Moon by 2030", *China Daily*, September 25, 2018 at http://www.chinadaily.com.cn/a/201809/25/WS5ba9f615a310c4cc775e801f.html (Accessed on April 17, 2019). Also see Dennis Wingo, *Moon Rush: Improving Life on Earth* with the Moon's Resources (Lancaster: Apogee Books, 2004).

[50] "What does China want to do in Space", BBC, April 20, 2016 at https://www.bbc.com/news/av/36089689/what-does-china-want-to-do-in-space (Accessed on April 17, 2019). Marina Koren, "China's Growing Ambitions in Space", *The Atlantic*, January 23, 2017 at https://www.theatlantic.com/science/archive/2017/01/china-space/497846/ (Accessed on April 18, 2019).

[51] Guo Meiping, "China's 'Lunar Palace' Breaks Record after 365+5 days", CGTN, May 15, 2018 at https://news.cgtn.com/news/3d3d514e7a67444e77457a6333566d54/share_p.html (Accessed on April 8, 2019).

[52] Rafi Letzter, "There are Plants and Animals on the Moon Now (because of China)", LiveScience, January 3, 2019 at https://www.livescience.com/64413-china-space-moon-plants-animals.html (Accessed on April 17, 2019).

[53] "China Focus: Flowers on the Moon? China's Chang'e 4 to Launch Lunar Spring", *Xinhuanet*, April 12, 2018 at http://www.xinhuanet.com/english/2018-04/12/c_137106440.htm (Accessed on April 17, 2019).

[54] Ibid.

efforts on China's SBSP efforts, and is the Deputy Head of the Chongqing Collaborative Innovation Research Institute for Civil-Military Integration (CCIRICMI) specified:

> We have to keep the temperature in the 'mini biosphere' within a range from 1 degree to 30 degrees, and properly control the humidity and nutrition. We will use a tube to direct the natural light on the surface of Moon into the tin to make the plants grow…We want to study the respiration of the seeds and the photosynthesis on the Moon.[55]

Only the cotton seed sprouted, before the CNSA declared the experiment closed as *Chang'e 4* entered a dormant mode during its first lunar night on January 15. Xie explained why, "Life in the canister would not survive the lunar night…We had no such experience before. And we could not simulate the lunar environment, such as microgravity and cosmic radiation, on Earth".[56] This experiment was aimed at understanding how seeds can be sprouted to acquire further knowledge on ensuring their survival into the lunar night. In a video released by the CNSA on April 24, 2018, anniversary of China's first satellite launch (1970),[57] China offered its vision of a lunar outpost to be manned by SBSP. CNSA reflected on the video that "We believe that the Chinese nation's dream of residing in a 'lunar palace' will soon become a reality."[58] Ye Peijian, head of CLEP, stated that:

> [t]he universe is an ocean, the moon is the Diaoyu Islands, Mars is Huangyan Island. If we don't go there now even though we're capable of doing so, then we will be blamed by our descendants. If others go there, then they will take over, and you won't be able to go even if you want to. This is reason enough.[59]

China's *Chang'e 4* that broke new ground, by landing humanity's first probe on the far side was both technologically and symbolically unique. In May 2018, the *Queqiao* relay satellite, or Magpie Bridge, was placed in the L2 Halo orbit to serve as a communication relay satellite from the Chang'e 4.[60] *Queqiao* can peer into the Lunar polar craters, enabling future landing zones for China's probes in the shadowed regions. Significantly, for purposes of space resources, *Chang'e 4* rover has a radar that can penetrate the lunar surface to look for lunar resources like iron ore. This is to achieve another stated ambition, coming out of Chinese state funded space institutions

---

[55] Ibid.
[56] "China Focus: Moon Sees First Cotton-Seed Sprout", Xinhua, January 15, 2019 at http://www.xinhuanet.com/english/2019-01/15/c_137745505.htm (Accessed on April 17, 2019).
[57] Echo Huang, "China Lays out its Ambitions to Colonize the Moon and Build a "Lunar Palace'", Quartz, April 26, 2018 at https://qz.com/1262581/china-lays-out-its-ambitions-to-colonize-the-moon-and-build-a-lunar-palace/ (Accessed on April 17, 2019).
[58] Neil Connor, "China Plans to Build Manned 'Lunar Palace' Powered by the Sun", *The Telegraph*, April 25, 2018 at https://www.telegraph.co.uk/news/2018/04/25/china-plans-build-manned-lunar-palace-powered-sun/ (Accessed on April 17, 2019). Kerry Brown, *China's Dream The Culture of Chinese Communism and the Secret Sources of its Power* (Cambridge: Polity Press, 2018).
[59] Brendon Hong, "China's Looming Land Grab in Outer Space", *Daily Beast*, June 22, 2018 at https://www.thedailybeast.com/chinas-looming-land-grab-in-outer-space (Accessed on April 17, 2019).
[60] Luyuan Xu, " How China's Lunar Relay Satellite Arrived in its Final Orbit", Planetary Society, June 15, 2018 at http://www.planetary.org/blogs/guest-blogs/2018/20180615-queqiao-orbit-explainer.html (Accessed on April 17, 2019).

like CAS, CAST, and CNSA;[61] that in order to develop space-faring capabilities and move on to the asteroid belt, capture an asteroid and extract resources from it, the Moon serves as a significant basing function. This perspective is supported at the highest level of space policy as articulated by Ouyang Ziyuan, Chief Scientist of China's Lunar Exploration Program (CLEP). Quyang specified more than a decade ago (2002) that "the moon could serve as a new and tremendous supplier of energy and resources for human beings… This is crucial to [the] sustainable development of human beings on Earth... Whoever first conquers the Moon will benefit first".[62] A year later, in 2003, Luan Enjie, the Director of the Chinese National Aerospace Bureau, reiterated that, "We will focus on deep space exploration. The first target selected is the Moon".[63] Similarly, Lieutenant General Zhang Yulin, former Deputy Commander of China's Manned Space Program and former Deputy Chief of the Armament Development Department of the Central Military Commission (CMC), now with the Strategic Support Force (SSF) specified the significance of the Moon in 2016 when he stated, "the earth-moon space will be strategically important for the great rejuvenation of the Chinese nation".[64] Yulin indicated in that same interview that China will be investing in building capacity to generate solar power in space. He was clear on what China's space program focus should be in the long term, "The future of China's manned space program, is not a moon landing, which is quite simple, or even the manned Mars program which remains difficult, but continual exploration of the earth-moon space with ever developing technology".[65] It was Yulin, who was the first Chinese high ranking military space official to publicly acknowledge in 2016 China's ambitions to send astronauts to the Moon by 2036,[66] today an integral part of the CLEP,[67] and included in their 2016 White paper on space activities, as a priority.[68]

5. **Space Mining (Industrialization):** Chinese space scientists are working on plans to capture a Near Earth Asteroid (NEA) and bring it to Earth to inspect and extract its resources. Researcher, Li Mingtao, with the National Space Science Center under CAS along with his team details that plan.[69] The idea is for a spacecraft to bag an asteroid and push it over Earth, followed by a heat

---

[61] "Chinese Lunar Exploration to Enter New Phase with Missions to Moon's Poles and Far Side", Chinese Academy of Sciences, March 02, 2017 at http://english.cas.cn/newsroom/news/201703/t20170302_174524.shtml (Accessed on April 17, 2019).
[62] David Whitehouse, "China denies Manned Moon Mission Plans", BBC, May 21, 2002 at http://news.bbc.co.uk/2/hi/science/nature/2000506.stm (Accessed on April 17, 2019).
[63] David Whitehouse, "China Sets its Sights on the Moon", BBC, December 3, 2003 at http://news.bbc.co.uk/2/hi/science/nature/3288043.stm (Accessed on April 17, 2019).
[64] "Exploiting Earth-Moon Space: Chinese Ambitions after Space Station", Xinhua, March 08, 2016 at http://m.chinadaily.com.cn/en//2016-03/08/content_23775949.htm (Accessed on April 17, 2019).
[65] Ibid.
[66] Zhao Lei, "Senior Officer Expects Moon Visit by 2036', *People's Daily*, April 29, 2016 at http://en.people.cn/n3/2016/0429/c90000-9051633.html (Accessed On April 17, 2019).
[67] "China's Lunar Exploration Program", People's Daily, at http://en.people.cn/90002/91752/index.html (Accessed on April 17, 2019).
[68] "Full text of White Paper on China's Space Activities in 2016", The State Council, The People's Republic of China, December 28, 2016 at http://english.gov.cn/archive/white_paper/2016/12/28/content_281475527159496.htm (Accessed on April 17, 2019).
[69] "Capture an Asteroid, Bring it Back to Earth?", Chinese Academy of Sciences, June 24, 2018 at http://english.cas.cn/newsroom/news/201807/t20180724_195396.shtml (Accessed on April 17, 2019). For more on asteroid mining, please see John Lewis, *Mining the Sky Untold Riches from the Asteroids, Comets, and Planets*

shield that unfolds reducing the velocity of the asteroid as it enters Earth's atmosphere. The landing must be minutely controlled so that it lands in an area far from human habitation. Li is working in collaboration with scientists from the Qian Xuesen Laboratory of Space Technology, under the China Aerospace Science and Technology Corporation (CASTC) to place satellites in the heliocentric Venus orbit, in order to search and analyze NEAs, with a diameter of 10 meters. The challenge after capture would be to drop the speed of the asteroid from 12.5 km per second to 140 meters per second before it touches down on its Earth landing spot. The timeline for such a launch to capture an asteroid is 2029 and the aim is to bring it back to Earth around 2034. A NEA like *3554 Amun*, approximately two kilometers in diameters, contains nickel and iron worth $8 trillion, cobalt ($6 trillion), other precious metals and gold worth $6 trillion, which together totals $20 trillion.[70] Based on such estimates, Li asserts that:

> Space mining might become a new engine for the global economy… Unlike missions to bring samples back, we aim to bring back a whole asteroid weighing several hundred tonnes, which could turn asteroids with a potential threat to Earth into usable resources…Our analysis shows that maneuvering a small asteroid is feasible in principle, and could bring enormous economic and social benefits.[71]

Li's perspective is supported by Huang Wei, who is Chief Engineer within CAST. Wei believes that ideas such as Li's would result in the promotion and development of futuristic space technologies.[72] Space mining is perceived to be to China's future advantage given the rising demands for energy within China. Towards achieving the goals of harvesting space-based resources, a China Aerospace Science and Technology Corporation (CASTC) report outlined in 2017 that China will be developing nuclear powered space shuttles by 2040. Such a long-term strategy is geared towards reusability and developing a space outpost, that augments the development of space transportation capabilities. By 2025, reusable sub-orbital carriers should come to fruition enabling the path towards a long-term vision.[73] China is developing the *Long March 9*, its super heavy lifter. The *Long March 9* is designed to carry a payload of 140 metric tons to LEO, a 50-ton spacecraft to a lunar transfer orbit and a 44-ton payload to Mars transfer orbit.[74] Importantly, in its justifications for the *Long March 9*, China listed the following four goals: 1) launch a Mars robotic exploration mission which is requires 41 tonne payloads, 2) manned Mars missions, 3) deep space missions, and 4) "Constructing orbital solar power plant with 10,000 MW capacity, massing some 50,000 tonnes, requiring 620+ launches)."[75]

(New York: Helix Books, 1997). Robert Zubrin, *Entering Space: Creating a Spacefaring Civilization* (New York: TarcherPerigee, 2007).

[70] Andrew M. Thorpe, *The Commercial Space Age: Conquering Space Through Commerce* (Bloomington: AuthorHouse, 2003), p. 149.

[71] "China Focus: Capture an Asteroid, bring it back to Earth?", Xinhuanet, July 23, 2018 at http://www.xinhuanet.com/english/2018-07/23/c_137342866.htm (Accessed on April 17, 2019).

[72] Ibid.

[73] "China to Achieve "major breakthrough" in Nuclear-Powered Space Shuttle Around 2040: Report", Xinhuanet, November 16, 2017 at http://www.xinhuanet.com/english/2017-11/16/c_136757737.htm (Accessed on April 17, 2019).

[74] http://www.chinadaily.com.cn/a/201903/11/WS5c859b62a3106c65c34edcc0.html

[75] As quoted from Journal of Rocket Propulsion, January 2011, in https://www.globalsecurity.org/space/world/china/cz-x.htm

In summary, the articulated Chinese space goals across a cross-section of their state-owned space institutions (CNSA, CAST, CASC, CALVT) as well as their 2016 White paper, highlight the following, from now to 2050:

2019: Chang'e 5 probe to bring back lunar samples to Earth (China White Paper 2016, CNSA).
2020: First Mars probe (China White Paper 2016).
2020: Finish the industrial level testing of in-orbit construction and wireless transmissions of SBSP (CAST).
2022: Asteroids Probe (CNSA, CAST, CALVT).
2022: Permanent space station, *Tianhe-1* (China space policy papers).
2024: Chang'e 6 to bring back samples from the South Pole (CNSA).
2025: Reusable Suborbital Carrier/suborbital tourism (CASC).
2025: Complete the first 100kW SBSP demonstration at LEO (CAST).
2028: Mars sample return (CNSA).
2029: Jupiter probe (CNSA).
2029: Mission to capture a Near Earth Asteroid (NEA) (CAS).
2030: Probe to Lunar South and North Pole (CNSA).
2030: Launch of *Long March 9* super heavy lifter (CASC).
2030: 1 mW of SBSP power demonstration in GEO (CAST).
2034: Return Asteroid to Earth (CAS).
2035: Test key technologies like 3D printing to lay groundwork for the construction of a lunar base (CAS).
2035: 100 mW SBSP will have electric power generating capacity (CAST).
2036: Manned mission to Moon and establishment of lunar research base (CNSA).
2040: Nuclear powered space fleet to be ready (CASC).
2040: SBSP to orbit (36,000 kms) above Earth and start generating power (CAST).
2045: Most advanced Space Nation (President Xi).
2049: 100^{th} year celebration of the establishment of the PRC and the leading space technology power (President Xi).
2050: First Commercial Level SBSP in operation in GEO (CAST).

The potential for economic return from space-based resources and energy as laid out in China's space ambitions are so vast, and the military potential of an industrial space-logistics system is so militarily imperative, that the U.S. risks two very important losses:

1) That space and its vast potential for commerce will not be part of a U.S.-led world order.
2) That there will not be a U.S.-led world order, because the nation that leads in space will be economically and militarily dominant.

China's space strategy is an incremental development plan to work on these space goals over a long period. China plans on consistently achieving success on the long timelines they set for themselves. Their lunar base enables their SBSP, as well as space mining and plan for permanent space presence.

Should the Commission Take Chinese Future Space Timelines Seriously?

The critical question is: can the Commission take these future Chinese space goals seriously? In order to examine that, I studied the pattern of stated Chinese space ambitions in the past, and whether it met the goals within the specific timeline set. China announced its ambitions for space in the 1950s along with its nuclear ambitions under Mao Tse Tung responding to threatened nuclear weapons use by the United States in the Korean War. Mao's decision was aimed at developing China's own nuclear arsenal as a deterrent against future vulnerabilities. At the same time, in order to shore up international prestige for China, Mao aimed to place a satellite in orbit by 1959 under Project 581. When Soviet technical assistance was withdrawn, there was realization that this aim for a satellite was not possible, and consequently, Project 581 was abandoned.[76] This however did not completely eliminate the space program. Work continued for the next two decades to build the foundations for a long-term program, and finally, in 1970, China's first satellite *Dong Fang Hong 1* was launched on April 24 broadcasting the song 'East is Red' from orbit. After Deng Xiaoping took over as Premier of China, the space scientist community received a further boost to lay down specific aims for China's future space program.[77]

In the late 1980s, China declared that it aimed to send a manned spaceflight in the next two decades. China successfully launched its unmanned mission to space in 1999. In 2003, China sent its first manned space mission, the *Shenzhou V* into space. While some argue that China's success in its unmanned and manned missions was as a result of its 1996 agreement with Russia on space technology acquisition, yet reengineering of Russian space technology simply does not mean the same technology but added on technology fitted by Chinese engineers and scientists. In 2004, Wang Yongzhi, the chief designer of China's space program, stated that China plans to have a permanent crewed space station in the next 15 years.[78] That aim has been reiterated in its 2016 White paper on space activities. The plans to establish a space station incrementally have been met, again as per stated schedule. In 1992, China established Project 921-2 whose mission was to launch a manned spaceflight in next ten years (2003 mission goal met), an orbiting station by 2010 (2011 mission goal met), and finally a permanent space station by 2020-22.[79] In 2007, China announced that between 2008 and 2010, the *Shenzhou* unmanned and manned spaceflights will be launched to dock with *Tiangong* 1(again mission goal met).[80] In 2011, China declared its intentions to launch *Tiangong* 2 by 2015, later postponed to 2016, followed by the *Shenzhou* 11 manned spaceflight to dock with it, to be followed by the Chinese space cargo ship in 2017.[81] All these stated goals have been met within timelines set, including the successful launch and docking of the indigenously built Chinese space cargo ship, the *Tianzhou 1*. In 2016, CNSA announced that China will launch a probe to the far side of the Moon in December 2018, a first

---

[76] "Project 581", http://www.astronautix.com/p/project581.html
[77] Namrata Goswami, "China in Space: Ambitions and Possible Conflict", *Strategic Studies Quarterly*, March 1, 2018 at http://www.airuniversity.af.mil/Portals/10/SSQ/documents/Volume-12_Issue-1/Goswami.pdf (Accessed on April 18, 2019).
[78] "Timeline: China's Spaceflight History", *New Scientist*, 12 October 2005, https://www.newscientist.com/article/dn8144-timeline-chinas-spaceflight-history/
[79] Ibid.
[80] "Project 921-2", Astronautix.com, http://www.astronautix.com/p/project921-2.html
[81] Tania Branigan and Ian Sample, "China Unveils Rival to International Space Station", *The Guardian*, 26 April 2011, https://www.theguardian.com/world/2011/apr/26/china-space-station-tiangong

attempt by humanity of any such feat.[82] On December 8, 2018 (Beijing time:2:23 a.m.), the *Long March* 3B lifted off from *Xichang* Satellite Launch Center, carrying the *Chang'e 4* rover and lander with it, to the lunar surface, again meeting another critical deadline set two years ago. On January 3, 2019, the mission successfully landed on the far side of the moon.[83]

While the West tends to underplay China's space capabilities with a tendency to call it largely propaganda by the CPC, is it really the case? When China initiated the *Tianzhou* spacecraft resupply program in 2010 and gave the contract to CAST to develop it in 2011,[84] declaring it will send the indigenously built cargo spacecraft by 2016-2017, it was written off in the West as mere propaganda and building prestige for the CPC.[85] When in 2017, the *Tianzhou 1* was successfully launched and docked with the *Taingong*-2 within the stated deadline, the world expressed surprise.

China's stated future space goals of developing a SBSP station and beaming that energy wirelessly back to earth, establishing a manned lunar presence, land on the far side of the moon, explore and mine asteroids, utilizing these resources for in-situ manufacturing, and build a permanent space station, are technologically ambitious to achieve in the 20-30 year time span. The sceptics would argue that such goals are not achievable or feasible given the absence of proven technology. Or that China may rhetorically state these ambitions but it remains to be seen if these goals are achievable. The success in, not only building the technology but also successfully meeting stated timelines announced, vindicates enormous credibility to China's future stated goals of a 2029 asteroid capture mission, a 2036 manned mission to the moon, and establishing an SBSP space station by 2050. It is a fact that these stated goals would require enormous indigenous technology innovation and if successful would establish the independent innovation potential of China's space enterprise. Nevertheless, the *Tianzhou 1*, the *Queqiao* relay satellite, and the *Chang'e 4* are great examples of the growing indigenous technological progress of China's space program. Given the PRC's outstanding record of accomplishing its stated space goals, those who dismiss or ignore China's announced roadmaps for space, should consider the fact that achievements in space are directly connected to the CPC's legitimacy and are not taken lightly, given the high levels of political engagement with the space program. China's achievements in the field of science and technology is well documented. These includes, but are not limited to quantum computing and communications,[86] Artificial Intelligence (AI),[87] data science, etc. While the U.S. is quick to dismiss China's achievements as based on theft of

---

[82] "China to Send *Chang'e 4* to South Pole of the Moon's Far Side", China Academy of Sciences, June 15, 2016 at http://english.cas.cn/newsroom/news/201606/t20160615_164411.shtml (Accessed on April 8, 2019).
[83] "Liftoff for Chang'e 4", *Planetary Society*, December 7, 2018 at http://www.planetary.org/blogs/emily-lakdawalla/2018/liftoff-for-change-4.html (Accessed on April 8, 2019).
[84] Tianzhou", China Space Report, https://chinaspacereport.wordpress.com/spacecraft/tianzhou/ (Accessed on April 17, 2019).
[85] Marco Alberti, *When China Goes to the Moon* (New York: Springer International, 2015). Michael Sheehan, "Did you see that, Grandpa Mao? The Prestige and Propaganda Rationales of the Chinese Space Program", ScienceDirect, 29/2, May 2013, pp. 107-112 at https://www.sciencedirect.com/science/article/abs/pii/S0265964613000246 (Accessed on April 17, 2019).
[86] "China's Quantum Satellite Clears Major Hurdle on way to Ultrasecure Communications", Nature, June 15, 2017 at https://www.nature.com/news/china-s-quantum-satellite-clears-major-hurdle-on-way-to-ultrasecure-communications-1.22142 (Accessed on April 17, 2019).
[87] Louis Columbus, "How China is Dominating Artificial Intelligence", Forbes, December 16, 2018 at https://www.forbes.com/sites/louiscolumbus/2018/12/16/how-china-is-dominating-artificial-intelligence/#550950de2b2f (Accessed on April 17, 2019).

intellectual property, this perspective fails to take into account the fact that China has emerged as second only to the U.S. when it comes to investment in Research & Design (R&D) with $475 billion spent in 2018, compared to U.S $ 553 billion.[88] In 2018, the U.S. National Science Foundation (NSF) statistics revealed that China for the first time surpassed the U.S. (409, 000) with the largest number of published scientific articles (426,000).[89] Foremost amongst those steering the field is the CAS which has about 120 other institutions under it, followed by Chinese Science and Technology universities and their privately owned industries.[90] Take the example of *Huawei* Technologies, the largest telecommunications company in the world. The company invested and is forging closer commercial ties with countries in Asia and Europe, to emerge as the leader in 5G. It has signed 25 Memorandums of Understanding (MoUs) that includes Britain's BT, Bell Canada (BCE), France's Orange, Germany's Deutsche Telekom and global player Vodafone.[91] Vodafone is a big player in India. Huawei is investing in AI as well.

There are certain areas of concern that we need to address with this kind of infrastructure development. For instance, the African Union (AU) headquarters in Addis Ababa was built with an aid of $200 million from the China Development Bank. But in January 2018, it was reported that between 2012 (the year the building was built) to January 2018, the computer system of AU was compromised, with data transferred from AU servers to servers in Shanghai, 8000 kms away. While China and AU have condemned these reports as deliberate ploy by the West to discredit that relationship, the main provider of "information and communication technology systems to the AU headquarters was China's best-known telecoms equipment company – Huawei".[92] Nothing has been proved so far, but challenges to Huawei remain. Ren Zhengfei, the founder of Huawei, employs nearly 80,000 of its staff for R&D alone, and has committed $15-20 billion on its R&D program.[93] This is augmented by the rapid increase in engineering, science and tech graduates in China since 1999.[94] To be sure, those with engineering, science degrees are sought after and draw high start salaries. This is further supported by the Chinese government's 'Made in China 2025' policy.[95] A recent investigative report by NPR reveals that issues like technology theft and cyber hacking, originating in China were known for two decades, but U.S.

---

[88] "2018 Global R&D Funding Forecast", R&D, Winter 2018, at http://digital.rdmag.com/researchanddevelopment/2018_global_r_d_funding_forecast?pg=1#pg1 (Accessed on April 8, 2019).
[89] Jeff Tolefson, "China Declared World's Largest Producer of Scientific Articles", *Nature*, January 18, 2018 at https://www.nature.com/articles/d41586-018-00927-4 (Accessed on April 08, 2019).
[90] Ibid.
[91] Eric Auchard and Sijia Jiang, "China's Huawei Set to Lead Global Charge to 5G Networks", *Reuters*, February 23, 2018 at https://www.reuters.com/article/us-telecoms-5g-china/chinas-huawei-set-to-lead-global-charge-to-5g-networks-idUSKCN1G70MV (Accessed on April 08, 2019).
[92] Karisma Vaswani, "Huawei: The Story of a Controversial Company", *BBC*, March 06, 2019 at https://www.bbc.co.uk/news/resources/idt-sh/Huawei (Accessed on April 08, 2019).
[93] Sijia Jiang, "China's Huawei to Raise Annual R&D Budget to at least $15 billion," *Reuters*, June 26, 2018 at https://www.reuters.com/article/us-huawei-r-d/chinas-huawei-to-raise-annual-rd-budget-to-at-least-15-billion-idUSKBN1KG169 (Accessed on April 08, 2019).
[94] Katherine Stapleton, "Inside the World's Largest Higher Education Boom", *The Conversation*, April 10, 2017 at https://theconversation.com/inside-the-worlds-largest-higher-education-boom-74789 (Accessed on April 08, 2019).
[95] U.S. Chamber of Commerce, "Made in China 2025: Global Ambitions Built on Local Protections", 2017 at https://www.uschamber.com/sites/default/files/final_made_in_china_2025_report_full.pdf (Accessed on April 17, 2019). Joachim Jan Thraen, *Mastering Innovation in China:* Insights from History on China's Journey towards Innovation (Wiesbaden, Germany: Gabler Verlag, 2016).

business turned the other way as they had invested too much of their capital in these joint ventures.[96] We can see a similar pattern emerging in Africa where the African Union is turning a blind eye to Chinese hacking allegations as so much Chinese investments are tied up to African countries, to include their Belt and Road Initiative (BRI). There are allegations that a Chinese national was indicted for stealing technical data from Lockheed Martin, including the plans for the Raptor, shortly after which China developed its J-20 fighter plane [a plane similar to Lockheed Martin's F-22 Raptor].[97]

Civil-Military Integration

China's space program is inspired by three long-term future space goals: developing their ability to access Space-Based Solar Power (SBSP); [98] develop technologies for space mining and permanent presence.[99] China is seeking to update and adapt its civil and military earth-based space institutions, to include the private space sector.

Dual Use is Driven by Top CPC Leadership. President Xi Jinping has offered a clear policy guidance of 'Civil-Military Integration". [100] This last point is critical as Xi is clear about what he wants from such an integration policy: China's space activities, what Xi terms as "China's space dream" [now a part of his signature 'China Dream', and enshrined in the Communist Party of China (CPC) constitution][101] is to utilize China's space capabilities to create the economic resources to maintain China's leading position in the world. In short, China wants its space program to contribute to comprehensive national power and rejuvenation of the Chinese nation.[102] In fact, Xi who is the Chairman of the Central Military Commission (CMC) has frequently urged China's space sector to take up a leading role in his 'civil-military integration strategy'.[103] Xi also specifies that all space agencies (civilian and military) to include the People's Liberation Army Strategic Support Force (PLASSF) must owe complete loyalty and allegiance to the CPC. Party loyalty is, over and above, everything else.[104] Under such a long-

---

[96] Laura Sullivan "As China Hacked, U.S. Businesses Turned a Blind Eye", NPR, April 12, 2019 at https://www.npr.org/2019/04/12/711779130/as-china-hacked-u-s-businesses-turned-a-blind-eye (Accessed on April 17, 2019).

[97] Ibid.

[98] Eric Rosenbaum and Donovan Russo, "China Plans a Solar Power Play in Space that NASA Abandoned Long Ago", CNBC, March 17, 2019 at https://www.cnbc.com/2019/03/15/china-plans-a-solar-power-play-in-space-that-nasa-abandoned-long-ago.html (Accessed on April 17, 2019).

[99] Stephen Chen, "China Plans Ambitious Space Mission to Hunt and 'Capture' Asteroids by 2020", May 11, 2017 at https://www.scmp.com/news/china/policies-politics/article/2093811/china-plans-ambitious-space-mission-hunt-and-capture (Accessed on April 17, 2019).

[100] "Xi Calls for Deepened Civil Military Integration", *Xinhua*, March 12, 2018 at http://www.xinhuanet.com/english/2018-03/12/c_137034168.htm (Accessed on April 6, 2019).

[101] "Full Text of Resolution on Amendment to CPC Constitution", *China Daily*, October 24, 2017 at http://www.chinadaily.com.cn/china/19thcpcnationalcongress/2017-10/24/content_33656521.htm (Accessed on April 6, 2019). Also see Liu Mingfu, *The China Dream Great Power Thinking & Strategic Posture in the Post-American Era* (New York: CN Times, 2015).

[102] "Full Text of White Paper on China's Space Activities in 2016", n.20. Also see Col. Qiao Liang and Col. Wang Xiangsui, *Unrestricted Warfare China's Master Plan to Destroy America* (Panama: Pan American Publishing Company, 2002).

[103] "Xi Urges Efforts to Boost Integrated Military and Civilian Development", Xinhua, June 21, 2017 at http://eng.chinamil.com.cn/view/2017-06/21/content_7646680.htm (Accessed on April 17, 2019).

[104] "Strive to Build a Strong, Modern Strategic Support Force: Xi", Xinhua, August 28, 2016 at http://eng.chinamil.com.cn/view/2016-08/29/content_7231309.htm (Accessed on April 17, 2019).

term direction from Xi, Chinese state funded space agencies to include the CNSA and the China Aerospace Science and Technology Corp (CASC) have come up with clear roadmaps[105] within the guidance provided by Xi, as to what China's space program intends to achieve in the next 30 years.[106] China's space program under President Xi is a critical part of his civil-military integration strategy.[107] Since Xi took up leadership of China in 2012, civil-military integration has become a priority for China's national strategy. On April 24, 2016, Xi announced China's national day of spaceflight, commemorating the launch of its first satellite, *Dong Fang Hong I* that reached for the stars that same day in 1970.[108] This is a move clearly aimed at gaining internal and external legitimacy for China's space program. The 2016 White paper reiterated the significance of space, stating, "To explore the vast cosmos, develop the space industry and build China into a space power is a dream we pursue unremittingly."[109] To boost this power projection capacity in outer-space, President Xi has encouraged reform within the PLA anticipating China's independent space enterprise. Xi succinctly articulated China's space activities within his vision of China's Space Dream, while talking to *Shenzhou 10* astronauts onboard the *Tiangong 1* space station in 2013: "The space dream is part of the dream to make China stronger. With the development of space programs, the Chinese people will take bigger strides to explore further into space".[110] He went on to elaborate that, "exploring the vast universe, developing space programs and becoming an aerospace power has always been the dream we've been striving for".[111] Xi believes that 'the spirit of aerospace' is akin to the 'spirit of the Long March', instrumental in establishing the PRC in 1949.[112] Consequently, he has expressed the desire to turn China into the most dominant space power by 2049, the year China celebrates in 100th birthday.[113] Such a historic connection is significant as it deliberately encourages both state and societal commitments to state funded space programs to include ambitions for a lunar presence, asteroid mining, and deep space exploration.

Coordinating Bodies for Civil-Military Integration.

To provide institutional support for such a strategy, the Political Bureau of the CPC Central Committee established the Central Commission for Integrated Military and Civilian

---

[105] Ma Chi, "China Aims to be Leading Space Power by 2045", *China Daily*, November 17, 2017 at http://www.chinadaily.com.cn/china/2017-11/17/content_34653486.htm (Accessed on April 17, 2019).
[106] Stephen Chen, "China's Nuclear Spaceships will be 'Mining Asteroids and Flying Tourists' as it Aims to Overtake US in Space Race", *South China Morning Post*, November 17, 2017 at https://www.scmp.com/news/china/policies-politics/article/2120425/chinas-nuclear-spaceships-will-be-mining-asteroids (Accessed on April 7, 2019).
[107] "Xi Stresses Military-Civilian Integration in a New Era", Ministry of National Defense of the People's Republic of China, March 3, 2018 at http://eng.mod.gov.cn/cmc/2018-03/03/content_4805775.htm (Accessed on April 17, 2019).
[108] "China to Set April 24 as National Day of Spaceflight", Chinese Academy of Sciences, March 23, 2016 at http://english.cas.cn/newsroom/china_research/201603/t20160323_160828.shtml (Accessed on April 17, 2019).
[109] "Full Text of White Paper on China's Space Activities in 2016", The State Council, The People's Republic of China, December 28, 2016 at http://english.gov.cn/archive/white_paper/2016/12/28/content_281475527159496.htm (Accessed on April 7, 2019).
[110] "Backgrounder: Xi Jinping's Vision for China's Space Development", Xinhua, April 24, 2017, n. 17.
[111] Ibid.
[112] Namrata Goswami, "Waking up to China's Space Dream", n.42.
[113] "Full Text of Xi Jinping's Report at 19th CPC National Congress", *China Daily*, October 04, 2017 at http://www.chinadaily.com.cn/china/19thcpcnationalcongress/2017-11/04/content_34115212.htm (Accessed on April 6, 2019).

Development (CCIMCD) in January 2017. This was the first such body dedicated to civil-military integration to be established by the top CPC leadership.[114] In March 2018, Xi presided over a plenary session of the CCIMCD.[115] In this session, Xi urged private companies across sectors (to include space private startups), to locate their work within this civ-mil integration strategy, in order to build integrated national strategic systems and capabilities.

Role of SASTIND and Other Space Agencies in Civ-Mil Integration. China's space program is directed by the State Administration on Science, Technology, and Industry for National Defense (SASTIND) which functions under the direction of the Ministry of Industry and Information Technology (MIIT).[116] SASTIND overseers the vital link between space technology and nuclear power, and communicates this aspect with other countries and international organizations.[117] SASTIND is tasked with managing and coordinating China's space activities.[118] As per its website, SASTIND is responsible for

> nuclear weapon, aerospace technology, aviation, armament, watercraft and electronic industries. It is established to strengthen military forces with additional personnel and more advanced equipment. Ensuring material supplies for the army is its top priority. Furthermore, it intends to contribute to the prosperity of the whole country by stimulating the manufacturing industry, gaining competitive edges through with superior production techniques. As the administrative and regulatory agency of science, technology and industry for national defense, SASTIND serves the needs of national defense, military forces, national economy, and military-related organizations. Meanwhile, it is also responsible for the coordination of communications and cooperation on the use of nuclear power and space activities with countries and international organizations.[119]

Under SASTIND is CNSA established in 1993. The CNSA is responsible for articulating China's space policies, direct its manned space mission, the lunar mission, the *Tiangong* space station, and the *Long March* series of rockets.[120]

Dual Space Hats Worn by Chinese Military Officials. Significantly, there are several overlaps between those posted into the PLA and China's state funded space agencies. For instance, Major General Liu Shangfu, who now heads China's Military Equipment Development Division (EDD), was Deputy Commander and Chief of Staff of the PLASSF and the commander of the Xichang Satellite Launch Center. He was also Deputy Commander of the human spaceflight program, the General Armament Division (GAD) chief of staff, and till 2017, deputy commander of China Lunar Exploration Program (CLEP). General Zhang Yulin, once with GAD in charge of space applications and Deputy Head of China's space program, now with the PLASSF, offers critical leadership to steer China's space program towards long term technologies like SBSP, and

---

[114] Zhao Lei, "Civil-Military Integration will deepen", *China Daily*, March 3, 2018 at http://www.chinadaily.com.cn/a/201803/03/WS5a99d67ca3106e7dcc13f437.html (Accessed on April 14, 2019).
[115] Ibid.
[116] "Ministry of Industry and Information Technology", The State Council, The People's Republic of China, at http://english.gov.cn/state_council/2014/08/23/content_281474983035940.htm (Accessed on April 17, 2019).
[117] "State Administration for Science, Technology, and Industry for National Defense", The State Council, People's Republic of China, , at http://english.gov.cn/state_council/2014/10/06/content_281474992893468.htm (Accessed on April 17, 2019).
[118] Marco Aliberti, *When China Goes to the Moon* (Switzerland: Springer, 2015), 10-11.
[119] "State Administration for Science, Technology, and Industry for National Defense", The State Council, n. 109.
[120] Elizabeth Howell, "China National Space Administration: Facts & Information", Space.com, 25 May 2016, http://www.space.com/22743-china-national-space-administration.html (Accessed on April 19, 2019).

his insistence on CIS-LUNAR focus. Yulin is now assistant Director for CMC EDD, which is headed by a former top space official as well, General Shangfu. Of critical note is the fact that the Deputy Head of the Chongqing Collaborative Innovation Research Institute for Civil-Military Integration (CCIRICMI), Xie Gengxin, is also in charge of the SBSP Chongqing plant and was the chief designer of the three kg bio-lab experiment that was carried on the *Chang'e 4*. These convergences point to the civil-military integration strategy that has been undertaken under President Xi. In a similar vein, Yang Shizhong, Professor at Chongqing University as well as the Chinese Academy of Engineering, wears several other hats, besides his academic affiliations. Shizhong is also Director of the Academic Board of 'Spacecraft TT&C [telemetry, tracking & Command Systems]', and technical consultant of Military Science and Technology Research Commission at the PLA Headquarters of the General Staff. Shizhong has been instrumental in developing China's first transmission-type satellite remote sensing system, which is now being utilized by China's special forces. Shizhong now has the responsibility for research and development of China's Next Generation Internet (CGNI)-5G under the National Development and Reform Commission. Interconnected to his contribution to wireless mobile access terminals for CGNI, is his engagement with research on the microwave power beaming and supply of space-based solar power. He has been tasked to track the progress of the Chongqing SBSP plant, strengthen the demonstration of key technologies like wireless beaming, as well as plan for making breakthroughs in the years ahead.[121]

PLASSF. According to Xi, the PLASSF is an important decision made by the CPC Central Committee and the CMC to realize the Chinese Dream and the Dream of a Strong Military, and a strategic initiative to build a modern military power system with Chinese characteristics.[122] The PLASSF is also involved in Civ-Mil integration. In 2017, the PLASSF signed a 'Cooperation Framework Agreement" with the China University of Science and Technology, Shanghai Jiaotong University, Xi'an Jiaotong University, Beijing Institute of Technology, Nanjing University, Harbin Institute of Technology and other six universities, as well as Aerospace Science and Technology Corporation, Aerospace Science and Industry Corporation, Electronic Technology Group Corporation.[123] These agreement is aimed at civil-military integration to attract talent, innovation, carry out special training based on technical expertise, and allow smooth transition between civilian agencies and the PLASSF.
[124]

---

[121] Chongqing University, Scholars Page for Yang Shizhong, at http://english.cqu.edu.cn/info/1162/1298.htm (Accessed on April 16, 2019). Xinbin Hou, "Space Solar Power Development in China and MR-SPS", China Academy of Space Technology, Qian Xuesen Laboratory of Space Technology, November 09, 2018 at http://www.sspss.jp/MR-SPS4.pdf (Accessed on April 16, 2019).

[122] "Xi Stresses Military-Civilian Integration in a New Era", n. 142. "Speech Delivered by Xi Jinping at the First Session of the 13th People's Congress", *Xinhua*, March 21, 2018 at https://www.chinadailyhk.com/articles/184/187/127/1521628772832.html (Accessed on April 17, 2019). "Backgrounder: Xi Jinping's Vision for China's Space Development", Xinhua, April 24, 2017 at http://eng.chinamil.com.cn/view/2019-02/18/content_9429066.htm (Accessed on April 6, 2019).

[123] "Strategic Support Force Cooperates with 9 Local Units to Train High End Talents of New Combat Forces", *Xinhua*, July 13, 2017 at http://military.people.com.cn/n1/2017/0713/c1011-29402123.html (Accessed on April 14, 2019).

125The establishment of the PLASSF meet three specific requirements for power projection capabilities for China in outer-space.[126]

First, the PLASSF offer China the capability to establish co-orbital presence (Earth-Moon space), to include support for its plans for permanent space presence, engage in 'area denial of space' to adversaries by jamming of adversary satellites,[127] and most importantly, the projection of military power in space. Such indigenous space military capabilities are backed by China's growing space presence and ambitions. The PLASSF, for the first time, brings together China's growing military space assets, into a single unit, aimed at dominance across the spectrum of air, space and cyber. This, the PLASSF aims to establish, by taking advantage of the U.S. military's overt dependence on space assets and space infrastructure for combat, reconnaissance, navigation, precision targeting, early warning, weather forecasting, intelligence gathering.[128] All China would require doing to expose U.S. vulnerability is threatening such assets by developing 'asymmetric capabilities' to include its 2007 Anti-Satellite Test (ASAT), that demonstrated its ability to down a U.S. satellite if required during combat. Such ASAT technologies have been further refined in 2010, 2013 and 2014, enhancing their capabilities without generating space debris as did its 2007 test. There are open sources reporting that the SSF is training with ASAT missiles aimed at US satellites. These ASAT includes the variant of the HQ-19 surface to air missile,(utilized in tests in 2007, 2010) and the DN-2 (2013) and the DN-3 (2015, 2016, 2017). According to the National Space and Air Intelligence Center (NASIC) report, *Competing in Space*,

> China has military units that have begun training with anti-satellite missiles. Russia is probably also developing an anti-satellite missile. These missiles can destroy U.S. and allied space systems in low Earth orbit, making intelligence, surveillance, reconnaissance, and communications satellites vulnerable.[129]

Second, by establishing the PLASSF, China is innovating its military to develop futuristic doctrines, training and capabilities to back its state funded space ambitions as well as growing private space industry. Critically, Xi urged China's private space industries to integrate their strategy within his Civil-Military Integration Strategy. Since 2014, President Xi has been urging China's private space sector to emerge as the leader in the "implementation of civil-military integration strategy".[130] Xi's policy guidance has been followed up by the PLA, and

---

[126] Namrata Goswami, Waking up to the China Dream", n. 42.
[127] Daniel R. Coats, Director of National Intelligence, "Worldwide Threat Assessment of the US Intelligence Community", February 13, 2018 at https://www.dni.gov/files/documents/Newsroom/Testimonies/2018-ATA---Unclassified-SSCI.pdf (Accessed on April 14, 2019). Zachery Kack, "China will Soon be Able to Destroy Every Satellite in Space", *The National Interest*, June 30, 2018 at https://nationalinterest.org/blog/buzz/china-will-soon-be-able-destroy-every-satellite-space-27182 (Accessed on April 14, 2019).
[128] Omar Lamrani, "What the U.S. Military Fears Most: A Massive Space War", *The National Interest*, May 18, 2016 at https://nationalinterest.org/blog/the-buzz/what-the-us-military-fears-most-massive-space-war-16248 (Accessed on April 17, 2019).
[129] National Air and Space Intelligence Center, "Competing in Space", December 2018 at https://media.defense.gov/2019/Jan/16/2002080386/-1/-1/1/190115-F-NV711-0002.PDF, p.21 (Accessed on April 14, 2019).
[130] "PLA welcomes Launches of Private Rockets", *China Daily*, February 18, 2019 at http://eng.chinamil.com.cn/view/2019-02/18/content_9429066.htm (Accessed on April 17, 2019).

it has opened up its *Jiuquan Satellite Launch Center* [China's primary launch facility] in the northwestern Gobi Desert for private rocket launches. The planning chief of the *Jiuquan Satellite Launch Center,* Jia Lide, stated that "favorable policies and targeted measures have been created for the benefit of private space enterprises".[131]

Third, in case a dispute breaks out over 'resource ownership' in space, the PLASSF is being optimized and structured to respond in a manner that builds upon domain expertise given its focus solely on utilizing space and cyber for optimal ends. President Xi in a speech to the PLASSF in August 2016 stated that "Innovation is what we need most in building the strategic support force. Innovation is the fundamental solution".[132] Xi stressed the significance of building a training regime and augment war-fighting capacities solely focused on domain expertise and focus. To motivate its personnel, the CMC promoted the Commander of the PLASSF, Gao Jin to General in 2017, the highest 'active-duty' rank in China.[133]

Evidence of Dual Use Systems. There have been conferences and meetings on the dual use of technologies like Artificial Intelligence, Space and Robotics, where China is emerging as a leader. The development of a satellite with a robotic arm that simulated the grab of another Chinese satellite in space in 2013, indicated that such a capacity has dual use and could grab an adversary satellite if required. China has enhanced its capacities for space debris removal through the *Aolong-1 debris cleaner,* which was onboard the Long March 7 rocket launched in 2016. The *Aolong-1* can conduct proximity operations, called Rendezvous Proximity Operations (RPO), to identify, and conduct clean-up of defunct satellites for active debris removal.[134] While space debris removal and satellite refueling, maintenance and repair, are benign activities, such Chinese assets are now directed by the SSF. This implies that civilian space capacities can easily switch to military use when required given China's space program is directed and led by the PLA.

China and Multilateral Engagements in Space.

China's up-coming space station, *Tianhe-1* (harmony of the heavens) is scheduled for launch in 2022.[135] Bai Mingsheng, chief designer of China's first cargo spacecraft *Tianzhou-1*, in an interview to China Central Television, stated that "China might be the only country that will run a space station in the foreseeable future. We could invite other nations to carry out experiments on [our] space station, making it an international scientific platform for all humankind."[136] On May 28, 2018, China issued a call for all U.N. nations to participate in its upcoming space station (including the U.S.) for the peaceful use of outer-space in cooperation with the United Nations

---

[131] Ibid.
[132] "Strive to Build a Strong, Modern, Strategic Support Force: Xi", Xinhua, August 29, 2016 at http://eng.chinamil.com.cn/view/2016-08/29/content_7231309.htm (Accessed on April 17, 2019).
[133] "China Promotes 5 Officers to General", Xinhuanet, July 28, 2017 at http://www.xinhuanet.com/english/2017-07/28/c_136480993.htm (Accessed on April 17, 2019).
[134] Stephen Chen, "Is China Militarising Space? Experts Say New Junk Collector Could be Used as anti-satellite weapon", *South China Morning Post*, June 28, 2016 at https://www.scmp.com/news/china/diplomacy-defence/article/1982526/china-militarising-space-experts-say-new-junk-collector (Accessed on April 17, 2019).
[135] Deyana Goh, "China's Space Station to be Operational by 2022", Spacetech, March 15, 2018 at http://www.spacetechasia.com/chinas-space-station-to-be-operational-by-2022/ (Accessed on April 17, 2019).
[136] "China's Space Station will Serve all Mankind: Expert", *China Daily*, September 18, 2017 at http://en.people.cn/n3/2017/0918/c90000-9270409.html (Accessed on April 17, 2019).

Office for Outer Space Affairs (UNOOSA).[137] Simonetta Di Pippo, Director of UNOOSA stated in an interview to Xinhua that "This is an agreement which will allow the entire world to use, for scientific purposes, the China Space Station when it will be ready...it's the first time it is open to all member states."[138]

China's invitation to all U.N. member states to participate in scientific experiments abroad its space station is clearly a dig at the U.S. In 2011, a spending bill passed by the U.S. Congress included a clause that prohibited any scientific cooperation between China, NASA and the White House Office of Science and Technology Policy (OSTP). The clause states that NASA or OSTP are prohibited "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." It prevents NASA facilities from hosting 'official Chinese visitors'.[139] During my visit to China in 2016 to interact with Chinese space policy makers, academia and students, I asked them about the 2011 U.S. Congressional ban. Almost all argued that such a ban actually galvanized space research in China and improved their indigenous capacities. Chinese academics specializing on outer- space specified that soon it will be only China on whom everyone else will depend, to establish presence in outer-space. This development, by default, would force the U.S. to cooperate with China in outer-space. China's Memorandum of Understanding (MoU) with UNOOSA adds credibility to such a claim and affords it powerful agency in the construction of regulatory regimes in outer-space.

China's former Ambassador to the United Nations, Shi Zhongjun, in a May 28, 2018 statement stated, "The China Space Station belongs not only to China, but also to the world,". As mentioned earlier, in cooperation with UNOOSA, China is inviting applications from public and private companies, universities, all U.N. members, and especially developing countries to submit proposals for conducting scientific experiments abroad its upcoming space station.[140] Zhongjun specified,

> A shared vision for the future in space exploration and use is not only consistent with the objectives and purposes established in the Outer Space Treaty -- that the exploration and use of outer space should be for the benefit and in the interest of all countries -- but also in line with current needs to protect the outer space environment and promote sustainability both for outer space activities and socioeconomic development.[141]

---

[137] United Nations/China Space Station Announcment of Opportunity Ceremony", United Nations Office for Outer Space Affairs, May 28, 2018 at http://www.unoosa.org/oosa/en/informationfor/media/2018-unis-ma-222.html (Accessed on April 17, 2019).

[138] "Interview: Opening up of China's Space Station to Reinforce Cooperation for Outer Space's Peaceful Use—UN Official", Xinhuanet, May 29, 2018 at http://www.xinhuanet.com/english/2018-05/29/c_137214412.htm (Accessed on April 17, 2019).

[139] Jeffrey Mervis, "Spending Bill Prohibits U.S-China Collaborations", Science, April 21, 2011 at https://www.sciencemag.org/news/2011/04/spending-bill-prohibits-us-china-collaborations (Accessed on April 17, 2019).

[140] "United Nations and China Invite Applications to Conduct Experiments on-board China's Space Station", UNOOSA, Press Release, May 28, 2018. Also see Loren Grush, "China invites international researchers to do science on its future space station", The Verge, May 29, 2018 at https://www.theverge.com/2018/5/29/17404896/china-space-station-international-cooperation-united-nations (Accessed on April 17, 2019).

[141] "Chinese Envoy Calls for Strengthening of Outer Space Governance. Cooperation", Xinhua, June 21, 2018 at http://www.xinhuanet.com/english/2018-06/21/c_137268993.htm (Accessed on April 16, 2019).

China's White paper of 2016 highlight multilateral engagements with UNOOSA, the United Nations Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee and Legal Subcommittee, as well a field office by the UN in Beijing, called the Regional Center for Space Science and Technology Education in Asia and the Pacific (China). China is a key member of the Asia-Pacific Space Cooperation Organization (APSCO), that includes the APSCO Joint Small Multi-Mission Satellite Constellation Program. It also organized the APSCO Development Strategy Forum within the theme of "the Belt and Road Initiative for Facilitating Regional Capacity Building of the Asia-Pacific Countries."

This kind of 'grandstanding' offers China, influence and power, especially the ability to influence others to do what you want them to do. China views its space initiatives as part of its BRI and is especially keen to see countries the initiative enjoy the benefits of China's space capabilities. While announcing April 24, 2016 as the first National Space Flight day (China's first satellite, the *Dong Fang Hang* 1 launched into space on April 24, 1970), Xu Dazhe, Vice Minister of China's Ministry of Industry and Information Technology (MIIT), administrator of SASTIND and the CNSA specified that China views its international space activities as part of the OBOR, and aims to build an Asia-Pacific focused space cooperation.[142] With such high-end outer-space cooperation comes the power to craft alternate regime structures and norms. China is building a $9 billion Beidou Navigation System (BDS) to be globally operational by 2020. The profits to be earned from this system is estimated to be $ 57 billion in 2020 itself, as predicted by the China Satellite Navigation Office. Companies like NavInfo Co, funded by TENCENTS, aims to make semiconductors for navigation systems based on Beidou. Already, smartphones from Samsung support Beidou. China is already mandating all car companies that sell in China to make them Beidou compatible by 2020. Car makers like Volkswagen are already meeting those requirements.[143] As per its white paper on the Beidou navigation system, China has developed Beidou as per its national security and economic needs. At the sometime, it wants to offer this system to the world. As per the white paper, the third level development of Beidou is to, "provide basic services to the countries along the Belt and Road and in neighboring regions by 2018, and to complete the constellation deployment with the launching of 35 satellites by 2020 to provide services to global users".[144] The first BRI 2017 summit drew the Heads of 28 states, to include Russian President Vladimir Putin, Philippine President Rodrigo Duterte, Turkish President Recep Tayyip Erdogan, Malaysian Prime Minister Najib Razak, Indonesian President Joko Widodo, Vietnamese President Tran Dai Quang and Myanmar's leader Aung San Suu Kyi, besides others. It was also attended by Heads of States from Switzerland, Italy, Hungary, Czech Republic, Kenya, Nigeria. The 2019 summit is scheduled for May. Space is an important component of the BRI.

---

[142] "SCIO Briefing on China's 1st National Day of Space Flight", China.org.cn, April 23, 2016 at http://www.china.org.cn/china/2016-04/23/content_38309726.htm (Accessed on April 17, 2019).
[143] "China Building $9 Billion Beidou Rival to U.S-Run GPS, looks to go global", *The Japan Times*, November 26, 2018 at https://www.japantimes.co.jp/news/2018/11/26/asia-pacific/china-building-9-billion-beidou-rival-u-s-run-gps-looks-go-global/#.XLeZ2OhKiUk (Accessed on April 17, 2019).
[144] State Council, PRC, "Full Text of White Paper: China's Beidou Navigation Satellite System", June 2016 at http://www.scio.gov.cn/zfbps/ndhf/34120/Document/1480623/1480623.htm (Accessed on April 17, 2019).

Bilateral Agreements.

China has signed 121 cooperation agreements with 37 countries and four international organization, as per CNSA spokesperson, Li Gouping.[145] These include a 30 year relationship with Brazil on earth resource satellites, an ocean observation satellite with France, the construction of a BRICS (Brazil, Russia, India, China, South Africa) remote sensing satellite constellation, satellites launches for Sri Lanka, Bangladesh, Algeria, and satellite data sharing with Pakistan, Iran, Turkey, Peru, Chile, Thailand, Laos, Cambodia, Burma.[146] Significantly, China has signed bilateral agreements with Russia, the European Space Agency (ESA), Brazil, Chile, France, the U.K., Germany, the Netherlands, Algeria, Argentina, Belgium, India, Indonesia, and Kazakhstan to strengthen exchanges and cooperation in such areas as space technology, space applications, and space science, education and training. Interestingly, China's White paper on Space 2016 claims that "China and the United States, within the framework of the China-US Strategic and Economic Dialogue, carried out a civil space dialogue, stating that the two countries would strengthen cooperation in space debris, space weather, response to global climate change, and related areas".[147]

Expectations from China's Industrial Space Ambitions based on Territorial Behavior on Earth

While others offer insights that PRC space efforts are mostly aimed at anti-access, or information dominance strategies, in my perspective, what should be of concern to the U.S are the elements that are focused on material and economic strength and securing of space resources. Chinese space activities should be seen through the lens of territorial and resource competitive offensives such as the Belt and Road Initiative and 5G internet.

China's space ambitions indicate that under the leadership of Xi, it is not only establishing capacity to take advantage of the multi-trillion dollar space industry that awaits but also enhancing and streamlining its military capacities for power projection in outer-space. Leading to these are proclaimed ambitions of colonizing the moon, and establish norms and regulations for outer-space led by China. The Commission has good reasons to be skeptical of PRC efforts at norm construction. China supported a joint draft proposal with Russia for the "Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects" in 2008 and again in 2014.[148] While the move for such a treaty appears noble, an in-depth assessment indicates that it does not include a ban on direct ascent ASAT technologies or terrestrially based space weapons.

The Commission should consider that there are indications China views space territorially and therefore it is relevant to examine how China behaves with respect to territory and resources on

---

[145] "China Strengthens International Space Cooperation", *China Daily*, April 19, 2018 at http://www.chinadaily.com.cn/a/201804/19/WS5ad899eea3105cdcf65195a1.html (Accessed on April 16, 2019).
[146] Ibid.
[147] "Full text of White Paper on China's Space Activities in 2016", n. 109.
[148] "Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects (Draft), Ministry of Foreign Affairs of the People's Republic of China, June 16, 2014 at https://www.fmprc.gov.cn/mfa_eng/wjb_663304/zzjg_663340/jks_665232/kjfywj_665252/t1165762.shtml (Accessed on April 17, 2019).

Earth. China's history of signing bilateral agreements with countries it has land disputes with committing to de-escalation and peaceful resolution of disputes, while simultaneously engaging in behavior that is contrary to its signed commitments, do not give us much assurance it will behave any differently in the space domain.[149] This aspect was visible in the 2017 China-Bhutan border dispute. The dispute started when the Royal Bhutan Army (RBA) observed Chinese road-building activities in the Doklam area. The RBA tried to dissuade the People's Liberation Army (PLA) engineers from constructing the road but failed. This led to Indian military intervention on behalf of Bhutan, and de-escalation of the conflict after a 73 days standoff between two nuclear armed nations. Critically, China and Bhutan had signed agreements to resolve this dispute peacefully and have held 24 rounds of negotiations on the same, since 1984. The Bhutanese government's take is that China's roadbuilding activities is against the 1988 and 1998 bilateral China-Bhutan agreements by which all boundary disputes will be resolved by negotiations. Bhutan states that "we have written agreements of 1988 and 1998 stating that the two sides agree to maintain peace and tranquility in their border areas pending a final settlement on the boundary question, and to maintain status quo on the boundary as before March 1959. The agreements also state that the two sides will refrain from taking unilateral action, or use of force, to change the status quo of the boundary".[150] On the other hand, the Chinese perspective is that its road-building activities do not infringe upon Bhutanese territory as Doklam has always been a part of China. Foreign Ministry Spokesperson, Lu Kang, asserted "Doklam has been a part of China since ancient times. That is an indisputable fact supported by historical and jurisprudential evidence, and the ground situation. China's activities in Doklam are acts of sovereignty on its own territory. It is completely justified and lawful".[151]

An analysis of China's past behavior regarding negotiations on disputed territory reveals a clear systematic pattern of engagement which is relevant to its future space ambitons. In its active border and territorial disputes, be it with India over Arunachal Pradesh, or the South China Sea (SCS), or Bhutan, China has favored the signing of 'Guiding principles' or 'Agreements to maintain peace and tranquility" with the state it is in dispute with. Such a framework, by establishing clear guidelines constrains the negotiating power of the fellow signatory state blindsiding it to China's future plans of sudden aggressive broadcasting of territorial claims. For instance, China and India signed a 2005 agreement on "Political Parameters and Guiding Principles for the Settlement of the India-China Boundary Question".[152] As per the agreement's Article IX,

---

[149] Namrata Goswami, "Can China be Taken Seriously on its 'Word' to Negotiate Disputed Territory?", The Diplomat, August 18, 2017 at https://thediplomat.com/2017/08/can-china-be-taken-seriously-on-its-word-to-negotiate-disputed-territory/ (Accessed on April 17, 2019).

[150] Ministry of Foreign Affairs, Government of Bhutan, "Press Release", June 29, 2017 at http://www.mfa.gov.bt/?p=4799 (Accessed on September 19, 2017).

[151] Ministry of Foreign Affairs of the People's Republic of China, "Foreign Ministry Spokesperson Lu Kang's Regular Press Conference on June 29, 2017 at http://www.fmprc.gov.cn/mfa_eng/xwfw_665399/s2510_665401/t1474166.shtml (Accessed on September 19, 2017).

[152] "Agreement between the Government of the Republic of India and the Government of the People's Republic of China on the Political Parameters and Guiding Principles for the Settlement of the India-China Boundary Question", Ministry of External Affairs, Government of India, April 11, 2005 at https://www.mea.gov.in/bilateral-documents.htm?dtl/6534/Agreement+between+the+Government+of+the+Republic+of+India+and+the+Government

> Pending an ultimate settlement of the boundary question, the two sides should strictly respect and observe the line of actual control and work together to maintain peace and tranquility in the border areas.

Yet, despite this agreement which establishes both China and India's commitment to maintain *status quo* and peace at the border, in 2006, the Chinese ambassador to India, Sun Yuxi stated categorically that "In our position, the whole of the state of Arunachal Pradesh is Chinese territory. And Tawang is only one of the places in it. We are claiming all of that. That is our position".[153] This was followed by frequent PLA incursions into the Indian side of the LAC on several occasions, as well as an attempt to set up permanent camps and settlements.[154] These intrusions have been augmented by the Chinese Ministry of Foreign Affairs publishing maps in Chinese passports depicting Arunachal Pradesh and other disputed areas like the SCS as Chinese sovereign territory.[155]

A similar pattern of Chinese behavior emerges with regard to the SCS as well which may inform expectations of future Chinese space behavior. China and ASEAN agreed on the framework on a Code of Conduct (CoC) in the SCS in May 2017.[156] The draft CoC commits the parties to resolve crisis peacefully and avoid placing offensive weapons in the SCS islands. In 2002, a 'Declaration on the Conduct of Parties in the South China Sea" was adopted by China and ASEAN.[157] Interestingly, art.5 of the declaration states:

> The Parties undertake to exercise self-restraint in the conduct of activities that would complicate or escalate disputes and affect peace and stability including, among others, refraining from action of inhabiting on the presently uninhabited islands, reefs, shoals, cays, and other features and to handle their differences in a constructive manner.

Yet, China is using early presence and facts on the ground to alter territorial claims despite its adoption of the 2002 declaration and establish exclusion zones and zones of military coercion in the SCS. In January 2014, it was discovered that Chinese vessels were dredging white sand and placing them onto corals at seven points in the disputed Spratlys, namely; Fiery Cross Reef, Mischief Reef, Gaven Reef, Cuarteron Reef, Subi Reef, South Johnson Reef, and Hughes

---

+of+the+Peoples+Republic+of+China+on+the+Political+Parameters+and+Guiding+Principles+for+the+Settlement+of+the+IndiaChina+Boundary+Question (Accessed on April 17, 2019).

[153] "Arunachal Pradesh is our Territory: Chinese Envoy", Rediff, November 14, 2006 at https://www.rediff.com/news/2006/nov/14china.htm (Accessed on April 17, 2019).

[154] Ben Arnoldy, "Growing Number of China Incursions into India Lead to a Strategy Change", *The Christian Science Monitor*, September 29, 2009 at https://www.csmonitor.com/World/Asia-South-Central/2009/0929/p06s06-wosc.html (Accessed on April 17, 2019).

[155] Jonathan Kaiman, "Chinese Passport Map Causes Diplomatic Dispute", The Guardian, November 27, 2012 at https://www.theguardian.com/world/2012/nov/27/chinese-passport-row-diplomatic-dispute (Accessed on April 17, 2019).

[156] "China, ASEAN Agree on Framework for South China Sea Code of Conduct", *Reuters*, May 18, 2017 at https://www.reuters.com/article/us-southchinasea-china-philippines-idUSKCN18E1FS (Accessed on April 17, 2019).

[157] "Declaration on the Conduct of Parties in the South China Sea", Association of Southeast Asian Nations, October 17, 2012 at https://asean.org/?static_post=declaration-on-the-conduct-of-parties-in-the-south-china-sea-2 (Accessed on April 17, 2019).

Reef.[158] Once the artificial islands have been built, China has followed it up with erecting buildings, harbors and airstrips, deploying radar and surveillance, as well as stationing its troops: all activities geared towards establishing ownership and sovereign control over disputed territory.

We see a similar pattern emerge in China's activities in Antarctica as well. As per the Antarctic Treaty System (ATS), in 1961, all territorial claims are to be suspended and the region must remain demilitarized and nuclear-free, and the primary goal is for cooperative scientific exploration. Additional agreements over the continent include the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR, 1982) to protect marine resources, and the Protocol on Environment Protection of the Antarctic Treaty (1991), known as the "Madrid Protocol," which forbids the exploitation of mineral resources. Any alterations to the ATS cannot take effect until 2048 without unanimous approval. CCAMLR tightly prohibits overfishing which can, as a direct flow-on effect, affect the availability of fish in other EEZs.[159] However, Illegal, Unreported and Unregulated (IUU) fishing in the Ross Sea is raising significant concern, particularly the fact that some of the infringing fishers are from ATS signatory states.[160] A Stockholm report from January 2015 tallied 147 cases of suspected IUU activities in Antarctic waters using 72 vessels between 1995 and 2009. These vessels frequently change their names and flag states to conceal the true beneficiaries of their fishing.[161] Anne-Marie Brady suggests that China is flouting the rules of the ATS. In 2014 the Chinese krill catch was 55,000 tons, worth approximately US$10 million. However, in 2015 China announced plans to increase their intake to between one to two million tons.[162] CCAMLR restricts annual krill catch to 680,000 tons.[163] As such, Chinese plans were to definitively and pugnaciously exceed the limits. IUU fishing is not only a security risk to the Antarctic region, it flouts the laws of the global commons and displays ill strategic intent. Furthermore, under the guise of "scientific research" any exploration is deemed accidental, which creates the situation where many real exploratory events are masked under the name of science. This exploration and potential mining are of concern as any conflict arising over minerals would likely involve multiple sovereign claimant states. Scholars suggest that China is the foremost player in the mineral exploitation game, as their four (soon to be five) bases are all in areas it has identified as strategically important and rich in resources.[164] The Polar Research Institute of China (PRIC) estimates there

---

[158] Derek Watkins, "What China has been Building in the South China Sea", *The New York Times*, February 29, 2016 at https://www.nytimes.com/interactive/2015/07/30/world/asia/what-china-has-been-building-in-the-south-china-sea-2016.html (Accessed on April 17, 2019).

[159] Anne-Marie Brody, "New Zealand's Strategic Interests in Antarctica", *Polar Record*, 47/2, April 2011 at https://www.cambridge.org/core/journals/polar-record/article/new-zealands-strategic-interests-in-antarctica/139EB0FC4E97E6A68D010BB2BFC705B2 (Accessed on April 17, 2019).

[160] L.M. Foster and Namrata Goswami, "What China's Antarctic Behavior Tells us About the Future of Space", *The Diplomat*, January 11, 2019 at https://thediplomat.com/2019/01/what-chinas-antarctic-behavior-tells-us-about-the-future-of-space/ (Accessed on April 19, 2019).

[161] "The Toothfish Bites Back", Stockholm Resilience Center, 2011 at https://www.stockholmresilience.org/research/research-news/2011-06-16-the-toothfish-bites-back.html (Accessed on April 17, 2019).

[162] Stuart Leavenworth, "China Fishing Plan in Antarctica Alarms Scientists", McClatchy, March 19, 2015 at https://www.mcclatchydc.com/news/nation-world/world/article24781990.html (Accessed on April 17, 2019).

[163] CCAMLR, "Krill Fisheries", at https://www.ccamlr.org/en/fisheries/krill-fisheries (Accessed on April 17, 2019).

[164] Anne Marie Brody, "China's Expanding Antarctic Interests: Implications for New Zealand", SSANSE, Policy Brief 2, June 3, 2017 at https://www.canterbury.ac.nz/media/documents/research/China's-expanding-Antarctic-interests.pdf (Accessed on April 17, 2019).

are 500 billion tons of oil and 300-500 billion tons of natural gas on the continent, plus more in the Southern Ocean stating "when all the world's resources have been depleted, Antarctica will be a global treasure house of resources."[165] China's focus is on exploiting resources in and above the ground.

Another issue of growth in the Antarctic is in the development of China's ice-based satellite communications system, the placement of *BeiDou 2* ground stations (China's GPS equivalent) on the ice increasing the accuracy and capability of missile tracking, timing and positioning; and an astronomical program that includes infrared telescopes capable of detecting enemy satellites, drones, and missile launches. The use of this suite of technology means that in any future dispute, the targeting of the Antarctic bases could be a reality even if the conflict is not on the continent. Similarly, China has established its first overseas fully owned 'China Remote Sensing Satellite North Pole Ground Station', at the Kiruna's Esrange Space Centre, 200km north of the Arctic Circle. Professor Liao Mingsheng, a satellite radar expert at Wuhan University's State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, specified, "A polar station will significantly boost our country's capability for global data surveillance. We should build more ground station overseas – maybe not only in the North Pole, but in the South Pole as well."[166] This project is part of China's Gaofen project – a network of observation satellites orbiting the Earth to provide global surveillance capabilities –due to be completed in 2020. Locating a ground station on the poles implies cutting the time for downloading satellite data from seven hours (from those that fly over China) to about 3.5 hours, for those that fly over the poles. This is due to the fact that satellites used for mapping, forecasting weather and military surveillance, intelligence gathering and reconnaissance are able to orbit the North Pole 12 times per day, compared to five times for those flying over China. This has raised concerns within Sweden with Swedish Defense Research Agency researchers suspecting that China will use these images to compliment military intelligence and surveillance. This scenario is even more plausible given China's space program is run under the direction of the PLA.[167]

What China aims to achieve from its space ambitions is to establish alternative institutions, investment mechanisms and capacities that not only challenges U.S. dominance in outer-space but establishes a China-led space order that it projects as benefiting the world. We can already see this manifesting with its BRI. In 2018, China established the China International Commercial Court,[168] in Xian, Shaanxi province and Shenzhen under its Supreme People's

---

[165] L.M. Foster and Namrata Goswami, "What China's Antarctic Behavior Tells us About the Future of Space", n. 160.

[166] Stephen Chen, "China Launches its First Fully Owned Overseas Satellite Ground Station near North Pole", *South China Morning Post*, December 16, 2016 at https://www.scmp.com/news/china/policies-politics/article/2055224/china-launches-its-first-fully-owned-overseas-satellite (Accessed on April 16, 2019).

[167] Nilobon Bantoey, "Satellite Station in Sweden can be serving Chinese Military", ScandAsia.com, January 16, 2019 at https://scandasia.com/satellite-station-in-sweden-can-be-serving-chinese-military/ (Accessed on April 16, 2019).

[168] "China International Commercial Court", at http://cicc.court.gov.cn/html/1/219/index.html (Accessed on April 16, 2019).

Court in Beijing, to adjudicate international commercial disputes, especially stemming from Chinese companies' engagement in BRI countries.[169]

Policy Recommendations

General Recommendations

a) The U.S. needs to take the Chinese space goals and timelines seriously. There must be a clear understanding that China's space program is a military directed and led program in which the CPC has staked its credibility.

b) As a response to the goals set by China, the U.S. should craft a long-term space resource policy that offers guidelines on both resource utilization and extraction. These should include long term plans for the Moon, asteroids and Space Based Solar Power.

c) There is a serious competition ongoing with China for leadership of space, and who has the more attractive long-term vision of space resource utilization.

d) The most useful lens through which to understand the Chinese Space program are its terrestrial efforts to secure resources (Tibet, Antarctica, South China Sea). China follows an incremental strategy of capacity development, establishing presence and then crafting institutions that support its presence.

e) Congress should fund a serious study of what a space economy would look like and what would be the implications of such a space-based economy.

China's space program and its future goals indicate a discourse shift from viewing space merely from a 'flags and footprints' model to a long-term presence capacity building model.

Given that, I would recommend further hearings on:

1. The state of Space Based Solar Power within the U.S. and China.
2. The State of Space Mining within the U.S. and China
3. Proposals for a Lunar Industrial Facility.
4. Development of Space Nuclear Propulsion.

Recommendations for Research

1. Intelligence mapping of Chinese space goals, from now to 2050, and a comparative assessment of the U.S. and Chinese space resource programs.
2. Develop scenarios of U.S. or PRC leadership in space resources and recommendations on how to get to a preferred future.
3. Track the progress of the Chinese space exploitation program on an annual basis.

[169] Freshfields Bruckhaus Deringer, "China Establishes International Commercial Courts to handle Belt and Road Initiative Disputes", University of Oxford, Faculty of Law,

Recommendations for Policies to get to a Preferred Future

1. Create capacity to maintain U.S. relative advantage in CIS-LUNAR space.
2. Create a vision for Space Industrialization.
3. Establish near-term goals to drive Space Mining and Space Based Solar Power.
4. Create a dedicated military space service for unity of effort in the space domain, where space is the topmost institutional priority.
5. Ensure the proposed U.S. Space Service has a broad set of missions that allow them to respond to the Chinese strategic offensive, including defense of commerce missions similar to what the U.S. Navy does in the maritime domain.
6. Give significant attention to establish bilateral relationships with non-European democracies such as India, Japan, Indonesia, Brazil, Australia, New Zealand.
7. Empower National Space Council to develop whole of government plans to compete with PRC in space.
8. Task new U.S. SPACE COMMAND as the operational lead for implementing the aforementioned National Space Council Plan.
9. Make U.S. SPACE COMMAND an interagency command. Include other key agencies that deal with space as represented in the National Space Council.