SECTION 3: THE IMPLICATIONS OF CHINA'S CIVIL AND MILITARY SPACE ACTIVITIES

Introduction

Decades of high prioritization and steady investment from Chinese leaders, coupled with incremental indigenous achievements by Chinese scientists and engineers, place China among the top space powers in the world today.* Qualitatively, China's space industries now produce state-of-the-art systems for certain applications, such as guided weapons that use space assets for targeting. Quantitatively, numerous active programs continue to increase China's inventory of satellites and other space assets. China's capabilities still generally lag behind those of the United States, Russia, and perhaps other nations by some measures. But of note, particularly as many nations' space programs proceed with relatively modest goals, China's civil and military space programs are in the ascendancy, in some cases on a steep trajectory.

Commission research and hearings held over the past year found that the implications of this trend for the United States and the rest of the world depend considerably on how the Chinese government seeks to use its increasingly robust space capabilities. Official statements emphasize reasonable and nonthreatening goals: prestige, scientific experimentation, exploration, and the attendant commercial and economic benefits. However, the substantial role the People's Liberation Army (PLA) plays in most facets of China's space activities demonstrates their heavily military orientation. Notwithstanding the inherently dual-use nature of many space activities, programmatic decisions such as concerted investment in counterspace technologies also indicate the centrality of military objectives. This raises questions about the Chinese government's willingness to be a responsible actor in the space domain. Threats to space infrastructure, particularly massive, orbital debris-creating events like the PLA's 2007 antisatellite demonstration (discussed below), have the potential to deny the benefits of space activities and technologies to the entire international community.

Basic Features

China's space capabilities are advancing on several fronts. Information about China's current, space-related infrastructure illus-

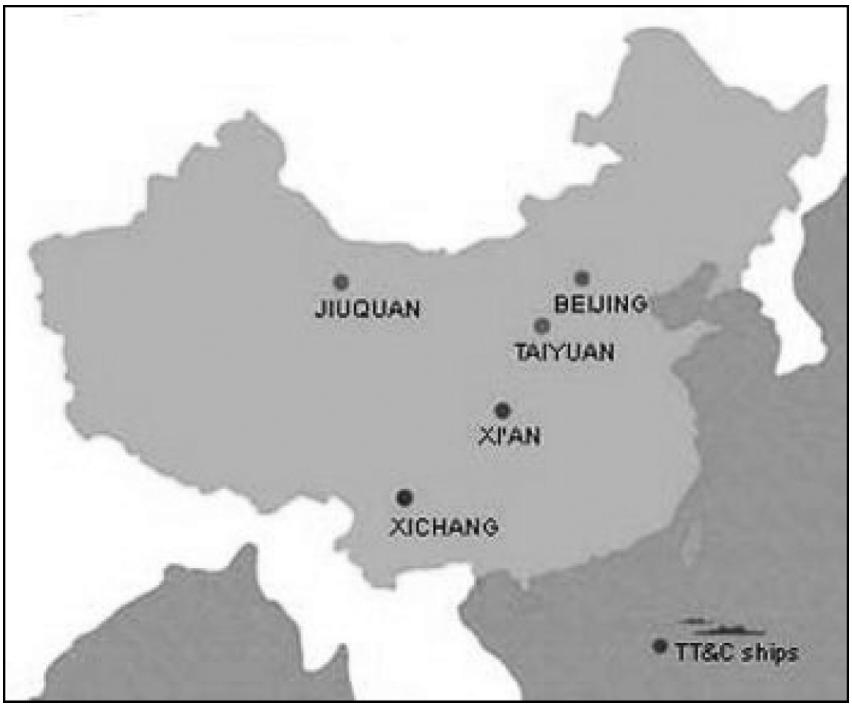
* Although subjective, space program capabilities and expenditure levels suggest that the term "space powers" would also include the United States, Russia, Japan, and the European Union. For figures, see The Space Foundation, "The Space Report 2011" (Colorado Springs, CO: 2011). p. 42; and Union of Concerned Scientists, "UCS Satellite Database (through 4/30/11)" (Cambridge, MA: 2011). *http://www.ucsusa.org/nuclear_weapons_and_global_security/space_weapons/technical_issues/ucs-satellite-database.html*.

trates the depth of China's space programs. Three areas in particular bear mentioning: terrestrial infrastructure, launch vehicles, and satellites.

