“Strategic Trajectories: Assessing China’s Space Rise and the Risks to U.S. Leadership”

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Introduction

Over the past three decades, the People’s Republic of China (PRC) has been undertaking a steady effort to expand its range of space capabilities. This includes a range of satellite constellations that serve both military and civilian purposes. It is important to understand, however, that China’s development of space capabilities does not mirror the American or Soviet an Russian experiences. Indeed, China’s space program has followed a different path from either the United States or the Soviet Union.

The U.S. space program is said to have begun on December 8, 1941, in the belief that satellites could have allowed earlier detection of the Japanese fleet and averted Pearl Harbor. The same might be said for the Soviet Union, which experienced the surprise of the June 22, 1941, German invasion. There is no real equivalent in recent Chinese history of a similar strategic surprise. China’s two wars with Japan, as well as its conflicts in Korea, with India and Vietnam, and on the Sino-Soviet border did not begin with a thunderclap surprise, in which better intelligence information, such as that afforded from space, might have averted the conflict.

Moreover, China has, until recently, been poorer than either superpower, and even today considers itself a less-developed country. It has always, therefore, had relatively fewer resources to commit to its space program. Consequently, the PRC has sought to maximize the payoff of each renminbi spent on space, applying aerospace capabilities towards economic development and diplomatic openings, as well as military modernization.

China's Evolving Space Capabilities from Mao to Hu

Since the 1950s, China's space program has been producing capabilities relevant for both civilian and military purposes. The program is considered to have been founded in 1958, soon after U.S.-trained scientist Qian Xuesen forwarded "A Proposal to Establish China's Defense Aviation Industry" to the senior Chinese leadership. This document called for the creation of an aerospace industry, which would not only design and build aircraft, but also rockets and missiles. His proposal was incorporated into the "National Long-Term Plan for the Development of Science and Technology, 1956-1967," a broad blueprint for the development of Chinese scientific and technical capabilities.[1]

Longtime Chinese leader Mao Zedong subsequently called for an indigenous Chinese space program, stating at the Second Plenum of the Eighth Party Congress in May 1958 that "we should also manufacture satellites."[2] This reflects longstanding highest level leadership support for China's space program. The Chinese leadership subsequently established the Fifth Research Academy of the Ministry of National Defense, responsible for missile development, with Qian as its head. Chinese histories generally date the start of China's space, missile, and strategic weapons programs to the founding of the Fifth Academy. The initial space program, Project 581, reflects this 1958 start date.

Mao's vision of a Chinese space program following on the heels of Sputnik was extraordinarily ambitious for a nation that was still largely peasant, illiterate, and recovering from nearly twenty years of continuous war. Indeed, it was excessively ambitious, as China's human, financial, and industrial resources proved insufficient to sustain any kind of space development effort. Space capabilities nonetheless remained an official goal, embodied in the "two bombs, one satellite"

[1] Yanping Chen, *China's Space Activities, Policy and Organization, 1956-1986*, Ph.D. dissertation, George Washington University (1999), 7, and Deng Liqun, ed., *China Today: Defense Science and Technology*, volume one (Beijing: National Defence Industry Press, 1993), p. 32.

[2] Deng Liqun, ed., *China Today: Defense Science and Technology*, volume one (Beijing: National Defence Industry Press, 1993), p. 356.

(*liangdan yixing*, 两弹一星) program. This slogan referred to the creation of an atomic bomb, a hydrogen bomb, and a satellite. It reflects the reality that China's space efforts have long been tied to broader strategic goals, as well as strategic capabilities. The term "two bombs, one satellite," moreover, referred not only to programmatic objectives, but also to the idea of homegrown development of advanced capabilities. The PRC has long been proud of its space capabilities, in part because much of it has been indigenously developed, a trend that continues to this day.

China's space program, including its manned space program, were invigorated in the late 1980s by the efforts of four Chinese scientists: optical physicist Wang Daheng, nuclear physicist Wang Ganchang, electrical engineer Yang Jiachi, and electronics engineer Chen Fangyun.[3] These highly respected scientists, all of whom had ties to China's space and nuclear weapons programs, argued to Deng Xiaoping that unless China was willing to invest in high technology, it could never technologically or economically catch up with the West. Conversely, investments in high technology would not only improve China's level of science and technology, but would also help foster high-tech industries. These investments would, in turn, produce economic and military benefits.

Deng was so intrigued by their report that he initialed his copy with the instructions that this plan had to be acted upon without delay. This led to the National High-Technology Research and Development Plan (*guojia gao jishu yanjiu fazhan jihua*, 国家高技术研究发展计划), also known as Plan 863.[4] The initial Plan 863 proposal focused on seven areas, including aerospace.[5] The initial plan included two programs related to manned spaceflight. First was Project 863-204, which called for developing a new, large launch vehicle as part of a space transportation system capable of servicing a small space station. Second was Project 863-205, which aimed to launch a small space

[3] Evan Feigenbaum, *China's Techno-Warriors* (Stanford, CA: Stanford University Press, 2003), p. 141.

[4] Material drawn from *Guojia Gao Jishu Yanjiu Fazhan Jihua 863*, in FBIS-CHI, July 21, 2000. For further discussion of the creation of Plan 863, see Feigenbaum, *China's Techno-Warriors*, 141-143.

[5] The initial seven areas were automaton, biotechnology, energy, information technology, lasers, new materials, and space technology. Feigenbaum, *China's Techno-Warriors*, 157. The CMSEO website, however, lists them as biotechnology, aerospace technology, information technology, advanced defense technology, automation, energy, and new materials.

station with advanced capabilities, as well as associated scientific and technical research to support manned spaceflight.

After Deng's departure, China's space program continued to benefit from investment and high level support. Under Jiang Zemin (1992-2002), China deployed both low-earth orbit and geosynchronous weather satellites (the *Fengyun* series), and improved geosynchronous communications satellites (the Dongfanghong-3 series) and recoverable satellites with varying payloads (the Fanhui Shi Weixing-2 series). Chinese Earth observation capabilities also improved. In 1999, in cooperation with Brazil, China deployed the China-Brazil Earth Resources Satellite (CBERS), its first electro-optical imaging satellite capable of beaming its pictures directly down to Earth. China subsequently launched several similar satellites with no Brazilian involvement; these are known as the Ziyuan series, to distinguish them from the CBERS satellites. In 2000, China launched two *Beidou* regional navigation satellites into geosynchronous orbit, at an altitude of approximately 24,000 miles, becoming only the third country to deploy its own position and navigation system. This system also has a communications function, which was employed during the 2008 Sichuan earthquake relief operations.[6]

After succeeding Jiang as party general secretary in 2002, Hu Jintao maintained support for China's space program. During his two terms, China deployed a variety of additional satellites, including improved versions of the *Fengyun* and *Ziyuan* satellites, and a variety of satellites as part of the *Shijian* ("Practice" or "Application") program. The Chinese also deployed a number of *Yaogan* satellites equipped with synthetic aperture radars (SAR), which can provide high resolution images through clouds or other obscurations.

Under Hu, China also orbited several manned spacecraft (the Shenzhou program) and initiated the nation's lunar exploration program, launching the Chang'e-1 and -2 lunar probes (discussed below). Supporting these programs was a space-industrial complex that is believed to number over 200,000 people today. Two major aerospace conglomerates, the China Aerospace Science and Technology Corporation (CASC) and the China Aerospace Science and Industry Corporation

[6] "Lu Jing: Satellite Communications—The Information Bridge during Earthquake Relief Operations", Speech before the Chinese Communications Studies Association, (September 26, 2008), http://www.ezcom.cn/Article/8591.

(CASIC), manufacture the full range of space systems, including launch vehicles, satellites, and ground equipment, and the associated sub-systems and support items.

China's space program under Xi Jinping has continued to expand. China has continued to develop a variety of satellite capabilities under the "Practice (*Shijian*; 实践)" program name. This has included the Shijian-17, which was the first Chinese satellite with a robotic arm, and the Shijian-21, which apparently deployed a subsatellite. Under Xi, the PRC has also deployed the *Gaofen* series of earth observation satellites, substantially improving China's ability to conduct global space-based surveillance. China's domestically produced *Beidou* position, navigation, and timing (PNT) constellation has also been modernized, consequently enjoying worldwide use.

To be sure, these investments in space capabilities have not solely been for military purposes. Indeed, Deng's admonition to focus on national economic development still seems to resonate in many aspects of China's space program. Chinese development of earth observation satellites, PNT systems, and weather satellites all support Chinese economic development objectives. Nevertheless, these systems also provide the PLA with experience in the launch and operation of satellites, the undertaking of space surveillance, and a better understanding of both the capabilities and limitations of space-based systems.

In addition to civilian and dual use systems, the PLA developed counter-space capabilities during the Hu era. This included the PLA's test of a direct ascent, kinetic kill anti-satellite (ASAT) system in January 2007. Launched from the Xichang Satellite Launch Center, the Chinese ASAT destroyed a defunct Fengyun-1C weather satellite in low orbit. In the process, China also generated a massive amount of space debris.[7] Almost three years later, in January 2010, China conducted what was termed an anti-missile test, involving "two geographically separated missile launch events with an exo-atmospheric collision also being observed by space-based sensors," according to the U.S. Department of Defense.[8] This test, however, likely also helped Chinese scientists

[7] Leonard David, "China's Antisatellite Test; Worrisome Debris Cloud Encircles Earth," Space.com, (February 2, 2007), http://www.space.com/3415-china-anti-satellite-test-worrisome-debris-cloud-circles-earth.html .

[8] "China: Missile Defense System Test Successful," *USA Today*, (January 11, 2010), http://www.usatoday.com/news/world/2010-01-11-china-missile-defense_N.htm.

improve their ASAT system. In August 2010, two Chinese microsatellites were deliberately maneuvered into close proximity, and apparently "bumped" each other.[9] China has since tested an anti-satellite system aimed at geosynchronous orbits, a capability no other nation has developed.[10] Notably, the Shijian-21 towed a dead satellite into a higher (graveyard) orbit, demonstrating a clear potential military as well as civilian application.[11] In short, its sustained space development efforts of the past three decades have provided China with the material and experiential basis for undertaking *military* space operations in the future, whether for regional or global contingencies.

Space and PLA Concepts of Modern Warfare

Just as China was pursuing broad-based economic modernization under Deng and his successors, a revolutionary shift in the nature of warfare was taking place. Modern warfare, as demonstrated in conflicts in the Middle East and southeast Europe, was increasingly dependent on the quality of forces and weapons, rather than quantity. The U.S.-led coalition performance against Iraq in Operation Desert Shield/Desert Storm served as a wake-up call for the PLA, demonstrating that modern high-technology had fundamentally altered the operational art. As the then-Deputy Director of the PLA's Academy of Military Science (AMS), the PLA's "think-tank," observed: "the Gulf War marked a big step forward in both military theory and practice."[12]

The PLA engaged in extensive analysis of coalition operations and sought to incorporate the resulting lessons into their own approach to war. The result was a thorough revision of almost every aspect of PLA thinking about future conflict. In 1993, the PLA produced a new set of "Military Strategic Guidelines for the New Period," introducing the concept of "local wars under modern, high-tech conditions." These guidelines constitute "the highest level of national guidance

[9] William Matthews, "Chinese Puzzle," *Defense News*, (September 6, 2010), available at http://www.defensenews.com/story.php?i=4767907.

[10] Brian Weeden, "Through a Glass Darkly: Chinese, Russian, and American Anti-Satellite Testing in Space*," The Space Review*, (March 17, 2014), https://www.thespacereview.com/article/2473/1.

[11] Andrew Jones, "China's Shijian-21 Towed Dead Satellite to a High Graveyard Orbit" Space News (January 27, 2022) https://spacenews.com/chinas-shijian-21-spacecraft-docked-with-and-towed-a-dead-satellite/

[12] SHI Yukun, "Lt. Gen. Li Jijun Answers Questions on Nuclear Deterrence, Nation-State, and Information Age," *China Military Science* 3 (1995), in FBIS-CHI.

and direction" to the Chinese armed forces.[13] In a December 1995 speech to the Central Military Commission, Jiang emphasized the importance of these new guidelines when he charged the PLA with undertaking the "Two Transformations" (*liangge zhuanbian*, 两个转变). These included a shift from a military focused on quantity to one focused on quality, and from a military preparing for "local wars under modern conditions," to one that was preparing for "local wars under modern, high-tech conditions."[14]

According to PLA assessments, "local wars under high-tech conditions" were marked by several key characteristics. The most important feature was the increasing reliance on joint operations as the basic form of military operations, and the attendant demand for improved command, control, communications, and intelligence (C3I), in order to coordinate and integrate the disparate forces, especially across the broader field of operations at much higher operational tempos. [15]

As envisioned by the PLA, joint operations would involve multiple services operating together across significant distances. The Gulf War, for example, sprawled across some 140 million square kilometers and included forces ranging from armored units to aircraft carriers and long-range bombers. [16] The successful conduct of joint operations on this vast geographic scale would therefore require close coordination, extensive communications, and precise navigation and positioning information, both for units and for the growing plethora of precision munitions. Moreover, joint operations also required coordination of combat and logistical forces and the ability to command and control operations across five domains: the traditional ones of land, sea, and air, but increasingly also outer space and the electromagnetic domain.

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[13] David Finkelstein, "China's National Military Strategy: An Overview of the 'Military Strategic Guidelines,'" in Roy Kamphausen et al., eds., *Right-Sizing the People's Liberation Army: Exploring the Contours of China's Military* (Carlisle, PA: Strategic Studies Institute, 2007), 82.

[14] Qinsheng Zhang and Bingyan Li, "Complete New Historical Transformations—Understanding Gained from Studying CMC Strategic Thinking on 'Two Transformations,'" *Jiefangjun Bao*, (January 14, 1997), in FBIS-CHI.

[15] Chinese Military Encyclopedia Committee, *Chinese Military Encyclopedia* , volume two (Beijing: Academy of Military Science Press, 1997), 126-127.

[16] Houqing Wang and Xingye Zhang, eds., *The Science of Campaigns*, (Beijing: National Defense University Press, 2000), 400.

This need for improved C3I, spanning greater distances and in support of 24/7 operations, influenced PLA assessments of the importance of space for future military operations. In this light, the PLA recognized space capabilities as playing an essential role in “local war under modern, high-tech conditions.” The 70 satellites that were brought to bear against Iraq in the Gulf War provided the U.S. military, according to PLA estimates, with 90% of its strategic intelligence, and carried 70% of all transmitted data for coalition forces.[17] Indeed, these assets were the first to be employed, since they were essential for the success of subsequent campaign activities. As one Chinese analysis observed, “Before the troops and horses move, the satellites are already moving.”[18]

The PLA’s conception of future wars was refined under Hu, with the information domain playing a more prominent role. From “local wars under modern, high-tech conditions,” the PLA now expected to engage in “local wars under informationized conditions.” This new phrase appeared in 2002 and was incorporated into China’s 2004 defense white paper. “Informationized conditions,” in this context, did not simply refer to computers and cyberwarfare. Rather, the informationized battlefield (*xinxihua zhanchang*, 信息化战场) is one in which all relevant military activities, including tactics, operations, and decision-making, are digitized, and military materials and equipment are managed through advanced information technology. The shift in terminology reflected the PLA’s conclusion that, among the various high technologies, the most important are those relating to information management.

This emphasis on the information domain was also reflected in an apparent modification of the “campaign basic guiding concept (*zhanyi jiben zhidao sixiang*, 战役基本指导思想)” during the 2000s. The concept, a distillation of military laws and theories, is intended to serve as a guide for PLA officers planning, organizing, and prosecuting campaign-level operations. In some ways, it parallels the “principles of war,” which the U.S. Army defines as “the most important non-physical factors of war that affect the conduct of operations at the strategic, operational, and tactical levels,”

[17] Yubiao Gao, ed., *Joint Campaign Course Materials* (Beijing: Academy of Military Science Press, 2001), 54.

[18] Qingjun Gao, “Characteristics and Deficiencies of Space Reconnaissance in High-Tech Local Wars,” *Journal of the Academy of Equipment Command and Technology* (I, 16, 2005).

while taking into account contemporary conditions.[19] In 2025, joint operations are still seen as a key part of "informationized local wars," the current characterization of the wars the PLA is preparing to fight and win. "If one wishes to fight victorious wars then one must improve joint operations capacity, based on networked information system-of-systems, as well as all domain operational capabilities."[20]

This is in part because, from the PRC's perspective, space is fundamentally linked to overall national security. In December 2004, Hu gave a speech outlining the "historic missions of the PLA in the new phase of the new century" (*xinshiji xinjieduan wojun lishi shiming*, 新世纪新阶段我军历史使命). These "new historic missions" included safeguarding China's expanding national interests, specifically including access to space (*taikong*, 太空) and the electromagnetic sphere.[21] The speech also clearly charged the PLA with undertaking military space missions. Hu observed that "maritime security, space security, and electromagnetic spectrum security are already vital regions for national security," requiring Chinese military preparations to secure them.[22] The incorporation of space into the specific responsibilities of the PLA under the "new historic missions" indicated a growing view of space as essential to Chinese national security.

This higher profile for space is reflected in a range of authoritative PLA and Chinese government sources. In the 2020 edition of the *Science of Military Strategy*, a chapter is devoted to discussing military conflict in the new domains of space and cyber (as well as biological and artificial intelligence) domains, where the authors note that the importance of space has grown significantly

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[19] Headquarters, Department of the Army, *FM 3-0 Operations* (Washington, DC: Department of the Army, 2022), pp. 1-7, A-1-A-5.

[20] National Defense University Socialist Theory with Chinese Characteristics Research Center, "Firmly Grasping the Party's Strong Military Goal in the New Era," *Qiushi* (April 15, 2018) http://www.qstheory.cn/dukan/qs/2018-04/15/c_1122670090.html

[21] The other historic missions include guaranteeing the continuing rule of the CCP, safeguarding national economic development, and helping ensure world peace. Hu Jintao, "See Clearly Our Military's Historic Missions in the New Period of the New Century", (December 24, 2004), available on the official National Defense Education website of Jiangxi province, http://gfjy.jxnews.com.cn/system/2010/04/16/011353408.shtml. For further discussion of the "new historic missions," see Daniel Hartnett, *Towards a Globally Focused Chinese Military: The Historic Missions of the Chinese Armed Forces* (Alexandria, VA: CNA Corporation, 2008).

[22] Hu Jintao, "See Clearly Our Military's Historic Missions in the New Period of the New Century", December 24, 2004, <http://gfjy.jxnews.com.cn/system/2010/04/16/011353408.shtml>

for both military and broader national purposes.[23] A separate chapter is devoted to discussing the development and expansion of military aerospace capabilities.[24] The 2015 National Security Law specifically mentions outer space as an area where Chinese security interests must be preserved. Similarly, China's 2015 defense white paper refers several times to space as a "commanding height" in the international strategic competition. In the 2019 defense white paper, outer space is described as an area where China's national interests must be safeguarded: "outer space is a critical domain in international strategic competition. Outer space security provides strategic assurance for national and social development."[25] As the PLA's military guidelines have shifted again, to "informationized local wars," the role of space has become ever more salient.

China's Evolving Concepts of Military Space Operations

Various PLA writings consistently emphasize five broad styles (*yangshi*, 样式) or mission areas: space deterrence, space blockades, space strike operations, space defense operations, and provision of space information support.[26]

Space Deterrence (kongjian weishe, 空间威慑*)*

Space deterrence is the use of space capabilities to deter or coerce an opponent, preventing the outbreak of conflict, or limiting its extent should conflict occur. By displaying one's own space capabilities and demonstrating determination and will, the PLA hopes to induce doubt and fear in an opponent, so that they either abandon their goals or limit the scale, intensity, and types of operations. Space deterrence is not aimed solely, or even necessarily, at deterring actions in space, but rather, in conjunction with nuclear, conventional, and informational deterrence capabilities and activities, they seek to influence an opponent's overall perceptions and activities.

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[23] Academy of Military Science Strategy Research Department, *The Science of Military Strategy* (Beijing: Military Science Press, 2020), pp. 142-180.

[24] Academy of Military Science Strategy Research Department, *The Science of Military Strategy* (Beijing: Military Science Press, 2020), pp. 391-401.

[25] PRC State Council Information Office, *China's National Defense in the New Era* (Beijing: State Council Information Office, 2019), http://www.andrewerickson.com/2019/07/full-text-of-defense-white-paper-chinas-national-defense-in-the-new-era-english-chinese-versions/.

[26] This section draws upon Lianju Jiang, *Space Operations Teaching Material*s (Beijing: Military Science Press, 2013), 126-154.

Both the 2005 and 2013 volumes referenced above suggest that there is a perceived hierarchy of space deterrence actions, perhaps akin to an "escalation ladder." First, "displays of space forces and weapons" (*kongjian liliang xianshi*, 空间力量显示) occur in peacetime, or at the onset of a crisis. The goal is to warn an opponent, in the hopes of dissuading them from escalating a crisis or pursuing courses of action that will lead to conflict. Second, "military space exercises" (*kongjian junshi yanxi*, 空间军事演习) are undertaken if displays of space forces and weapons are insufficient to compel an opponent to alter course. They can involve actual forces or computer simulations, and are intended to demonstrate one's capabilities but also military preparations and readiness. At the same time, such exercises will also improve one's military space force readiness. Third, "space force deployments" (*kongjian liliang bushu*, 空间力量部署) are seen as a significant escalation that occurs when one concludes that an opponent is engaged in preparations for war, and involve the rapid adjustment of space force deployments, including the recall of certain space assets and modifications of orbits or behavior of others. As with military space exercises, this measure is not only intended to deter an opponent, but should deterrence fail, may improve one's own preparations for combat.

Chinese sources term the final step of space deterrence "space shock and awe strikes" (*kongjian zhenshe daj*i, 空间震慑打击). If the three previous, non-kinetic measures are insufficient, the PLA suggests punitive strikes to warn an opponent that one is prepared for full-blown conflict in defense of the nation. Such strikes are seen as "the highest, and final, technique" (*zuigao xingshi he zui hou shouduan*, 最高形式和最后手段) to deter and dissuade an opponent. Employing hard- and soft-kill methods, one would attack an opponent's physical space infrastructure or data links, respectively. If this succeeds, opposing decision-makers will be shaken and cease their activities. If it fails, an opponent's forces will still have suffered some damage and losses.

Space Blockade (kongjian fengsuo zuozhan, 空间封锁作战)

Space blockades involve the use of space and terrestrial forces to prevent an opponent from entering space and gathering or transmitting information through space. Chinese writings suggest that there are several types of space blockades. First is physically obstructing an adversary's operations, such as blockading terrestrial space facilities, including launch and TT&C sites and missions control centers, or preventing spacecraft from entering certain orbits. Second is obstructing launch windows by delaying launches. In the past, some American space launches have been delayed because fishing and pleasure boats were present down-range.[27] Third are information blockades, which can take several forms. For instance, by interfering with an opponent's data links, one can effectively neutralize an orbiting satellite by hijacking its control systems or preventing ground control from issuing instructions. Alternatively, one can contaminate or block the data that the satellite is gathering or transmitting. Yet another form involves "dazzling" a satellite using low-powered directed energy weapons against its sensors or other systems. In each case, the intent is to achieve a "mission kill," whereby the satellite cannot perform its functions, but is not necessarily destroyed.

Space Strike Operations (kongjian tuji zuozhan, 空间突击作战*)*

Space strike operations involve space and other forces undertaking offensive operations against an enemy's land, sea, air, and space assets. They are therefore not limited to attacks against the adversary's space infrastructure. Space strike operations, in the Chinese view, are marked by "integrated operations; stealth and surprise; key point strikes; rapid, decisive action." In this formula, "integrated operations" reflects all the aspects discussed earlier, with an additional emphasis on exploiting stealth and surprise. "Key point strikes," part of the general guiding thought for space operations, denotes the reality that neither side is likely to field large numbers of space systems, so planning for maximum effect and efficiency is important. "Rapid, decisive action" refers to the need to use space strikes to seize the initiative in a campaign. By overwhelming an opponent, and sustaining strikes afterwards, one can gain the initiative and ideally achieve operational goals and conclude the conflict. At the same time, due to the limited space platforms and weapons likely to be available, and their fragility and expense (which limits numbers acquired), space strike operations are likely to be of relatively limited duration.

Defensive Space Operations (kongjian fangyu zuozhan, 空间防御作战*)*

Defensive space operations are intended to counter an opponent's space strike operations by safeguarding one's own space forces and defending key strategic and campaign targets from

[27] "Atlas 3 Scrubbed to Tuesday," *Space Daily*, (May 21, 2000), http://www.spacedaily.com/news/eutelsat-00g.html; and Jessica Orwig, "A Rocket Launch Monday Was Delayed Because of a Boat," *Business Insider*, (October 28, 2014), http://www.businessinsider.com/why-rocket-launch-delayed-by-a-boat-2014-10.

enemy space strike operations. Defensive space operations include defense against ballistic and cruise missiles, defense of space-related bases and infrastructure, and "spacecraft defensive operations." The latter involve a combination of active and passive measures, including camouflage and reduction of spacecraft radar, infrared and electronic signatures so that their capabilities and identity are obscured, shifting to "swarms" of small satellites to improve resilience if one or more component satellites are lost, and hardening satellites to allow them to survive attacks from directed energy weapons. In addition, ground controllers can move satellites if there are indications that they might be attacked.

Space Information Support Operations (kongjian xinxi zhiyuan zuozhan, 空间信息支援作战*)*

In the 2005 edition of *Military Astronautics*, provision of information support by space systems was listed as the second task, after space deterrence.[28] In the 2013 PLA teaching materials, it is now the fifth of five tasks. This suggests that space information support operations, while still important, are being eclipsed by more active space offensive and defensive operations. Indeed, as one Chinese analyst observes, as space resources become ever more important, and military aerospace technology, especially those related to offensive space operations, steadily develop, space force development will shift from providing information support towards securing space dominance.[29]

Nonetheless, in the context of informationized warfare, space information support will be integral to achieving space dominance. As the 2013 edition of the *Science of Military Strategy* notes, "space information support is now and for a long time into the future will be the main form (*zhuyao fangshi*, 主要方式) by which various nations apply space strength."[30] As the PLA emphasizes joint operations, it will increasingly depend on space-based systems to provide information support, especially as Chinese forces move farther and farther away from Chinese territory (and therefore, land-based information support infrastructure). Key tasks within "space information support" (*kongjian xinxi zhiyuan*, 空间信息支援)" to ground, air, and naval forces include space

[28] Xianqi Chang, *Military Astronautics*, (Beijing: National Defense Industries Press, 2005), 304-309.

[29] Rukun Tan, *Operational Strength Construction Teaching Materials* (Beijing: Military Science Press, 2012), 170.

[30] Academy of Military Science Strategy Research Department, *The Science of Military Strategy* (Beijing: Military Science Press, 2020), 181.

reconnaissance and surveillance, missile early warning, communications and data relay, position, navigation, and timing services, and Earth observation, such as geodesy, hydrographics, and meteorology. These capabilities will likely be of growing importance to the PLA, as it shifts towards more globally oriented force.

Creation of the PLA Strategic Support Force and Military Aerospace force

Further reinforcing China's military focus on space has been the establishment of dedicated aerospace forces within the PLA. In 2015, the PLA established the PLA Strategic Support Force (PLASSF). The PLASSF combined the PLA's electronic warfare, network warfare, and space warfare capabilities. This included what had previously been specific departments under the General Staff Department (GSD), such as the GSD Third Department (responsible for signals intelligence) and the GSD Fourth Department (responsible for electronic intelligence and electronic warfare). It also involved the transfer of key space facilities that had been part of the GAD, including China's launch sites, satellite control centers, TT&C facilities, and fleet of space surveillance ships.[31]

One reason for the establishment of the SSF appears to be to shift from a task or mission-oriented approach to warfare (e.g., reconnaissance, strike) to one more focused on specific domains.[32] The PLASSF, as a service, will be responsible for planning, force construction, and operations within the information domain, including space operations. While the GAD had space responsibilities, it was neither a service nor a war-fighting entity. The GAD's main tasks were supporting military research and development, including new weapons, as well as managing China's nuclear and space facilities. Creating the PLASSF effectively created a service that was more focused on space warfighting doctrine and forces, rather than space systems and capabilities.

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[31] Because of China's emphasis on influencing adversary commanders and staffs, some political warfare elements from the General Political Department have also been incorporated into the SSF.

[32] John Costello and Joe McReynolds, *China's Strategic Support Force: A Force for a New Era*, INSS China Strategic Perspectives 13 (Washington, DC: National Defense University Press, 2018), 12.

Moreover, this new service was "intended to create synergies between disparate information warfare capabilities, in order to execute specific types of strategic missions."[33] By combining various information-related departments, offices, and bureaus across the PLA, many of the organizational stovepipes that impeded programmatic and doctrinal coordination were effectively eliminated. In the case of space operations, the PLASSF's Space Systems Department now oversees GAD space facilities and units responsible for space-based C4ISR (such as space-based remote sensing) that had resided in the GSD.[34]

At the same time, by embedding the PLASSF Space Systems Department alongside the Network Systems Department, responsible for cyber and electronic warfare, there is greater ability to integrate space operations with other activities in the information domain. Chinese writings emphasize the importance of electronic and network warfare as key means of establishing space dominance, as soft-kill (e.g., laser dazzlers, cyber attack methods against TT&C facilities and onboard systems) approaches are an essential complement to hard-kill (e.g., direct ascent anti-satellite missiles, co-orbital anti-satellite systems) ones. By placing all of these capabilities in the same service, albeit in separate subordinate departments, PLA space dominance efforts will benefit from enhanced coordination and integration. In this regard, unlike many other nations, China is not pushing the development of a "space force," so much as an "information warfare force," with a substantial space capability embedded within it.

In April 2024, however, the PLA dissolved the PLASSF. The component elements were established as independent "major arms (*da bingzhong*; 大兵种)," specifically the Military Aerospace Force (*junshi hangtian budui*; 军事航天部队), the Networkspace or Cyberspace Force (*wangluo kongjian budui*; 网络空间部队), and the Information Support Force (*xinxi zhiyuan budui*; 信息支援部队). The PLA now describes itself as comprising four "major services (*da junzhong*; 大军种)," the PLA Ground Forces, PLA Navy, PLA Air Force, and PLA Rocket Force, and the four

[33] John Costello and Joe McReynolds, *China's Strategic Support Force: A Force for a New Era*, INSS China Strategic Perspectives 13 (Washington, DC: National Defense University Press, 2018), p. 5.

[34] John Costello and Joe McReynolds, *China's Strategic Support Force: A Force for a New Era*, INSS China Strategic Perspectives 13 (Washington, DC: National Defense University Press, 2018), p. 20.

"major arms."[35] This would seem to suggest a structure of four domain-oriented services, and four "strategic/functional forces."[36] As some PLA analyses have suggested, this is based on the idea that the services are focused on respective main operational domains (*zhuyao zuozhan lingyu*; 主要作战领域), with specific missions and equipment to differentiate them. The "arms" are described as "strategic branches (*zhanlue bingzhong*; 战略兵种)" or "relatively independent branches (*xiangdui duli bingzhong*; 相对独立兵种) reflect the growth of new strategic domains and vital operational domains. These "arms" will be able to undertaken certain missions independently, but can also be task-organized to join with other forces to undertake specific missions.[37]

The Military Aerospace Force (MAF) is responsible for space surveillance and space situational awareness, as well as deploying space systems. Consequently, it controls most of the PRC's space infrastructure, inheriting the "base (*jidi*; 基地)" organizational structure from the PLASSF, which in turn had been bequeathed that structure from the GAD.

Chinese Lunar Program

The development of China's space capabilities has not been wholly oriented towards explicit military objectives. Well before the establishment of the PLASSF and subsequent MAF, the Chinese had already authorized the Chinese Lunar Exploration Program (CLEP). The Chang'e program, named after a goddess of Chinese mythology who lives on the Moon (with her pet, "Jade Rabbit"), began in 2004. It has its own leading small group (like the manned program) and its own leadership structure separate from the China National Space Administration.

The lunar program has followed a three-step approach. The first step was to place satellites in ***lunar orbit*** to ensure that China's launch vehicles and TT&C networks were sufficient to place spacecraft in the lunar vicinity. The deployment of lunar orbiters would also allow for mapping of

[35] "The Chinese PLA Embraces a New Type of Services and Arms Structure," Defense Ministry Net (April 19, 2024) http://www.mod.gov.cn/gfbw/xwfyr/ztjzh/16302059.html

[36] Joe McReynolds, John Costello, "Planned Obsolescence: The Strategic Support Force in Memoriam (2015-2024)," *Jamestown Foundation China Brief* (XXIV, #9, April 26, 2024) https://jamestown.org/planned-obsolescence-the-strategic-support-force-in-memoriam-2015-2024

[37] Ruoyu Wang, "Military Aerospace Force, Cyberspace Force, Information Support Force—After 75 Years, What New Types of Services and Branches Have Been Added?" Shanghai ObserverNet (October 4, 2024) https://www.163.com/dy/article/JDLB5EM4051481US.html

the Moon's gravitational field and allow imaging of the lunar surface to determine suitable landing sites. The second step was to ***soft-land*** probes on the lunar surface. This was a substantially more difficult task, since relatively few states have actually landed spacecraft on the Moon. It would require even more precise control of spacecraft functions, including being able to trim and adjust the spacecraft's attitude relative to the lunar surface. The deployment of a rover would also increase weight and add additional complications to the mission (e.g., how to deploy the rover, and how to keep it operational during the long lunar night which lasts roughly two weeks). The third step is to undertake ***sample retrieval*** missions, where Chinese probes would bring lunar material back to Earth for further study. The weight involved is even greater, since the lander would have to carry sufficient fuel to at least depart the lunar surface, whether to reach a lunar orbiter module or to return straight to Earth. As of 2025, the PRC has fulfilled all three of these steps, including retrieving samples from the lunar far side, a region hitherto only observed from orbit.

A key part of the Chang'e-4 and Chang'e-6 missions was the need to maintain communications with the landers. Since both operated on the far side of the Moon, it would be impossible to establish direct communications with the landers. Consequently, the Chinese deployed the *Queqiao*-series of data relay satellites. Queqiao-1 was deployed to LaGrange Point-2 (L-2). Launched in May 2018, it arrived at L-2 some 24 days later. From its location 250,000 miles from Earth (and 40,000 miles from the Moon), it relays data and instructions from Earth to the Chang'e-4/Yutu-2 probe.[38] Queqiao-2 is in an elliptical lunar orbit, and supported the Chang'e-6 sample retrieval mission.

Politically, China's lunar program has demonstrated an ability to undertake cutting edge scientific programs, as demonstrated in the innovative Chang'e-4 and Chang'e-6 probes. In terms of direct military benefits, its value is more limited. China is not in a direct space race with any other state, nor is it racing to establish settlements or "space colonies." While there are theories of how one might employ a lunar base to undertake surveillance or even kinetic operations against terrestrial

[38] Alice Shen, "What You Need to Know about Chang'e-4, China's Mission to the Far Side of the Moon," *South China Morning Post*, (January 3, 2019), https://www.scmp.com/news/china/science/article/2180587/what-you-need-know-about-change-4-chinas-mission-far-side-moon.

targets, the costs associated with such ambitions would be enormous. Surveillance platforms on the Moon, for example, would be almost 240,000 miles from Earth. To obtain high resolution images would be enormously costly. It is not at all clear that such efforts would win a cost-benefit analysis against systems in standard earth orbits (LEO, MEO, GEO), or even air-breathing systems.

Instead, the most likely military benefits are in terms of improvements in Chinese space support capabilities, thus expanding the volume of space employed for military purposes. The deployment of the Queqiao-1 satellite marked the first time that any nation has deployed an "application" satellite, i.e., one not oriented towards scientific surveys and exploration, to any of the LaGrange points. While there are some orbits that go beyond the geosynchronous belt (e.g., High Earth orbits and the graveyard orbit for inoperative satellites), the objects are still largely within the range of current space objective surveillance and identification (SOSI) systems. However, few SOSI systems are oriented towards general surveillance of the cis-lunar space between the geosynchronous belt and the Moon. By deploying "application" satellites to this area, China is challenging its own SOSI networks. This suggests that in the coming years, Beijing will develop a substantial SOSI network capable of surveilling a substantial volume of space—which will be under the control of the MAF.

One element of this network that recently became operational is a 16-story, 35 meter array in Las Lajas Argentina. It is operated by the China Satellite Launch and Tracking Control General, which used to be subordinated to the GAD and now belongs to the PLASSF.[39] (In the past, China used its space program to justify establishing facilities in a number of countries, including Namibia, Kiribati, and Pakistan.)

Other states will also have to upgrade their own SOSI capabilities, as more and more states operate in the cis-lunar region. Until they have done so, however, China can try and "lose" one or more satellites in that volume of space. Such systems could serve as a strategic reserve, replacing satellites in lower orbits that might be destroyed or damaged in wartime. In theory, the *Queqiao*

[39] Cassandra Garrison, "China's Military-Run Space Station in Argentina Is a 'Black Box,'" Reuters, (January 31, 2019), https://www.reuters.com/article/us-space-argentina-china-insight/chinas-military-run-space-station-in-argentina-is-a-black-box-idUSKCN1PP0I2.

could be used as a data relay satellite for purely terrestrial purposes. This would be by no means optimal, but attempting to destroy the satellite would be very difficult and likely engender a popular outcry by polluting a key region of space. If China were to expand its lunar footprint, it could well deploy a number of Queqiao-type satellites to L-2 or other LaGrange points, and create a data relay constellation that would be a challenge to track.

At the same time, because there has been less international attention to cis-lunar space, deployment of Chinese anti-satellite systems into that area would complicate adversary contingency planning and attribution capacity. At present, most anti-satellite systems are ground-launched (such as the Chinese anti-satellite system used in 2007) or co-orbital (such as the Russian Burevestnik system).[40] By contrast, an anti-satellite system coming from beyond GEO would significantly expand the volume of space that would have to be kept under surveillance.

An additional strategic military benefit from the Chinese lunar program is that it supports the broad goal of "military-civil fusion." This phrase refers to China's effort "to leverage breakthroughs in the civilian science and technology (S&T) sector" in order to meet the military's science and technological requirements.[41] This is reflected in the shift in Chinese writings from calling for "civil-military integration" (*junmin jiehe*, 军民结合) to the more ambitious concept of "military-civil fusion" or "civil-military melding" (*junmin ronghe*, 军民融合). The idea of "fusion" or "melding" underscores the need for a broader reorganization of the national economy, so that the civilian and military sectors are served by a common industrial base.[42] Indeed, as one Chinese analysis points out, the goal of MCF is not to encourage civilian use of military technology, or

[40] Theresa Hitchens, "Russia Builds New Co-orbital Satellite: SWF, CSIS Say," *Breaking Defense*, (April 4, 2019), https://breakingdefense.com/2019/04/russia-builds-new-co-orbital-satellite-swf-csis-say/.

[41] Philip C. Saunders and Joel Wuthnow, "Conclusion: Assessing Chinese Military Reforms," in Phillip C. Saunders et al., eds., *Chairman Xi Remakes the PLA: Assessing Chinese Military Reforms* (Washington, DC: National Defense University Press, 2019), p. 718. See also Brian Lafferty, "Civil Military Integration and PLA Reforms" in the same volume.

[42] Innovation Department, Beijing University Science and Technology Park, "An Outline of the Development of Our Nation's Civil-Military Fused Enterprises," (April 15, 2019), http://www.chinahightech.com/html/paper/2019/0415/521151.html.

military use of civilian technology, but to generate complementarity between efforts to enhance military production and general economic development.[43]

The lunar program, with its demands for larger boosters (as required by the Chang'e-5 lander with its returning payload), further presses Chinese industry to support systems integration, systems engineering, and precision manufacturing. These improvements will aid Chinese development of better military systems, whether ICBMs, unmanned aerial vehicles, or military spacecraft—all of which are products from the same state-owned enterprises as are part of the Chinese space-industrial complex.

More importantly, the CLEP, as well as China's human spaceflight program, encourage the overall development of China's aerospace work force, with benefits for all of China's space programs, military and civilian, with further spill-over effects for the broader economy. Major, "glorious" (*weida*; 伟大) projects can attract human talent, while the implementation of such projects helps train that talent.[44]

Conclusion

For the PLA and Chinese national security decision-makers, the Information Age and the Space Age are inextricably linked. Both eras have been heavily influenced by the growth in computing power and the role of telecommunications. Indeed, China's first series of satellites, the Dongfanghong-2, were communications satellites, rather than early warning satellites. Chinese analyses of recent wars underscore the intimate relationship between these two realms when it comes to warfighting. Modern wars have demonstrated the linked relationship between information and space, where space systems play a central role in the collection, transmission, and exploitation of information. Consequently, "seizing the space information advantage as a high

[43] Benyao Shu, "The Real Impact of the Human Spaceflight Project on Military-Civil Fusion-Style Development's Strategic Thought," *Journal of the National Defense University* (#2, 2013)

[44] Benyao Shu, "The Real Impact of the Human Spaceflight Project on Military-Civil Fusion-Style Development's Strategic Thought," *Journal of the National Defense University* (#2, 2013).

ground is the first decisive condition for seizing information dominance, space dominance, air dominance, naval dominance, land dominance, and therefore the initiative in wartime."[45]

By dominating space, one gains several advantages in terms of access to information and managing information flows. First, one's combat forces can be much more effective because enemy and friendly force dispositions will be known. Second, because the battlefield is more transparent, commanders can respond in real-time or near-real time to enemy actions, and widely separated units drawn from a variety of services can act in a highly integrated manner. Third, by dominating space, one has secured the most important portion of the battlefield: the information space. This facilitates command and control and enables long-range, precision strikes. Friendly casualties are reduced, while one's own actions are much more effective.

For Chinese military planners, these advantages are further enhanced by certain geographic and strategic realities. Even now, the PLA is not oriented towards conducting extensive military operations far from China's shores. Instead, it remains focused on regional flashpoints such as Taiwan, the Korean peninsula, the South China Sea, and the Sino-Indian border. For Beijing, the consistent concern since the 1980s has been on "local wars." Such wars are not only limited in means, but also are expected to occur mainly on China's periphery. Space information support is less important, given the plethora of Chinese intelligence gathering platforms and dense communications networks, but space denial and counter-space capabilities are essential in countering any adversary (e.g., the United States, Japan, and Taiwan).

However, as its resources grow and its interests expand, China may become more dependent on space-based systems to provide intelligence about the military situation in places such as the Arabian Sea and the central Pacific or to maintain communications with PLA facilities in Djibouti and elsewhere (on Djibouti, see the chapter by Isaac Kardon in this volume). This is not to say that China will become as dependent on space as the United States, much less that its space architecture will resemble the American one. But China may become more dependent on space to sustain intelligence gathering and global communications than it has been in the past.

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[45] Lanzhou Military Region Headquarters Communications Department, "Space Information Support and Its Influence on Future Terrestrial Operations," *Military Art* (#10, 2003).

China’s interests in lunar exploration, as documented in this chapter, support broader efforts to develop its military space capabilities. Investments in lunar exploration, whether in terms of improving the industrial base, advancing SOSI networks, or familiarizing the PLASSF with operations in the regions beyond the geosynchronous belt, all contribute to developing China’s space warfare capabilities, and therefore its information warfare capabilities. This is a reminder of China’s “whole-of-society” approach to national security.