Chapter 9

Review of China's New Space Warfare Capability

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I. Introduction

In 2021, the PLA's Strategic Support Force achieved major milestones in the development of space technology by launching the Tianhe core module into the earth's orbit on April 29. The astronauts of the Aerospace System Department entered the Tianhe core module on June 17, successfully launched from the space station on July 14, and returned safely to the earth on September 17. During this period, China continuously demonstrated its national power in space. It is now the only country in the world operating a space station. Its astronauts completed the operation of going in and out of the space capsule, showcasing China's strong capabilities in precise launching, targeting, communications, and anti-satellite (ASAT).

Furthermore, in 2021, China completed the first-stage development of its communications relay satellite and successfully supported the functioning of the space station and the audio/video communications between the space station and the earth.[1] China's achievements in space development go beyond space stations and space communications. On May 15, the Mars exploration led by the China National Space Administration declared good news. After the thrilling nine minutes, Tianwen-1 successfully landed by itself on the surface of Mars, making

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1 "Chronicle of the Success of China's First Generation of Data Relay Satellites Developed by CASC," *China Space News*, July 16, 2021, http://m.spacechina.com/n2014789/n2014809/c3274335/content.html.

China the world's second country that has successfully landed on Mars.[2] With these accomplishments, the Chairman of the Central Military Commission, Xi Jinping, visited the satellite base in Xian on September 15 and vowed to protect China's assets in space.[3] This means China will enhance its resilience in terms of space and military technological development. It also means China is comparable to the U.S., with strengths and vulnerabilities, given its military dependence on space assets.

In the second version of the white paper "China's National Defense in the New Era" in 2019, China stated that it would accelerate the development of technology, the integration of satellite information and resources and the command of Space Situational Awareness (SSA) to enhance the abilities in accessing and utilizing the space.[4] Given China's achievements in space development in 2021, this chapter focuses on the military implications by focusing on the PLA Strategic Support Force's relevant activities in 2021. The purpose is to examine how the Aerospace System Department under the Strategic Support Force combines cyber and electronic warfare units and utilizes the space development plans and relevant warfare capabilities to support the PLA's information warfare or establish information advantages through gray-area conflicts.

Below is a summary of the PLA Strategic Support Force's progress in its space station, satellite communications network, and anti-satellite (ASAT) capabilities. The section also provides an analysis on the implications of the military's strengthening the access and utilization of the space, enhancement of Space Situational Awareness (SSA), and countering the enemy's use of space to achieve information advantages.

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[2] Steven Lee Myers and Kenneth Chang, "China's Mars Rover Mission Lands on the Red Planet," *New York Times*, May 14, 2021, https://www.nytimes.com/2021/05/14/science/china-mars.html?_ga=2.146445553.455917626.1632233103-1542753318.1629218292.

[3] "A Space Dream Built with Precision and Ingenuity," *people.cn*, September 20, 2021, http://politics.people.com.cn/BIG5/n1/2021/0920/c1001-32232002.html.

[4] "China's National Defense in the New Era (full text)." *Ministry of National Defense of the People's Republic of China*, July 24, 2019, http://www.mod.gov.cn/big5/regulatory/2019-07/24/content_4846424.htm.

II. Leverage of space development to establish information advantages on multiple warfare fronts

In response to Russia's and China's deployment of anti-satellite (ASAT) activities possibly beyond the detention scope of 20,000 km covered by existing space radars, it was heard in July 2021 that the U.S. intended to work with the U.K. and Australia in the establishment of three radar stations to detect the space weaponry from Russia and China up to 36,000 km from the surface of the earth. China threatened to collaborate with Russia to impose countermeasures. Like the U.S., the U.K. and Australia are also members of the Five Eyes, allowing them to share intelligence closely. The distribution of monitoring activities enhances the accuracy of the information, improves the survivability of the command and control systems, and strengthens the flexibility and resilience of backup deployment.[5]

In addition to the Five Eyes, the Japan Ministry of Defense stated the importance of the stability of Taiwan's situation to Japan for the first time in the 2021 annual white paper "Defense of Japan" released on July 13, 2021. It also emphasized the necessity of constructing multi-domain defense forces to cope with the challenge of new warfare in space and cyber and electromagnetic power. Noteworthily, the U.S. Armed Forces are much even faster. Given the trend for integrating the cyber and electromagnetic spectrum, all the military forces are starting to combine the command and control systems for space and cyberspace. It is expected that the cross-disciplinary integration between military branches can boost the flexibility and resilience in all-domain warfare.[6]

As the U.S. utilizes space assets to enhance information advantages for the defense of the First Island Chain in the Indo-Pacific, China is also proactively using its space assets to enhance C4ISR and ensure partial information advantages

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[5] Edited and translated by Hsin-yu Shih, "U.S. Intends to Build Three Radar Stations, to Counter China's Space Expansion," *Youth Daily News*, July 19, 2021, https://www.ydn.com.tw/news/newsInsidePage?chapterID=1426358.

[6] Japan Ministry of Defense, *2021 Defense of Japan*, July 13, 2021, p. 13, https://www.mod.go.jp/en/publ/w_paper/wp2021/DOJ2021_Digest_CH.pdf.

in the future battlefield of informationization. To this end, the Strategic Support Force is constructing its own space information advantages mainly by deploying reconnaissance, navigation, and communications assets in space for surveillance, positioning, and Space Situational Awareness (SSA). The establishment of space communications with satellite constellations enhances the satellite communication speed, quality, and resilience of military forces and networks on land, at sea, over the air, and underwater.

To offset the enemy's information advantages with the use of space assets, the Strategic Support Force has been proactively developing anti-satellite (ASAT) weapons, robot arms for grabs, kinetic energy weapons (e.g., space objects or debris), and the capability to initiate non-kinetic attacks on space satellites or ground stations, such as lasers directed towards the ground or the space to cause blindness or damages, microwave interference, electromagnetic pulse shocks with an explosion nearby or cyber viruses.[7] For gray-area conflicts of a non-war nature, the techniques are limited to recoverable measures and non-kinetic attacks. Thus, the Strategic Support Force must ensure its information advantage in cyberwar and electromagnetic spectrum war against strategic opponents.[8] Moreover, going up against the U.S. Armed Forces remains a huge challenge for the Strategic Support Force.

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[7] Todd Harrison et al., "Space Threat Assessment 2021," *Report of the CSIS Aerospace Security Project*, April 2021, pp. 3-7, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/210331_Harrison_SpaceThreatAssessment2021.pdf?gVYhCn79enGCOZtcQnA6MLke Klcwqqks. Also see Fu-yu Tsai (trans), "Increasing Space Security Threats Become an International Concern (part 1)," *Youth Daily News*, May 4, 2021, https://www.ydn.com.tw/news/newsInsidePage?chapterID=1364439.

[8] Chris Dougherty, "Confronting Chaos: A New Concept for Information Advantage," *War on the Rocks*, September 9, 2021, https://warontherocks.com/2021/09/confronting-chaos-a-new-concept-for-information-advantage/.

III. China's Progress in Space Reconnaissance and Communications

1. Acceleration in the Deployment of Gaofen Reconnaissance Satellites

After launching multiple high-resolution remote sensing reconnaissance satellites from the end of 2015 to 2020, the PLA Strategic Support Force continued its rapid deployment of Gaofen Series dual-use optical remote sensing reconnaissance satellites in 2021 to detect offshore stealth fighter aircraft and hypersonic weapons for early warning and deterrence purposes. The speed of deployment seems to be accelerating, given the maturity of the multiple carrier rockets. In September alone, the Taiyuan Satellite Launch Center (TSLC) used the CZ-4C Yao-40 carrier rocket and successfully launched a hyperspectral observation satellite (Gaofen 5 Satellite 02)[9] on September 7. On the other hand, the Jiuquan Satellite Launch Centre (JSLC) launched Jilin-1 Gaofen-02D on September 27[10] to fast-track the construction of reconnaissance satellite constellations. China claims its hyperspectral observation satellite is equipped with seven detection instruments covering ultraviolet and long-wave infrared—an integration of imagining technology and hyperspectral sensing to achieve the all-in observation of space, light spectrum, and radiation data. This fusion of multiple observed data with the perspectives of hyperspectral, in full-spectrum polarized with performance, is likely to be internationally cutting edge.[11]

2. Significance of Tiangong Space Station to the Space Force

Back in 2013, when the crewed spacecraft Shenzhou-10 was launched, Xi Jinping expressed his desire to speed up the space development to realize the

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[9] Chu-ching Chao, "Successful Launch of the Hyperspectral Observation Satellite to Ensure the Data for Environmental Monitoring," *people.cn*, September 7, 2021, http://finance.people.com.cn/BIG5/n1/2021/0907/c1004-32220053.html.

[10] "Jilin-1 Gaofen-02D Successfully Launched," *China Daily*, September 28, 2021, https://jl.chinadaily.com.cn/a/202109/28/WS615273b9a3107be4979f0263.html.

[11] Op. cit. 9. Chu-ching Chao, "Successful Launch of the Hyperspectral Observation Satellite to Ensure the Data for Environmental Monitoring," *people.cn*, September 7, 2021, http://finance.people.com.cn/BIG5/n1/2021/0907/c1004-32220053.html.

"aviation dream of the Chinese people". At that time, China was already planning to build its own crewed space station in 2020 and said it wanted to catch up with Russia and the U.S. in 2030 to become a space power.[12] Noteworthily, the Tiangong Space Station's Tianhe core cabin module is one realization of China's space ambitions.

On April 29, 2021, the Tiangong Space Station launched its Tianhe core cabin module. On June 17 of the same year, Shenzhou-12, carrying three PLA astronauts (i.e., Nie Haisheng, Liu Boming, and Tang Hongbo), was successfully docked with the Tianhe core cabin module.[13] This launch is China's 19th flight mission of crewed spacecraft and the first human-crewed mission in the space station stage.[14] On July 4, 2021, Liu Boming and Tang Hongbo went out of the capsule for the first time for six to seven hours,[15] inspected the performance of the new generation of spacesuits in space, installed equipment for the space station, enhanced the panoramic camera, and tested the robot arm of the space station. On August 20, the astronauts went out of the capsule again and completed tasks like installing pumping sets and lifting the panoramic camera. According to the field tests, China has achieved breakthroughs in robot arms for core cabin modules, extravehicular maintenance and support tools, and air-space-ground communications. All these are powerful supports to extravehicular operations of the space station.[16]

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[12] Tzong-han Mu, "With Exploration of the Moon and Mars and Establishment of the Space Station, China Surpasses Russia and Catches up with the U.S. in Its Space Ambitions," *Central News Agency*, July 29, 2021, https://www.cna.com.tw/amp/topic/newsworld/153/202107290004.aspx.

[13] Yue Yang, Pu-chung An, Kang Chan, Ching-ching Tan, "Out on a Mission! Chinese Astronauts Fly to the Home in Space," *Chinese People's Liberation Army Daily*, cited from the website of Ministry of National Defense of the People's Republic of China, June 17, 2021, http://www.mod.gov.cn/big5/topnews/2021-06/17/content_4887501.htm.

[14] Op. cit. 8. Tzong-han Mu, "With Exploration of the Moon and Mars and Establishment of the Space Station, China Surpasses Russia and Catches up with the U.S. in Its Space Ambitions," *Central News Agency,* July 29, 2021, https://www.cna.com.tw/amp/topic/newsworld/153/202107290004.aspx.

[15] China's first space walk was in September 2008 on an extravehicular task from Shenzhou-7. That walk only lasted about 20 minutes. Thirteen years on, China's space walk has been extended to six to seven hours. Tze-han Lin, "Perfect Extravehicular Activity Demonstrates China's Strengths in Aviation," *People's Daily(Overseas Edition)*, August 30, 2021, http://finance.people.com.cn/BIG5/n1/2021/0830/c1004-32211570.html.

[16] Op. cit. 10. Tze-han Lin, "Perfect Extravehicular Activity Demonstrates China's Strengths in Aviation," *People's Daily(Overseas Edition)*, August 30, 2021, http://finance.people.com.cn/BIG5/n1/2021/0830/c1004 32211570.html.

The Tiangong Space Station will consist of the Tianhe core cabin module, namely the Wentian and Mengtian modules. There will be a total of ten space missions in 2021-2022 for the construction of the space station. According to Wang Wei, Director of the General Research Office of the Space Station, the General Design Department of China Aerospace Science and Technology Corporation (CASC) Academy No. 5, the Wentian and Mengtian modules will be launched to dock with the core cabin module to form a T-shaped three-cabin structure via configuration repositioned. Meanwhile, four cargo spaceships will be launched for living and working in space, and four human-crewed spacecraft will transport the astronauts to the space station for living and working.[17] These four flight missions will require a stay at the space station for three to six months.[18]

Even with continued scalability, the Tiangong Space Station's technical capabilities remain significantly behind those of the International Space Station as China still does not have the large orbital segments as those in U.S. space shuttles. Each of the Tiangong Space Station's Tianhe core cabin modules—the Wentian and Mengtian modules—is approximately 16.6 meters in length for the long stationing of three people. Together with the cargo spacecraft and the human-crewed spacecraft, this adds to a total of 80 to 100 metric tons, equivalent to Russia's third-generation space station Mir. Meanwhile, the International Space Station, jointly constructed by the U.S. and Russia since 1998, is 109 meters in length, 73 meters in width, 20 meters in height, and 419 metric tons in weight. Its internal capacity is 916 m3, equivalent to a seven-story small stadium and capable of providing seven astronauts for long-term living and working.[19]

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[17] "400 km in Space – How is China Building a 'Home in Space'?," *China News Services*, April 29, 2021, https://www.chinanews.com/gn/2021/04-29/9467173.shtml.

[18] Op. cit. 8. Tzong-han Mu, "With Exploration of the Moon and Mars and Establishment of the Space Station, China Surpasses Russia and Catches up with the U.S. in Its Space Ambitions," *Central News Agency*, July 29, 2021, https://www.cna.com.tw/amp/topic/newsworld/153/202107290004.aspx.

[19] "Is the Gap Big between International Space Station and China's Epitome in Aviation Technology, Tiang?," *Our China Story*, July 3, 2021, https://www.ourchinastory.com/zh/1148/%E4%B8%AD%E5%9C%8B%E8%88%AA%E5%A4%A 9%E7%A7%91%E6%8A%80%E7%9A%84%E4%BB%A3%E8%A1%A8%20%E3%80%8C%E5%A4%A9%E5%AE%AE%E3%80%8D%E8%88%87%E5%9C%8B%E9%9A%9B%E5%A4%AA%E7%A9%BA%E7%AB%99%E5%B7%AE%E8%B7%9D%E5%A4%A7%E5%97%8E%EF%BC%9F.

While China designates the Tiangong Space Station as its "national space laboratory", it is independently maintained and operated by China. On the other hand, the International Space Station is maintained by more than ten countries.[20] Whether China's Tiangong Space Station provides military service is an issue of great concern. Despite the limitation in hardware scalability, the Tiangong Space Station continues to install state-of-the-art communications and electronics technology and update software with artificial intelligence to achieve the extension of functions.[21] The two extravehicular activities by astronauts from the Tianhe Core Module showcased China's capability to manufacture, repair, and maintain space robot arms, spacesuits with life-support and communications systems, and real-time communications in space and between space and the ground with Tianlian relay satellites for the space station.

Furthermore, it is worth noting that the Tiangong Space Station will serve as a space harbor by providing maintenance and supplies to spacecraft in space and upgrading the spacecraft equipment and software accordingly. Neither the Mir space station in the past nor the International Space Station has this function. After completing the Tiangong Space Station, China will launch the XunTian CSST Chinese Synoptic Survey Telescope on its own and put it in the same orbit as the Tiangong Space Station, with short stops over at the Tiangong Space Station for the refilling of propellants, repair, maintenance, and upgrade.[22] In this way, the Tiangong Space Station will become part of China's space target acquisition and reconnaissance capability.

3. Military significance of Tianlian Communications Satellites

While the world is watching Musk's low-orbital Starlink to connect with 6G, autonomous driving, and solar energy generation in 2021, China is also proudly

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[20] Op. cit. 12. "400 km in Space—How does China Build a 'Home in Space'?," *China News Services*, April 29, 2021, https://www.chinanews.com/gn/2021/04-29/9467173.shtml

[21] Op. cit. 12. "400 km in Space—How does China Build a 'Home in Space'?," *China News Services*, April 29, 2021, https://www.chinanews.com/gn/2021/04-29/9467173.shtml.

[22] Op. cit. 12. "400 km in space—How does China Build a 'Home in Space'?," *China News Services*, April 29, 2021, https://www.chinanews.com/gn/2021/04-29/9467173.shtml.

demonstrating its Tianlian communications satellite group deployed in the geostationary orbit, 35,786 km above the ground at a cost lower than Starlink and with a technology higher than Starlink for satellite-to-earth communications. On July 6, 2021, the Xichang Satellite Launch Center (XSLC) used the CZ-3C carrier rocket to send Tianlian 1-05 into the intended orbit and join the global network involving Tianlian 1- 01, 02, 03, and 04,[23] and Tianlian 2-01.[24] This successfully included China's first generation of tracking and data relay satellite (TDRS) program, making China the world's second country with a relay satellite system of global coverage. Consequently, this development opened a new chapter for space exploration and data transmission.[25]

Since the launch of Shenzhou-7 in 2008, each crewed flight by Tianlian satellites has been rendering services in communications relay. Currently, the second-generation Tianlian relay satellites (i.e., the human-crewed Shenzhou Series), the space station (Tiangong-1 target spacecraft and Tiangong-2 space lab, Tianhe core cabin module), low-to-mid orbit spacecraft, and low-orbit high-resolution remote sensing satellites provide in-orbit high-speed data relay and monitoring services. This has established the capabilities of global surveillance and high-speed data real-time transmission and became the backbone of China's space communications. In addition, Tianlian provides the monitoring capability from space with the Chinese carrier rockets, greatly enhancing the capability to launch overall surveillance and data relay services by increasing the monitoring and communications coverage of Chinese human-crewed spacecraft from less than 20% to over 98%. Moving forward, the user group will extend from spacecraft to

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[23] Tianlian 1- 01, 02, 03, and 04 launched in April 2008, July 2011, July 2012, and November 2016, respectively. Tianlian 2-01 also successfully launched on March 31, 2019. Note 1: Chu-ching Chao, "BeiDou-3, the Last Satellite in the BeiDou Navigation Satellite System, will be Launched at 9:43 today," *people.cn—Technology channel*, June 23, 2020, http://scitech.people.com.cn/BIG5/n1/2020/0623/c1007-31756155.html.

[24] Cheng Fan, Hsia-qun Chen, Yi-fei Fu, "Tianlian 1-05 Liftoff! Let's Get to know Relay Satellite Group," *Science and Technology Daily*, July 8, 2021, https://www.chinanews.com/gn/2021/07-08/9514973.shtml.

[25] Challey, "How Fast is China's Tianlian? Which One is the Future? The Comparison between Starlink and 6G," *Electronics Engineering Times*, June 24, 2021, https://www.eet-china.com/news/12095.html.

users at sea, on land, and over the air—a tremendous boost to C4ISR.[26]

Tianlian Series satellites are built based on the Dongfanghong series satellites. By 2021, China has launched a total of 41 DFH-3 platform satellites for communications, navigation, and relay purposes. China-made satellites possess the all-phase three-axis attitude stabilization, advanced track control technology, and a control system over the core circuit box. Its liquid bipropellant technology is capable of multiple ignitions and switching on/off at any time. With continued efforts for its technology, the local content of Tianlian 1- 05 is as high as 92%.[27]

On top of the technological foundation of Dongfanghong satellites, the Chinese research team has achieved key breakthroughs in the closed-loop autonomous precision capturing and tracking in relay satellites. This development resolves the challenge of capturing and tracking satellites in high-speed motion, enabling high-quality link communication among satellites. Information on ground conversations arrives at Tianlian relay satellites with satellite-ground links from the ground station. In addition, the research team overcame the difficulty in the R&D of high-performance antennas. The integrated design in mechanics, electrical, and thermal resolves the challenge of design and manufacturing of plane of reflection in high-precision and dual-band band trace antennas. Consequently, microwave high-speed data transmission is enabled and satellite-ground communications empowered.[28]

The communications facilities of ground stations started to look old and worn out in 2017, which were gradually replaced with China's own software. On April 16, 2021, the Tianlian 1-02 ground system completed repair and maintenance and reentered the service to meet the satellite-ground communications required by the

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[26] Chu-ching Chao, "BeiDou-3, the Last Satellite in the BeiDou Navigation Satellite System, will be Launched at 9:43 Today," *people.cn-Technology channel*, June 23, 2020, http://scitech.people.com.cn/BIG5/n1/2020/0623/c1007- 31756155.html; Cheng Fan, Hsia-qun Chen, "China's Tianlian: Gold Bridge between Earth and Sky (Home in space —Constructing the China Space Station," *People's Daily Overseas Edition*, July 19, 2021, http://www.xinhuanet.com/politics/2021-07/19/c_1127668171.html.

[27] Chu-ching Chao, "BeiDou-3, the Last Satellite in the BeiDou Navigation Satellite System, will be Launched at 9:43 Today," *people.cn-Technology channel*, June 23, 2020, http://scitech.people.com.cn/BIG5/n1/2020/0623/c1007- 31756155.html.

[28] Cheng Fan, Hsia-qun Chen, "China's Tianlian: Gold Bridge between Earth and Sky (Home in space — Constructing the China Space Station," *People's Daily Overseas Edition*, July 19, 2021, http://www.xinhuanet.com/politics/2021-07/19/c_1127668171.html.

space station. This marks the achievement of integrated operation and management for the Tianlian first- and second-generation relay satellite system. In addition, it also enhances the reliability, maintainability, and automation of the Tianlian relay satellite system.[29]

The conversation on June 23 between Xi Jinping from the ground station and the astronauts in Shenzhou-12 was relayed through the satellite-ground communications with links from the Tianlian 2 satellite to its core cabin module. It was first through the precision-tracking of the space station with the linked antenna among Tianlian relay satellites. Upon receiving conversations from the ground station, Tianlian relay satellites transmitted data via their own linked attentions to the space station so that astronauts received the conversations from the ground station. On the other hand, the conservations from the astronauts to the ground are transmitted from the relay terminal of the space station, then the Tianlian relay satellite via satellite-ground downlinks to the ground station.[30]

Tianlian relay satellites operate in the S/Ka-band, with Kameter wave radar in 26.5G-40GHz for high-speed data communications. This frequency band is in the middle of FR2 (Frequency Range 2) for 5G at 24250MHz-52600MHz (vs. FR1 at Sub-6GHz: 450MHz-6000MHz). It is also the millimeter wave (mmWave) band advocated by Qualcomm.[31] Tianlian's speed is at least comparable to 4G communications on the ground. Meanwhile, the downlink rate of up to 1.2G is equivalent to the 5G speed rate. The ground stations for relay satellites receive real-time space data and transmit data to the Beijing Aerospace Control Center. The data is automatically distributed according to identifiers, with second latency. The satellite-ground Internet consists of in-orbit communications exchange networks and satellite-ground gateway systems based on ethernet switches. This satellite-

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[29] Jan Wang, Pu-chung An, "China Completes the Upgrade of First Generation Relay Satellite Ground System," *Chinese People's Liberation Army Daily*, April 17, 2021, http://www.gfdy.gov.cn/big5/information/2021-04/17/content_10028899.htm.

[30] Cheng Fan, Hsia-qun Chen, "China's Tianlian: Gold bridge between Earth and Sky (Home in space — Constructing the China Space Station," *People's Daily Overseas Edition*, July 19, 2021, http://www.xinhuanet.com/politics/2021-07/19/c_1127668171.html.

[31] Challey, "How Fast is China's Tianlian? Which One is the Future? The Comparison between Starlink and 6G," *Electronics Engineering Times*, June 24, 2021, https://www.eet-china.com/news/12095.html.

earth network convergence allows astronauts to connect from WiFi hotspots in the space station for high-speed Internet.[32]

IV. China's Progress in Anti-satellite (ASAT) Capability

It is believed that the PLA already established the kinetic hit-to-kill capability targeting low-earth orbit (LEO) satellites and the anti-satellite (ASAT) capability towards geosynchronous orbits (GEO). The PLA tests any potential dual-use technology of military value, such as space robot arms. However, the information on such technical capabilities was opaque until 2020, and it was difficult for the outside world to keep track of China's real progress.[33] It was not until April 21, 2021, when James Dickinson, commander of the United States Space Command, testified to the United States Senate that China's SJ-17 satellite is equipped with bionic robot arms, which can be used in the future to snatch other satellites and become the PLA's space weapon.[34]

China claimed its SJ-17 satellite is only used for "geosynchronous orbit technology validations" and the peaceful handling of space debris and junks.[35] However, the long-standing tracking by the western world noticed that this satellite

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[32] Cheng Fan, Hsia-qun Chen, "China's Tianlian: Gold Bridge between Earth and Sky (Home in space — Constructing the China Space Station," *People's Daily Overseas Edition*, July 19, 2021, http://www.xinhuanet.com/politics/2021-07/19/c_1127668171.html.

[33] Pratik Jakhar, "China Claims 'Important Breakthrough' in Space Mission Shrouded in Mystery," *BBC News*, September 9, 2020, https://www.bbc.com/news/science-environment-54076895b.

[34] Ken Moriya Su, "China Can' Grapple' US Satellites with Robotic Arm, Commander Says," *Nikkei Asia*, April 21, 2021, https://asia.nikkei.com/Politics/International-relations/US-China-tensions/China-can-grapple-US-satellites-with-robotic-arm-commander-says.

[35] "SJ-17 Satellite is Equipped with Anti-satellite (ASAT) Capability but China Claims that It is a Test of the Technology to Observe Space Debris for Peaceful Purposes. SJ-17 Satellite was Launched on November 3, 2016 from Hainan Wenchang Spacecraft Launch Site with a CZ-5 carrier rocket. It is a geosynchronous orbit (GSO) technology test satellite and developed by China Academy of Space Technology. On the DFH-4S platform, its weight is close to four tons. SJ-17 satellite's missions include tests in new energy and non-toxic propellants. There will also be a test on the high-orbit technology for observation of space debris. Space debris consists of decommissioned or defunct spacecrafts. It is a threat to in-orbit satellites." From Hsi-fu Ou, "Chinese Robot Arms of SJ-17 Satellite," *National Defense Security Real-Tome Assesement*, June 17, 2021, https://indsr.org.tw/tw/News_detail/3401/%E4%B8%AD%E5%9C%8B%E6%A9%9F%E6%A2%B0%E8%87%82%E5%AF%A6%E8%B8%9017%E8%99%9F%E8%A1%9B%E6%98%9F.

has changed operational orbits multiple times and took turns with other Chinese satellites to get unusually close to western satellites.[36] It is determined that China is extremely likely to be validating the co-orbital satellite attack model.[37] According to the judgment from the United States Space Command, this type of technology can grabble or destroy other satellites as a potential space weapon despite the claim of Tianjin University that the R&D of bionic robot arms is only for capturing space debris (the same way the U.K. previously claimed its space net is for capturing space junks). Moreover, similar designs must be very close to spacecraft for Rendezvous Proximity Operations (RPO), which cannot capture space debris or defunct satellites tossing and turning violently and out of control. The capturing design must target the expected maneuvers in known orbits. Further, this is no different from the co-orbital satellite attack model using anti-satellite (ASAT) weapons.[38]

China indicated that it wanted to enhance its ability to access and utilize the space. In addition to the SJ-17 satellite, it proved the ability in July 2021 to successfully reuse space launched vehicles (SLV).[39] Derived and developed from space shuttles, space vehicles are similar to Musk's SpaceX series and can be launched in orbits synchronously with other satellites. Hence, it is considered a co-orbital satellite attack capability.[40] On March 12, 2021, the CZ-7A carrier rocket developed by the China Academy of Launch Vehicle Technology under the China Aerospace Science and Technology Corp. (CASC) successfully completed its first flight from the Hainan Wenchang Spacecraft Launch Site.[41] Soon after, and on July 16, the CZ-7A carrier rocket took off from the Jiuquan Satellite Launch Centre (JSLC), completed the plan first, and landed firmly at Alxa Right Banner Airport.

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[36] Todd Harrison et al., "Space Threat Assessment 2021," *ibid*., p. 10.

[37] Fu-yu Tsai trans., "Increasing Space Security Threats Become an International Concern (part 2)," *Youth Daily News,* May 5, 2021, https://www.ydn.com.tw/news/newsInsidePage?chapterID=1364768&type=forum.

[38] Todd Harrison et al., "Space Threat Assessment 2021," *ibid*., p. 10.

[39] Tze Hu, "Successful First Flight and Validation of China's Reuse of Suborbital Space Vehicles," *Xinhua Net*, July 16, 2021, http://www.xinhuanet.com/tech/2021-07/16/c_1127663488.htm.

[40] Nivedita Raju, "A Proposal for A Ban On Destructive Anti-Satellite Testing: A Role for the European Union?," *EU Non-Proliferation and Disarmament Papers*, No. 74, April 2021, https://www.sipri.org/sites/default/files/2021-04/eunpdc_no_74.pdf.

[41] Op. cit. 14, Tze Hu, "Successful First Flight and Validation of China's Reuse of Suborbital Space Vehicles."

It was China's first successful trial flight, in which it utilized a reused space launch vehicle.[42]

Compared to the CZ-7 Series carrier rockets, the CZ-7A carrier rocket has a booster of half an extra length. The faring is shorter by 2.5 meters and can carry 5.5 to 7 tons of equipment into the geosynchronous orbit. It can also carry out launch missions for lunar orbits and low-inclination orbits.[43] The BeiDou Navigation Satellite System and communications satellites also operate in the geosynchronous orbit. In theory, China's repeated use of space vehicles can transport kinetic or non-kinetic space weapons to the geosynchronous orbit for attacks on communications satellites or navigation satellites in lower orbits from other countries. The CZ-7A carrier rocket is at the preliminary stage of development for reusing space launch vehicles, similar to Falcon 2 of the SpaceX family.[44] Hence, considered by China a milestone as a tier 1 power in space development.[45]

V. Conclusion

2020 was a year of achievements for the BeiDou Navigation Satellite System,[46] and the year 2021 was a year of accomplishing the first stage of development for Tianlian communications relay satellites. Meanwhile, China is still in the process of utilizing increasingly mature carrier rockets and deploying Gaofen Series remote sensing reconnaissance satellites. Moving forward, it will continue to expand the Tiangong Space Station's capabilities in anchoring, supplying, repair, and maintenance, and will soon launch the Xuntian space telescope for target acquisition and reconnaissance by co-orbiting with the space station. The PLA

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42 Chu-ching Chao, "New Member of the CZ Family Revealing CZ-7A Carrier Rocket," *people.cn*, March 12, 2021, http://finance.people.com.cn/BIG5/n1/2021/0312/c1004-32049744.html.

43 Op. cit. 17, Chu-ching Chao, "New Member of the CZ Family Revealing CZ-7A Carrier Rocket".

44 Todd Harrison et al., "Space Threat Assessment 2021," *ibid*., p. 9.

45 Op. cit. 14, Tze Hu, "Successful First Flight and Validation of China's Reuse of Suborbital Space Vehicles".

46 Chu-ching Chao, "BeiDou-3, the Last Satellite in the BeiDou Navigation Satellite System, will be Launched at 9:43 Today," *people.cn-Technology channel*, June 23, 2020, http://scitech.people.com.cn/BIG5/n1/2020/0623/c1007- 31756155.html.

Strategic Support Force's Aerospace System Department is expected to make great progress by enhancing its own support and establishing information advantage in battlefields on multiple fronts. Meanwhile, the Strategic Support Force will also continue to integrate warfare in space, cyberspace, and the electromagnetic spectrum by constantly developing anti-satellite (ASAT) weapons to further offset the advantages of leading countries.

That said, China has its own less obvious worries for space and military development. While China cannot determine the maximum localization of components, vehicles, and software for space equipment, the computation for attitude control and real-time audio/ video transmission and communications require high-performance chips. There are sanctions, embargos, and control arising from the Clean Network initiative in the technological cold war between China and the U.S. Further, there is a shift of supply chains by Europe and Japan with the establishment of their own semiconductor supply chains. Noteworthily, China's unsophisticated but aggressive approach for domestic innovations and own semiconductor supply has not achieved much success. Therefore, how this affects China's space development and military application must be closely watched.