Terrestrial Infrastructure

Ground-based infrastructure enables all space operations. China has three active launch sites, located in Jiuquan, Gansu Province; Xichang, Sichuan Province; and Taiyuan, Shanxi Province (see figure 1, below). A fourth site is under construction at Wenchang, Hainan Island, and could become operational by 2013. In addition to these facilities, China operates two mission control centers: the Beijing Aerospace Flight Control Center, used for manned flight and lunar missions; and the Xi'an Satellite Telemetry and Control Center, used for tracking and controlling satellite data. Finally, an overseas tracking station in Swakopmund, Namibia, and four PLA-operated space tracking ships provide greater coverage areas for particular missions.[239]

Figure 1: China's Operational Terrestrial Space Infrastructure *



TT&C: Telemetry, Tracking, and Command. (Ship placement is for illustrative purposes only.)

Source: Globalsecurity.org, "Chinese Space Facilities," undated. *http://www.globalsecurity.org/space/world/china/facility.htm*.

* Domestic and maritime infrastructure only.

Launch Vehicles

In 2010, China conducted 15 successful satellite launches, as many as the United States and behind only Russia, according to testimony to the Commission by Clay Moltz, associate professor at the Naval Postgraduate School.[240] China relies primarily on the Chang Zheng ("CZ," or "Long March") family of rockets to launch objects into orbit. Although less capable than some American, European, and Russian launch vehicles, the Chang Zheng has amassed an impressive reliability rate.* A new variant of the vehicle, the CZ–5, could enter service as soon as 2014, according to a Commission-sponsored report on China's aerospace industry.[241] In contrast to this program, China has experienced substantial setbacks with its next-generation family of rockets, called Kaituozhe ("KT," or "Pioneer"). Though the Pioneer has been in development since 2000, two out of a possible five tests have failed, and the future of the program remains uncertain.[242]

Satellites

China controls approximately 70 satellites.† Chinese civil entities and state-owned enterprises (or commercial entities that involve state-owned enterprises), operate about 13, and other government or military entities control the remainder.[243] China's satellites fill numerous roles, including a variety of experimental functions; communications and data relay; earth observation; weather; imagery and reconnaissance; synthetic-aperture radar; and potentially signals intelligence or electronic intelligence.[244] In addition, an indigenous satellite navigation capability (similar to the U.S. Global Positioning System) appears to be a high priority for Beijing, which is developing a comparable system called Beidou. Beidou-1, an experimental constellation, currently provides limited coverage (see figure 2, below). Beidou-2, a follow-on system that already includes nine operational satellites, should provide regionwide coverage from 12 satellites by 2012. By 2020, the system intends to provide global coverage with 35 satellites (see table 1, below).[245]

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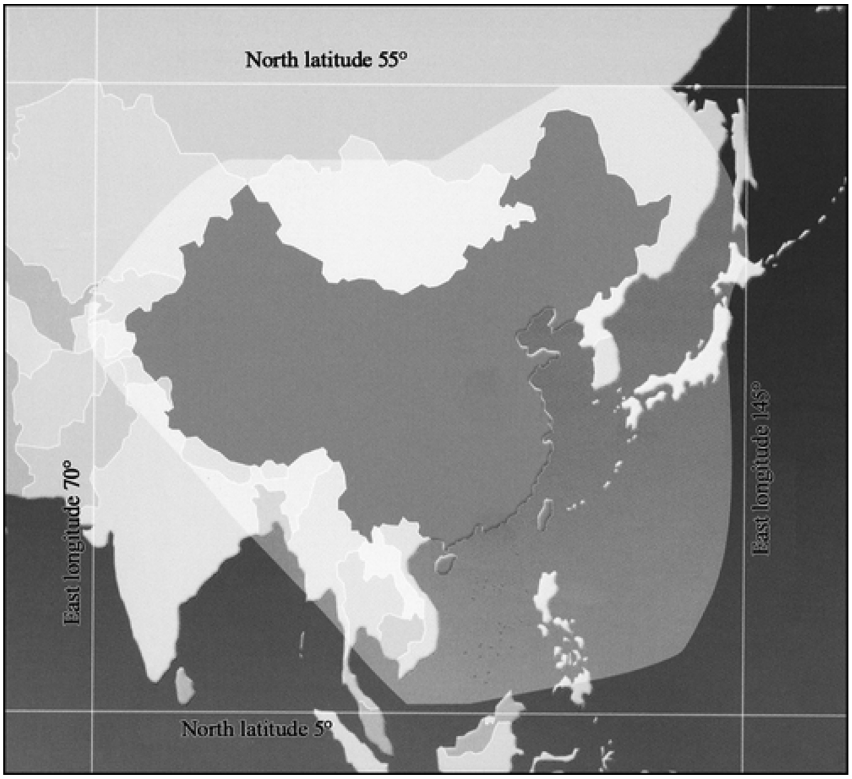
*Since a string of failures from 1992 to 1996 (after which American firms offered troubleshooting advice) the CZ has had only two failures: one in 2009 and one in 2011. There are some discrepancies about the CZ's precise success rate over the life of the program. By one count, there have been 132 CZ–2, –3, and –4 launches since 1974. Of those, only seven, or about 5.3 percent, failed. This includes not just catastrophic failures but also those in which the payload failed to reach its intended orbit (in some cases, a satellite in the wrong orbit can still perform certain functions). For information about the involvement of American firms with the CZ program in the early and mid-1990s, see Shirley A. Kan, "China: Possible Missile Technology Transfers Under U.S. Satellite Export Policy—Actions and Chronology" (Washington, DC: Congressional Research Service, updated October 6, 2003). *http://assets.opencrs.com/rpts/98-485_20031006.pdf*. For information about CZ failures in 2009 and 2011, see Stephen Clark, "Chinese rocket fails to orbit experimental satellite," *Spaceflight Now*, August 18, 2011. *http://spaceflightnow.com/news/n1108/18longmarch/*. For data on the CZ's success rate, see Ed Kyle, "2011 Space Launch Report," *Space Launch Report*, September 18, 2011. *http://www.spacelaunchreport.com/log2011.html#rate*.

†By way of comparison, the United States controls over 450 satellites, Russia controls over 100, and Japan controls over 40. See Union of Concerned Scientists, "UCS Satellite Database (through 4/30/11)" (Cambridge, MA: 2011). *http://www.ucsusa.org/nuclear_weapons_and_global_security/space_weapons/technical_issues/ucs-satellite-database.html*.

Figure 2: Representation of Beidou-1's Coverage Area



Source: Junping Zhao et al., "The Design and Implementation of a Rescue Terminal with Vital Signs Telemonitoring Based on Beidou 1 Navigation Satellite System," *Telemedicine and e-Health* 2:17 (March 2011): 76–79.

Table 1: Select Chinese Satellites (operational only)

Type	Series	Quantity
Communications	Dongfanghong 3, 4	6
Weather	Fengyun 1, 2, 3	5
Civilian Earth Observation	China-Brazil Earth Resources 2	1
	Huanjing 1	2
	Haiyang 1	1
Military Reconnaissance	Fanhui Shi Weixing*	—
	Ziyuan	3
	Yaogan 2, 3, 4, 5, 6, 7, 8, 9, 10	9
Satellite Navigation	Beidou 1, 2	11

Table 1: Select Chinese Satellites (operational only)—*Continued*

Type	Series	Quantity
Other	Shijian 6, 7, 11, 12	9
	Beijing 1	1
	Chuangxin 1	1
	Shiyan 1, 2, 3	3
	Naxing 1	1
	Zheda Pixing 1	3
	Xiwang 1	1

*Five different models exist and are used on a temporary basis. Together, they have flown 22 missions ranging between 18 and 27 days.

Source: Roger Cliff, Chad J.R. Ohlandt, and David Yang, "Ready for Takeoff: China's Advancing Aerospace Industry" (contracted research paper for the U.S.-China Economic and Security Review Commission, 2011). *http://www.uscc.gov/researchpapers/2011/RAND_Aerospace_Report%5B1%5D.pdf*. Satellite navigation quantities updated to reflect subsequent launches.

Civil Space Activities

This subsection provides background information on China's civil space activities. It discusses China's strategic approach to civil space and the space sector's organizational features. It then surveys China's recent developments and accomplishments. Finally, it discusses some apparent limitations.

Strategy

China's leadership views all space activities through the prism of "comprehensive national power,"[246] a construct that seeks to measure nations' relative strength in politics, economics, military capabilities, science and technology, and foreign affairs.[247] China's most recent official white paper on space, released in 2006, characterizes space development efforts "as a strategic way to enhance" China's standing in these areas.[248] Parallel to its military efforts (described below in the "Military Space Activities" subsection), Beijing has put forward initiatives in each area.

Politics: China's space endeavors serve to bolster the nation's standing both at home and abroad. For domestic purposes, "the [Chinese] government is using civil space activities to promote its legitimacy in the eyes of its people," according to Dr. Moltz.[249] Space activities for external consumption have both symbolic and concrete rationales. For example, Scott Pace, director of The George Washington University Space Policy Institute, testified that "Chinese astronauts are helpful to promoting the China 'brand' in promotional videos and international conferences."[250] More directly, "Conspicuous and autonomous achievements in space also reinforce China's great power status and its membership in the elite club of advanced spacefaring countries," according to testimony to the Commission by Alanna Krolikowski, visiting scholar at The George Washington University Space Policy Institute. She continued, "Achieving significant space capabilities ensures that China will have a 'seat at the table' when decisions about space are made."[251]

China's leadership appears to value space exploration's inherent prestige, for both domestic and external audiences, above any potential economic benefits. Ms. Krolikowski testified that:

> *The areas of space technology known to generate the most direct and reliable contributions to economic development are those with concrete applications, such as telecommunications satellites and remote-sensing satellites for resource management and weather monitoring. . . . In China, over the past two decades, resources devoted to civil space have been concentrated not in these relatively productive areas, but in a costly human spaceflight engineering program of no evident direct benefit to the national economy. The symbolism of human spaceflight has been an important driver of this effort.*[252]

Economics: China's economy benefits from the country's national space programs, regardless of certain programmatic decisions that emphasize prestigious accomplishments. Numerous firms, chiefly state-owned conglomerates (described below in the "Organization" subsection), engage in the research and development, design, engineering, production, launch, and maintenance of space and space-related systems. The firms employ over 200,000 people and produce systems with commercial applications. Ms. Krolikowski noted that "China is entering a phase of space-sector development during which even greater emphasis is placed on the commercialization of space technology."[253] Space technology also has spin-off benefits for other industries; for example, "[r]equirements for human space flight are used to improve the quality control of Chinese industries," according to Dr. Pace.[254] Finally, the use of space itself can have economic benefits, according to researchers at the China Institute for International Strategic Studies. During a 2010 Commission trip to China, researchers at the institute explained that China's earth observation satellites can help the agricultural sector understand soil conditions and other environmental factors, which can aid in yielding more productive crops.*

Science and technology: China's leadership recognizes the strategic value of space-related technologies. "High-end manufacturing and information technology, which include satellites and telecommunications, are among the seven new strategic sectors identified in the 2011–2015 [12th] Five Year Plan to receive policy support and public investment," according to Ms. Krolikowski. She testified that "[s]pace-related industries figure in government plans for building a knowledge economy, increasing domestic consumption, especially of high-technology products, fostering indigenous innovation, and building a sophisticated scientific, technical, and industrial base."[255] Beijing views science and technology development as inseparable from economic and defense imperatives (described above and below, respectively).[256]

Foreign affairs: China uses space cooperation and diplomacy to fulfill a range of space-related objectives and more general diplo-

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* Researchers also explained that Chinese scientists have found that seeds irradiated via exposure to space produce higher crop yields. (Director of Strategic Studies at the China Institute for International Strategic Studies), presentation to Commission, Beijing, July 28, 2010.

matic and foreign policy goals. China cooperates with other nations on various space projects in order to develop its domestic space capacity. A notable codevelopment project is the China-Brazil Earth Resources Satellite series, which include imagery capabilities sufficient for certain military applications.[257] China has also secured space-related components or systems from Russia, France, the United Kingdom, and Germany.[258] The United States and China have cooperated on space issues during several limited windows over the past 20-plus years.* Recent discussions at U.S.-China summits and a high-level National Aeronautics and Space Administration delegation to China suggested new momentum.[259] However, Representative Frank Wolf (R–VA) testified to the Commission that recent legislation prohibits any further cooperation.†

A key Chinese foreign policy objective is to secure natural resources.‡ According to Dr. Pace, China's "[o]ffers of space technology to developing countries are used to secure access to needed raw materials for the Chinese economy."[260] Dr. Moltz testified that China's "space deals with Nigeria and Venezuela, for example, were motivated by Chinese interests in long-term energy security."[261] Ms. Krolikowski testified that:

> *China's approach to space exports also leverages its firms' and government's unique advantage at operating in developing-world markets. Chinese satellite manufacturers are in a position to offer generous terms to buyers in developing countries, for whom price can be a decisive factor. Offering concessional financing terms, providing development assistance (formally or informally) tied to satellite purchases, and even accepting payment for satellites in barter has made it possible for China to create buyers of satellites where none previously existed.*[262]

Finally, a Chinese diplomatic objective is "to portray itself as a 'purveyor' of space know-how and technology to lesser-developed states in Asia and elsewhere," according to Dr. Moltz.[263] To this end, China founded the Asia-Pacific Multilateral Cooperation in Space Technology and Applications in 1992. In 2008, China led a subset of that group to form the Asia-Pacific Space Cooperation Or-

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* For a brief history of U.S.-China space relations, see Carl E. Behrens, "Space Launch Vehicles: Government Activities, Commercial Competition, and Satellite Exports" (Washington, DC: Congressional Research Service, March 20, 2006 (updated)), pp. 10–14. *http://www.fas.org/sgp/crs/space/IB93062.pdf.*

† The relevant section states that: "None of the funds made available by this division may be used for the National Aeronautics and Space Administration or the Office of Science and Technology Policy to develop, design, plan, promulgate, implement, or execute a bilateral policy, program, order, or contract of any kind to participate, collaborate, or coordinate bilaterally in any way with China or any Chinese-owned company unless such activities are specifically authorized by a law enacted after the date of enactment of this division. (b) The limitation in subsection (a) shall also apply to any funds used to effectuate the hosting of official Chinese visitors at facilities belonging to or utilized by the National Aeronautics and Space Administration." United States Congress, H.R. 1473, Section 1340, 112th Cong., 1st sess.; and U.S.-China Economic and Security Review Commission, *Hearing on the Implications of China's Military and Civil Space Programs*, testimony of Frank Wolf, May 11, 2011.

‡ For examples of the role of natural resources in China's foreign policy, see U.S.-China Economic and Security Review Commission, *2010 Annual Report to Congress* (Washington, DC: U.S. