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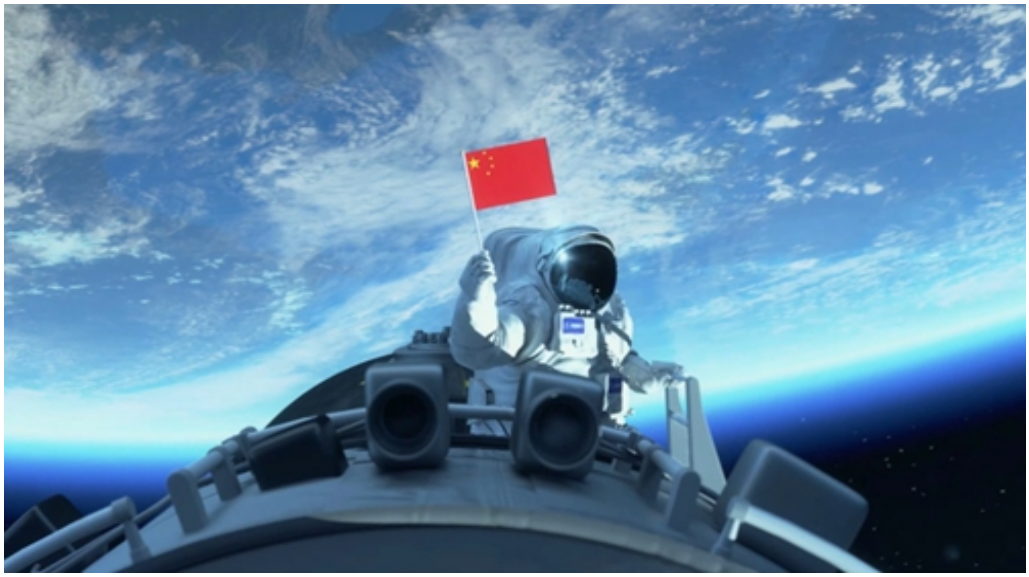
HOW CHINA HAS INTEGRATED ITS SPACE PROGRAM INTO ITS BROADER FOREIGN POLICY



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China Aerospace Studies Institute

CASI's mission is to advance understanding of the capabilities, development, operating concepts, strategy, doctrine, personnel, organization, and limitations of China's aerospace forces, which include: the PLA Air Force (PLAAF); PLA Naval Aviation (PLAN Aviation); PLA Rocket Force (PLARF); PLA Army (PLAA) Aviation; the PLA Strategic Support Force (PLASSF); and the civilian and commercial infrastructure that supports the above.

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INTRODUCTION: CHINA AS A SPACE POWER

The way that the People's Republic of China (PRC) is governed allows it to pursue a more holistic approach to policy. The Chinese Communist Party (CCP) not only controls the government, but also has a presence in every major organization, including economic, technical, and academic entities. Consequently, China is able to pursue not only a "whole of government" approach to policy, but a "whole of society" approach that incorporates elements that are often beyond the reach of other nations.

This has meant that China has been able to use its space program to promote various aspects of its foreign policy, integrating it not only into traditional diplomatic and security efforts, but also trade and even industrial elements. Indeed, the incorporation of space elements into Chinese foreign policy thinking has been characteristic of China's aerospace efforts from its earliest days.

While both Washington and Moscow's space efforts were initially motivated in part by the desire to undertake surveillance missions, prestige played a much greater role in motivating the early phases of China's space program. The senior Chinese leadership saw the development of space capabilities as reflecting on China's place in the international order. Thus, in the wake of Sputnik, Chairman Mao Zedong advocated the creation of a Chinese space program. As he stated in May 1958, at the Second Plenum of the Eighth Party Congress, "we should also manufacture satellites."[1] The Chinese leadership, even in 1958, saw the ability to compete in aerospace as reflecting their broader place in the international environment.

China's resources in 1958 were too limited to support a substantial space program, however, and with the Sino-Soviet split, any hope of rapid advancement with Soviet aid evaporated. Space capabilities nonetheless remained an official goal, embodied in the "two bombs, one satellite" program. This referred to the creation of an atomic bomb, a hydrogen bomb, and a satellite. This was partly due to pragmatism—if China was to have a full-fledged nuclear deterrent, it would have to develop a delivery system, which in turn could also serve as a space launch vehicle.

The term "two bombs, one satellite" went beyond a programmatic objective, however. It also referred to the idea of homegrown development of advanced capabilities. Because of the Sino- Soviet split, as well as the ongoing Cold War with the United States and broader isolationist policies pursued by Beijing, Chinese development of these capabilities would have to wholly rely on their own resources. The phrase "two bombs, one satellite," therefore, came to also be associated with the idea of indigenous development and self-reliance. These characteristics remain hallmarks of Chinese space program today. At the same time, it also reflects another diplomatic aspect of China's space efforts—while China employs space to support its various foreign policy objectives, it will remain an independent space player and seek

indigenous development that avoids dependence on any foreign partner.

China's space efforts were reinvigorated in the 1990s, thanks to steady economic growth providing sufficient industrial, financial, and human resources to support a much broader space enterprise. Whereas Beijing had launched only a handful of satellites between 1970 (when it launched its first satellite) and 1990, the 21st Century has seen China advance its space capabilities significantly. In the ensuing decades, China began to orbit a variety of constellations, including weather satellites (Fengyun); position, navigation, and timing (Beidou); and earth observation (Fanhui Shi and Ziyuan).

In 2003, China also joined the United States and Russia in the area of manned spaceflight. With the launch of Yang Liwei aboard Shenzhou-V, China demonstrated that it could place its own astronauts into orbit. Subsequent missions saw Chinese astronauts undertake space walks, dock their spacecraft, and stay in orbit for extended periods of time.

Today, Beijing can place satellites into orbit anywhere from low earth orbit to GEO, in sun-synchronous/polar orbits, and also into lunar orbit and at the Lagrange points. These various satellites are launched from China's four launch sites, atop Chinese-manufactured rockets. The Chinese field a range of launch vehicles in the Long March family, including the older LM-2, LM-3, and LM-3 medium throw-weight vehicles, and the more recent LM-5, -6, and -7 systems. China has improved its position, navigation, and timing (PNT) constellation, supplementing the original geosynchronous (GEO) orbit Beidou constellation with both mid-earth orbit as well as inclined-GEO orbiting satellites. Consequently, with 35 satellites in these different orbits (27 in mid-earth, five in GEO, three in inclined-GEO), there are more Beidou satellites potentially within line-of-sight of a given receiver than GPS, GLONASS, or Galileo (the US, Russian, and EU PNT systems respectively).[2] Similarly, China has fielded an extensive array of both geosynchronous and polar-orbiting weather satellites, and has expanded its communications satellite constellations as well.

Supporting these systems are a network of space support ships, data relay satellites, and terrestrial support facilities. The Chinese People's Liberation Army Strategic Support Force manages China's fleet of four *Yuanwang* space surveillance ships, as part of the China Satellite Maritime Tracking and Control Department, or 23rd Testing and Training Base.[3] China launched four Tianlian-1 data relay satellites between 2008 and 2016, allowing data from earth observation, weather, and other satellites to be promptly beamed back to Chinese ground stations.[4] China has since begun launching upgraded Tianlian-2 satellites, which will allow faster data transmission rates. Chinese mission support facilities are mostly located within the PRC, but it has also built facilities overseas as well as established ties with other nations' space programs to provide additional capacity.

The equipment at these facilities, the rockets, and the satellites are largely the product of Chinese state-owned enterprises (SOEs), especially China Aerospace Science and Technology Corporation (CASC—中国航天科技集团公司) and China Aerospace Science and Industry Corporation (CASIC—中国航天科工集团公司). These two companies, each employing over 150,000 employees, have been the mainstays of China's space-industrial complex.

In recent years, and especially since 2014, however, a more commercially oriented space industrial complex has emerged. A study by the Science and Technology Policy Institute identified 78 commercial space companies. Of these, 14 are tied to state-owned space enterprises (especially CASIC), nine are tied to the Chinese Academy of Sciences or other SOEs, and 13 are associated with large private Chinese companies (e.g., telecoms), while the remaining 42 are start-ups drawing upon a range of resources such as venture capital investments. [5]

They cover a variety of business areas:

- Satellite manufacturing—29
- Launch services—21
- Remote sensing operators—8
- Communications—17
- Applications (including ground stations and downstream analytics)—33[6]

HOW CHINA USES ITS SPACE PROGRAM TO SUPPORT FOREIGN POLICY

The extensive array of Chinese space activities, as the brief survey indicates, provides Beijing with a variety of methods to support its foreign policy. These include various measures aimed at promoting international space cooperation, both organizationally and programmatically; direct sale of space systems and provision of space-derived data; and participation in international industrial standards-setting bodies related to space activities.

International Space Cooperation

Chinese foreign policy employs space activities to expand its footprint and visibility through a variety of means. These include China's participation, and even formation, of international organizations relating to space; engaging other states in certain space related tasks such as space situational awareness (SSA); and cooperation on specific space missions.

China and Space Organizations

China has long seen space as a means of forging relations with other states. One approach has been to participate in multinational organizations with a space orientation.

United Nations.

China participates in a variety of United Nations-sponsored space activities. In the UN General Assembly, there is a Conference on Disarmament. While not a formal body, it is a forum for various proposals relating to disarmament. A longstanding, but ad hoc, committee within the Conference on Disarmament is focused on the Prevention of an Arms Race in Outer Space (PAROS). Within PAROS, Chinese and Russian diplomats have repeatedly tabled proposals for the Treaty on the Prevention of the Placement of Weapons in Outer Space. This proposal generally would prohibit the deployment of space-based missile defenses and certain types of anti- satellite weapons. Notably, China's own demonstrated anti-satellite systems (direct ascent kinetic kill vehicles launched from Earth) would not be prohibited by these proposals.

The United Nations formally established the Committee on the Peaceful Uses of Outer Space (COPUOS) in 1959. It is now "the main multilateral forum for discussing issues related to the peaceful uses of outer space."[7] China has been a regular participant in COPUOS discussions.

China has also had steady interaction with the United Nations Office for Outer Space Affairs (UNOOSA). In 2014, China began to offer scholarships to attend Beihang University (also known as the Beijing University of Aeronautics and Astronautics). Under the auspices of the Regional Center for Space Science and Technology Education in Asia and the Pacific (China), 237 international students from 24 countries have received post graduate education in the five areas of "remote sensing and geographic information system, satellite communication, global navigation satellite system, small satellite technology and space law and policy."[8]

More recently, the PRC has joined with the UNOOSA to solicit foreign experiments to be conducted on China's future space station.[9] It has also indicated that it would be willing to help train foreign astronauts, to help them participate in missions to that station.

FENGYUNCast/CMACast.

Another international space organization that China has cooperated with is GEONETCAST. GEONETCAST was established in 2005, under the initiative of the intergovernmental Group on Earth Observation (GEO), a consortium of over 100 countries who pool their earth observation data in the Global Earth Observation System of Systems. The goal is to provide comprehensive, reliable data to support a variety of activities including agriculture, water management, and public health. The key partners providing satellite data are

the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the American National Oceanic and Atmospheric Administration (NOAA), the Japan Meteorological Agency (JMA), and the China Meteorological Administration (CMA).[10]

To support GEONETCAST, the PRC established the "Fengyun Satellite Data Cast System," or FENGYUNCast. FENGYUNCast distributed data from China's Fengyun weather satellite constellation, via Asia Satellite Telecommunications Company (AsiaSat) assets, to all the members states of GEONETCAST. AsiaSat is a joint venture between China's CITIC and the Western Carlyle Group. The combination of weather and communications satellites provides a coverage footprint that spans most of Asia and the Pacific.[11]

Notably, China has donated FENGYUNCAST receiver stations (which at the time comprised mainly two computers and a 2.4 meter dish) to several nations to ensure that they can receive China's Fengyun data. This has included Bangladesh, Iran, Laos, Mongolia, Myanmar, Nepal, Pakistan, and Thailand.[12] In 2011, FENGYUNCast was upgraded with improved digital video support capability and was renamed CMACast.[13]

APSCO

Perhaps the most prominent Chinese initiative in space has been the creation of the Asia-Pacific Space Cooperation Organization (APSCO). Building off a 1992 workshop on multilateral space cooperation, the PRC helped midwife the establishment of this organization in 2005, when the convention was first signed by China, along with Bangladesh, Indonesia, Iran, Mongolia, Pakistan, Peru, and Thailand. Turkey subsequently also joined. Mexico is an observer; Egypt is an associate member.

In 2009, the PRC signed a Host Country agreement with APSCO. It also provided the funding and real estate for the headquarters, which is in Beijing.[14]

Under its auspices, APSCO has built six networks.

- Data Sharing Service Platform. Satellite images from a number of members, but mainly the PRC, are available for free to other APSCO members. This includes meteorological data.
- Space Segment Network and Interconnection of Ground Systems. APSCO operates three remote sensing satellites (the joint Small Multi-Mission Satellite constellation), provided by the PRC, with additional new satellites to be funded by the rest of the organization. The associated ground stations will be built in the member states, and linked together.
- Asia-Pacific Ground-Based Optical Space Object Observation System (APOSOS). APSCO has also laid the foundation for a network of ground-based space observation systems. These provide member states with the means to detect, track, and identify various space objects.
- Disaster Monitoring Network. APSCO has supported the development of a disaster management framework, beginning with studies on how to employ remote sensing data for droughts, floods, and landslides. These would be tied to the Beidou PNT system.

- Space Application Network. APSCO is apparently supporting research and development of a variety of space applications, including telemedicine, meteorology, and PNT monitoring.
- Education and Training Network. APSCO is also working across member states to develop online training programs to help improve the overall level of space capability.[15]

In addition to these various networks, APSCO has sponsored a variety of conferences, such as the 2013 APSCO Space Law and Policy Forum.

Chinese Cooperation on Space Missions

Besides organizing and participating in international space organizations, China has also undertaken joint space missions, albeit on a limited basis, with other nations.

Double Star. China's first official joint mission occurred in the early 2000s, when the PRC joined the European Space Agency in the "Double Star" program. The initial "Cluster" program was intended to study Earth's magnetosphere through two solar cycles. However, the destruction of the initial "Cluster" satellites when their Ariane-V launcher exploded in 1996 led to a significant delay in the overall program. Over the ensuing five years, Chinese and European space officials approached each other, and eventually China joined the "Cluster" program in 2001.[16] China deployed its two Tan Ce satellites into orbits that complemented the replacement "Cluster" satellites, with one in polar orbit and the other over the equator. Some of the instruments that were supposed to fly aboard "Cluster" spacecraft were also installed aboard the two Chinese satellites.[17]

Phobos-Grunt. Less successful was the Phobos-Grunt mission to Mars. A joint Sino-Russian effort, the plan was to land on the Martian moon Phobos and return a sample of it to Earth. The mission also included Yinghuo-1, China's first interplanetary probe. Unfortunately, "engineering failures" on the Russian rocket led to the probe never leaving Earth orbit and eventually crashing into the Pacific Ocean.[18]

Tianwen-1. Chinese scientists continued their Martian efforts, however, and in 2020 launched the Tianwen-1 mission that will deploy not only a Martian lander but a rover as well. Aboard the Tianwen-1 spacecraft are European instrument packages. The French Institute for Research in Astrophysics and Planetology, for example, has reportedly worked with the Chinese on the rover that will explore beyond the initial Tainwen-1 landing site.[19] Austria has also worked with the Chinese, with the Austrian Research Promotion Agency assisting in the development of a magnetometer also carried aboard the Chinese spacecraft. This was based on a memorandum of understanding signed by the Chinese National Space Agency (CNSA) and the Austrian Research Promotion Agency.[20]

Galileo. One additional aspect of Chinese international space activity was Beijing's participation in the European Galileo PNT constellation. The main players in the European Space Agency, France, Germany, and Italy, first conceived of a European alternative to the American GPS constellation in the 1990s. Funding was often rocky for what started as a public-private partnership, however, and European space agencies and legislators were open to non-European participation.

In 2003, a cooperation agreement was signed between the EU and the PRC's Chinese National Remote Sensing Centre (NRSCC). China contributed some 200 million euros (equivalent to $230 million at the time). This was welcome funding for the program. "China's financial and political support to Galileo was also a welcome counter to U.S. opposition to the rival European network."[21] It would also give Europe preferential access to the Chinese market for PNT signals.[22]

In return, China expected to have access to the algorithms of the new PNT network, a work- share in the manufacturing of the satellites, and additional training opportunities for Chinese engineers. By 2004, over a dozen contracts were signed between the Chinese and European parties.[23] As important, the NRSCC was made part of the Galileo Joint Undertaking (GJU), the entity that was supposed to supervise the overall project.[24]

In 2006, however, the GJU was liquidated, and all of its authorities were transferred to the European GNSS Supervisory Authority (GSA). The GSA would own the Galileo constellation, and would also have "some oversight authority for Galileo's Public Regulated Service, or PRS, the encrypted, government-only Galileo signal that will not be open to governments outside Europe."[25] European authorities concluded that China could not be a part of the GSA. As the European Space Policy Institute notes, the way in which the Chinese were removed from all governance aspects of the Galileo program "tarnished relations with the Chinese party," and gave significant impetus to China's decision to develop its own PNT system (what was previously known as "Compass" and is now referred to as Beidou-2 and Beidou-3).[26]

Chinese Outreach on Space Situational Awareness and Space Traffic Management

While the PRC has developed a substantial array of space capabilities mainly through its own efforts, it nonetheless faces certain limitations, especially in terms of space situational awareness (SSA) and space traffic management (STM). Unlike the United States or Russia, a major challenge for China's space program is maintaining space situational awareness throughout the course of its missions. For the United States, this is somewhat facilitated by not only overseas states and possessions such as Hawaii and Kwajalein, but also a network of alliances that allowed the US to deploy space tracking systems to places such as Australia. The Soviet Union, and subsequently Russia, has the advantage of a vast nation spanning 11 time zones. While Moscow is less capable of tracking objects over the Southern Hemisphere, Russia

nonetheless has an excellent ability to maintain space surveillance over much of the Northern.

The PRC, by contrast, has a much more limited expanse, and possesses no territories south of the equator, nor allies to whom it can turn to establish space surveillance facilities. As China has developed more extensive space capabilities, its requirements for more extensive space surveillance capabilities have correspondingly increased.

It is therefore not surprising that some of China's first overseas government facilities (outside of embassies and consulates) were space tracking centers established in Swakopmund, Namibia (2001), and Kiribati in the South Pacific (1997). These were established to support China's burgeoning manned space effort. The Kiribati facility was later closed down, when Tarawa switched its recognition to Taiwan in 2003. The recent flip by Kiribati back towards Beijing may lead China to open a new facility (the previous one was thoroughly demolished by China prior to their departure.) Other facilities to support the manned space effort have been established in Malindi Kenya and Karachi Pakistan. In addition, China has negotiated access to Swedish and Chilean space observation networks, as well as leased facilities in Australia.

A major effort spearheaded through APSCO has been APOSOS, the Asia-Pacific Ground- Based Optical Space Object Observation System (mentioned earlier). This space situational awareness network can monitor objects in both low-earth and geosynchronous orbit. By binding it to APSCO, it has allowed China to deploy telescopes to Iran, Pakistan, and Peru, with the eventual goal of telescopes and other space-tracking systems available in every member country.[27] China has also deployed sensors to Brazil, Ukraine, and Mexico, as part of APOSOS. The resulting data is managed by the Chinese Academy of Science's National Astronomical Observatory.[28]

Further supplementing these efforts have been arrangements made by the PRC to support specific missions. With the Chinese Tianwen mission to Mars, for example, Beijing has apparently made arrangements with the European Space Agency (ESA), the Argentine space agency, and the French space agency to access their deep-space surveillance and communications networks. ESA will apparently provide tracking data of the Tianwen spacecraft's trajectory, using its facilities in Australia and Spain, and support course corrections and spacecraft monitoring along the way to Mars.[29]

A space-tracking station built by the PRC in Argentina, meanwhile, will help monitor the spacecraft on its months-long flight to the Red Planet. The Neuquen facility has been formally accepted as a Chinese facility by the Argentine government earlier in 2020.[30]

Chinese Commercial Activities in Space

In addition to formal cooperation between and among governments, China has also used the sale of space equipment and services to expand its influence internationally.

International Satellite Sales and Development

The American imposition of International Traffic in Arms Regulations (ITAR), i.e., export controls, has limited China's ability to participate in the global launch services market. ITAR has meant that no satellite with even minimal American content (including screws and fasteners) can be launched from a Chinese launch site (because getting it there would require export licenses). Consequently, China has had to find alternative methods to support its commercial space launch industry.

One method has been Chinese cooperation with other countries in the manufacturing of satellites. In 1988, China and Brazil signed an agreement committing the two states to the co-development of the China-Brazil Earth Resources Satellite (CBERS). The first CBERS satellite, launched in 1999, was the first Chinese satellite to employ charge-coupled devices to allow direct transmission of images from the satellite to Earth. The Chinese subsequently further developed the Ziyuan series of satellites to provide higher resolution capabilities in support of military as well as civilian purposes, but the CBERS effort remains an ongoing concern.

In December 2019, China launched CBERS-4A, the sixth CBERS satellite. It replaces the CBERS-4, launched in 2014, and carries a pan-chromatic multispectral camera with 2 meters resolution compared with 5 on its predecessor. It is the highest resolution camera thus far fielded on a CBERS platform.[31]

In addition, China has sold satellites to a number of states. These have included Algeria, Belarus, Bolivia, Ethiopia, Laos, Nigeria, Pakistan, Sudan, and Venezuela.[32] Many of these have been communications satellites; indeed, these were the first communications satellites for Algeria, Belarus, Bolivia, and Nigeria. Others, however, have been earth-observation platforms, including satellites for Ethiopia and Venezuela.[33]

The terms have varied from case to case, but some of the Chinese sales have also included not only the design, manufacturing, and launch of a satellite, but construction of a ground control facility, and training of locals to help operate the satellite. The sale of NigComSat-1 to Nigeria, for example, saw the Chinese build a 26-transponder communications satellite, launch services, insurance, and a technology transfer package, all for $112 million.[34]

When NigComSat-1 failed after less than 18 months, China replaced the satellite, and in 2011 launched NigComSat-1R in its place.[35] This was at no cost to the Nigerian government, thanks to the insurance policy covering the satellite—extended by Chinese underwriters.

China has also cooperated with some countries in the development of scientific research satellites, such as the Belarusian State University's BSUSat-1.

Commercial Provision of Space Services

Not surprisingly, Chinese planners have sought to expand China's provision of satellite services, as their efforts to be a provider of space hardware have been frustrated. To this end, China's new commercial space sector, with companies that range from subsidiaries of state-owned enterprises to private start-ups to subsidiaries of major corporations, offer a new path. While many of these companies are oriented towards hardware development (including space launch and satellite manufacturing), others are interested in space services.

In 2018, for example, Autonavi, a map app that is part of the Alibaba conglomerate, reached 100 million daily active users.[36] The company provides support for ride-sharing companies, bike-sharing companies, and is contracting with foreign car companies to provide Chinese road atlases for their vehicles. Autonavi relies upon the Beidou satellite navigation system for its data.[37] While Autonavi is not itself a space company, it clearly relies upon space systems to operate. This is likely to be a major part of Chinese space activities in the coming years, as China's telecommunications and social media companies (e.g., Tencent, Alibaba) employ space-based systems and information.

In the past, this likely would have mainly involved the state-owned enterprises. Given the growing number of commercial Chinese space companies in areas such as earth observation, however, it is likely that the Chinese commercial space sector will play an increasing role. This is especially true if the telecoms and social media companies underwrite these companies in the first place. Thus, whereas Elon Musk took his Internet fortune to help create SpaceX, in China it is at least as possible that Alibaba will create a space subsidiary rather than a separate entity.

Participation in International Industrial Standards Setting Bodies

One last aspect of Chinese international space activity is the participation of Chinese space- related companies in space industry standards-setting bodies. Industry standards facilitate global supply chains, helps maintain quality control, and support interoperability. The industry standards for the aerospace sector are the AS91XX series. These govern all aspects of the aerospace industry's supply chains, whether for military or civilian systems, from spare parts to supply and maintenance services.[38]

Chinese aerospace representatives have participated in past meetings among standards-setting organizations. This is likely to become more salient for Chinese firms, however, with the promulgation of "China Standards 2035." "China Standards 2035" is a national effort that follows on the footsteps of "Made in China 2025." Where the latter was an industrial policy to establish Chinese self-sufficiency in 10 key industrial sectors, however, "China Standards 2035" is an attempt to shape global rules for industrial and technological development.[39] Among the China Standardization Commission's reports, Document #8 specifically includes aviation, satellite and space facilities, and commercial aerospace as areas for further standards

development.[40] It also mentions the need to ensure that standards both accommodate and support civil-military fusion, the broader Chinese effort to improve civil-military industrial integration.

CHALLENGES FROM CHINA'S SPACE DIPLOMACY

The multi-faceted nature of China's employment of space in support of its diplomatic efforts means that it poses many distinct challenges. That China has the ability to employ space in support of its own military goals, for example, clearly enhances its deterrence capabilities. Indeed, for the United States, China poses an unprecedented military space challenge in the post-Cold War era. In none of its wars since the fall of the Berlin Wall has the US confronted an adversary with its own space capabilities. Consequently, US military forces generally did not have to worry about space-based surveillance of its movements and preparations. As important, while there was the potential for cyber attacks against American space assets, no adversary could really threaten American space systems, whether those in orbit or on Earth, with physical harm.

In these regards, the PRC poses a wholly different scale of threat. It fields a full panoply of capabilities including electronic warfare, cyber, jamming, dazzling, direct-ascent kinetic kill vehicle, and co-orbital platform with which to attack and degrade or destroy elements of the American space enterprise. In any conflict, the Chinese are likely to employ these capabilities to try and deter and coerce both the United States and its allies.

Impact of Chinese International Space Behavior: Provision of Space Data

China's possession of substantial space-based surveillance capabilities does not only pose a direct threat to US military forces, however. Another potential impact of Chinese space capabilities would be the provision of space-based data to a variety of other states. During the Iran- Iraq War, the United States supported the Saddam Hussein regime by providing intelligence information to the Iraqis. This included satellite data, which supported both Iraqi operational and tactical decisions.[41] While it was not sufficient for Saddam to win the conflict, it allowed the Iraqis to employ their forces more efficiently.

In future confrontations, it may be the PRC that provides intelligence support, empowering a proxy such as Venezuela or Iran. This might be to support tactical and operational activities, but it might have strategic ramifications as well. For example, how might American military and political planning be affected if it was made clear at the outset that the United States probably could not attain strategic or perhaps even operational surprise, as China would provide reconnaissance satellite data?

Indeed, given the Chinese view of *weishe* (威慑), which is often translated as "deterrence" but is better translated as "coercion" or "compellence," the provision of space-based intelligence data to potential American adversaries, perhaps even conducted openly, is a potentially effective means of effecting *weishe*, while limiting the risk of escalation. Such a

move would make clear China's support for another state, in ways that are arguably less provocative than direct provision of arms, or offering bounties for American casualties.

As China expands its commercial, non-state-owned enterprise component of its space-industrial complex, an additional tool available to Beijing will be commercial space service providers. Much as Planet Labs and other Western companies can currently image various locations without jeopardizing the operational security of the American national security space infrastructure, the Chinese will be able to do the same. Whether this is providing space-based reconnaissance photographs to third countries, or broadcasting images of American deployments via China's global state-run media networks, American (and other) military forces are likely to find operational security harder and harder to maintain.

Chinese political warfare methods, which includes the "three warfares" of public opinion warfare, psychological warfare, and legal warfare, provide yet another venue for Chinese exploitation of space data for foreign policy ends. Raising doubts about the security of American operations would constitute a form of psychological warfare by space means.

In addition, adroit exploitation of space-based data can support public opinion warfare efforts. Public opinion warfare (*yulun zhan*; 舆论战) refers to the use of various mass information channels, including the Internet, television, radio, newspapers, movies, and other forms of media, in accordance with an overall plan and with set objectives in mind, to transmit selected news and other materials to the intended audience.

The purpose of public opinion warfare is more than just getting one's own point of view expressed, or to air certain facts. Rather, the goals are to preserve friendly morale, generate public support at home and abroad for oneself, weaken the enemy's will to fight, and alter the enemy's situational assessment. It also seeks to influence third parties, both at the popular and leadership level.

Consequently, public opinion warfare is more than highly focused public relations. Instead, it tries to shift public perceptions and opinion in order to create and improve one's advantage over an adversary.[42] To this end, communications efforts associated with public opinion warfare are undertaken in accordance with an over-arching plan, with specific messages, using specified channels, in order to achieve certain goals. While the news media plays an important role in the Chinese conception of public opinion warfare, it is only a subset of the larger set of means available for influencing public opinion.[43]

From the Chinese perspective, then, releasing overhead imagery of American military preparations, such as force deployments, can help undermine American claims of seeking a peaceful solution. Similarly, publicizing images of American military deployments (thereby reducing the potential level of surprise) can raise questions about the potential cost of war, eroding support. Conversely, images of Chinese forces on the move, such as nuclear forces moving from garrison positions, can be used to influence both American and other audiences,

underscoring China's commitment or credibility.

Beyond military support, however, China's space capabilities also pose challenges to other aspects of American foreign policy, extending beyond the purely military realm. China's various international space activities provides significant inroads for China's foreign policy. One obvious element is that China can use past space contacts to expand into the future. Thus, both Ethiopia and Nigeria have indicated that they would like to work with China to expand their respective nations' satellite fleets. In the case of Nigeria, the Chinese have indicated that, rather than requiring Lagos to provide 15% of the $550 million bill, Beijing would accept an equity stake in the holding company that manages Nigeria's communications satellites.[44]

Impact of Chinese International Space Activities: Beidou

The influence of China's international space activities goes beyond those directly related to space systems, however. Because of the holistic Chinese approach to foreign policy, where it regularly integrates scientific exchanges, trade relations, and military interactions into its diplomatic endeavors (and vice versa), China's space relations help build other commercial ties, and conversely, its commercial ties (including the Belt and Road Initiative) facilitate space sales.

Indeed, the Chinese have openly discussed the idea of a "Space Silk Road (*kongjian silu*; 空间丝路)" and "Space-Based Silk Road (*tianji silu*; 天基丝路)." These terms cover several different aspects. One is the development of a Chinese constellation of communications satellites. These, in conjunction with terrestrial telecommunications networks (e.g., cell phones, fiber optic cables) would provide reliable, 24-hour, all-weather communications across not only China, but Central Asia, the Indian Ocean, and much of the Pacific Basin.[45]

But the "Space Silk Road" also refers to the idea that there is a space component to the "Belt and Road Initiative" (BRI, previously referred to as the One Belt, One Road Initiative, and the Silk Road Economic Belt and 21st Century Maritime Silk Road). Some Chinese writings have referred to a "Belt and Road Space Information Corridor ("*yidai yilu" kongjian xinxi zoulang*; "一带一路"空间信息走廊)", which would tie together Chinese remote sensing, navigation, and communications satellites into a network that would undergird the BRI.[46]

Such a space information corridor would not only provide information support during the construction phase for many BRI projects, but would also have longer term impact during the life- time of various BRI projects. This is because space-based information support is increasingly essential to the successful operation of modern, complex systems. Pipelines, power grids, and even telecommunications networks rely upon PNT signals to synchronize their operations. This means that Beidou will play a role, not only for surveying and planning of key construction sites, but also for the basic operation of much of the infrastructure once it is completed.

One of the major elements of China's BRI, for example, is the construction of pipelines

to move oil and natural gas either directly to China (from Central Asia) or (in the case of overseas fields) to ports for subsequent transshipment. Provision of satellite-based timing data has become integral for most long pipelines. These are networks that typically include not only the main line, but various feeder lines.

> To ensure adequate, stable, and energy efficient delivery, flow along these pipes must be regulated by a series of pumps and valves, controlled by servers that have to consider various parameters (such as temperature, pressure, flow rate) reported by sensors distributed along the pipes. However, in order to process and optimize the flow of liquid, all the devices along the line must be controlled as parts of one integrated system rather than independently. As propagation of the liquid as well as the electronic signals takes time, all inputs have no effect unless we can ensure they are taken on the same time basis or -in other words -synchronized.[47]

This synchronization is often now achieved through the use of timing data from satellites, especially GPS. Not only does the PNT network help control pumping stations and other pipeline functions, but, coupled with other monitoring systems, the overall pipeline network can assess stresses on the pipeline infrastructure and ensure the integrity of the network.[48]

Telecommunications networks operate in a fashion similar to oil and gas pipelines. PNT satellite signals are currently used to ensure that cell tower frequency hopping is synchronized. This not only ensures that calls are not dropped, but also helps improve the efficiency of the use of the available bandwidth. It is expected that 5G cellular networks will make even more use of PNT satellite signals, not only for synchronizing the frequency hopping, but "to keep overlapping cells phase synchronized to avoid interference."[49] (This is partly because the density of 5Gtowers is expected to be much greater, because of the shorter range of the 5G signals.)

Since China is building the infrastructure of a number of nations via its BRI efforts, it is unlikely that the Chinese will rely upon GPS for the timing signals that will synchronize all these various systems. Instead, it is reasonable to presume that the Chinese would integrate Beidou PNT information into that infrastructure. In the longer term, however, this means that nations accepting Chinese BRI money and assistance may find it very difficult to extricate themselves, because of that same reliance.

The operation of various infrastructure such as power grids and pipelines is likely to be tied to Beidou signals. Changing from Beidou to an alternative system may require Chinese permission, as well as access to the algorithms. One should not be surprised if Beijing were to be reluctant to promptly undertake such measures (and not exploit the intervening period to either lobby against the change or wait for a shift in the political winds). In the case of 5G networks, it may be made even more difficult to find substitutes for the more extensive Beidou satellite network, which likely allows more than one satellite to be in line-of-sight at any time. In short, the

countries that ostensibly own these networks may well find that they have no choice but to continue to rely on China's provision of timing data for their continued operation.

There would also be potential national security aspects as well. The PRC is exporting a variety of unmanned aerial vehicles (UAVs) to many states, including many in the Middle East and Southeast Asia. Some of these UAVs apparently employ satellite support for locating themselves and navigating to their intended targets. Not surprisingly, these, too, are tied to Beidou. A recent contract signed between China Great Wall Industries Corporation and Thailand's Thaicom Public Company specifically covered satellite support for UAVs (although not military ones).[50] Other Chinese UAVs have demonstrated the ability to fire weapons based on commands issued thousands of miles away, also via satellite links.[51]

Consequently, those who have imported such systems are likely dependent upon access to Chinese communications and PNT satellites for their continued operation, unless they created their own, alternative ability to control the UAVs. Not only does this create a dependency upon the PRC, but it also gives Beijing significant influence in event of a Sino-American crisis. A state that has a significant fleet of Chinese UAVs would have to think carefully about whether it could afford to have that fleet neutralized, which would likely occur if it chose to support the United States over China. This could have distinct implications for the United States, in terms of access to facilities (e.g., in Thailand), or gaining political and even economic support (e.g., imposition of sanctions).

Potential Impact of Chinese Commercial Space Services

Another significant advantage that is likely to accrue to China from its international space behavior is insight gained from the provision of commercial space services. As noted earlier, Chinese companies are exploring not only launch services, but also remote sensing and data analytics; China already also provides satellite communications services (and has even provided it to the US Department of Defense).[52] This means that Chinese companies that provide space services will be both collecting information (e.g., imaging particular sites) and analyzing it (as data analytics) on behalf of foreign customers.

The problem is that foreign customers should not assume that there is any expectation of privacy or privileged information, on the part of the Chinese company. Indeed, China's legal system has made clear that, in fact, no such assumption should be entertained.

The PRC over the past decade has passed a number of laws that require companies and social organizations, as well as government agencies and ministries, to provide access to any data that they might possess. These include the 2014 Counter-Espionage Law, the 2015 National Security Law, the 2017 Cyber Security Law, and the 2018 National Intelligence Law. The Counter- Espionage Law, for example, states that involved organizations and individuals "cannot refuse" to cooperate in any investigation.[53] An American assessment of the Chinese Cyber-

Security Law concludes that it requires network operators to cooperate with both criminal and security investigators, including providing full access to all data, as well as computer hardware. It also requires network operators to store data they have gathered or produced in the PRC.[54]

These laws mean that Chinese commercial space companies would be liable to provide Chinese authorities with names of clients, types of information collected for them (e.g., sites being observed), as well as the analytical results. This could potentially provide Chinese security entities with enormously useful information, including:

- Which specific transponders may have been leased on Chinese communications satellites and when;
- What areas have been photographed or otherwise observed from space, and the associated clients;
- What areas may have been subjected to multiple different analyses (e.g., synthetic radar imaging, electro/optical imaging, commercial signals intelligence), and what analytical results were requested from that data

This data, in turn, can potentially be very helpful to Chinese foreign policy efforts. It can, for example, provide the Chinese government with insights as to what areas are of interest to foreign corporations and even governments. Knowing where a mining company is interested in topographic information, an agriculture ministry is asking for vegetation imagery, or where construction companies are conducting surveys can provide insights to Chinese state-owned enterprises who may wish to make counter-bids or otherwise take exploit the advantage.

PROSPECTS FOR THE FUTURE

This cursory review of China's international space activities, and linkage of space to other foreign policy efforts, is intended to highlight both the wide array of activities, as well as their integration into a number of other lines of effort. If the Chinese maintain these two aspects, it is likely that China will try to expand its array of space services, whether provided by SOEs or commercial entities. This would include sales of satellites, provision of satellite applications, and efforts to participate in international standards setting bodies. It is also likely to maintain the cooperative efforts it already undertakes. China is likely to continue to provide weather data from its meteorological satellites via CMACast.

As important, China may choose to integrate space and other foreign policy efforts more explicitly. For example, at present, while there is some overlap between APSCO members and locations of BRI investments, there does not appear to be any specific linkages between the two. But this could change in the coming years. China may offer to build out space infrastructure as

part of its BRI efforts, while discounting costs, or offering additional capacities, to APSCO members.

Less clear is the extent to which Beijing is likely to allow true cooperation in such areas as space science. China released data about the far side of the Moon only a year after Chang'e-4 touched down.[55] It would seem clear that the Chinese leadership wanted to ensure that Chinese scientists would have exclusive access to that data. The lack of high profile joint missions since the "Double Star" effort might suggest limited interest in cooperative efforts with other states, but the case of Phobos-Grunt might suggest otherwise. Similarly. China's tight control over facilities built in Argentina and elsewhere would seem to bode ill for genuine cooperation, but the Chinese- Brazilian joint effort at satellite development again would seem to contradict that conclusion.

Joint Manned Missions?

China has in the past indicated that it is prepared to train foreign astronauts to fly aboard the Chinese space station.[56] As China's space station (as opposed to the Tiangong space labs) takes more concrete form, so is this offer. It is quite possible that the first foreign astronaut aboard China's future space station will be drawn from an APSCO member nation.

China might also choose to invite a Russian aboard the Chinese space station. Chinese astronauts are known to have trained at Star City in the 1990s.[57] Given the increasing alignment of Moscow and Beijing (especially in opposing the United States), the joint efforts already displayed at the UN on space issues, as well as the Phobos-Grunt mission, there would seem to be significant political and bureaucratic investment already made on behalf of space cooperation.

Beijing may also apply this approach to potential European partners. The European Space Agency has dispatched a number of astronauts to train with their Chinese counterparts.[58] From Beijing's perspective, undertaking cooperative missions with Europe could be very attractive.

- It would dilute the embarrassing precedent of the Galileo satellite program.
- It would demonstrate that China is a reliable partner, especially in the wake of both COVID-19 and Huawei/5G.
- It would highlight China's scientific and technical parity, if not superiority (since Europe has no man-rated space launch system).

At the same time, however, Beijing is unlikely to countenance such a high profile, joint undertaking without assurances that it would be carried to completion. As important, it is dubious that it would be allowed if there are other outstanding irritants such as human rights-based sanctions, limits on technology transfer, or political criticism of Beijing.

Conclusions

China's leadership has long employed its space efforts to benefit all aspects of comprehensive national power, including building up domestic legitimacy, support national economic development, as well as gain international prestige and demonstrate national capabilities. Xi Jinping is no different in this regard, and is likely to sustain this trend throughout his time in office.

The decision to elevate Yang Jiechi to the Politburo, however, means that Chinese foreign policy, for the first time in nearly two decades, has a voice in the highest policy-setting body in the PRC. As we see Chinese diplomats become "Wolf Warriors," we should expect to see this reflected by an even tighter linkage of space capabilities to foreign policy endeavors in the coming decade.

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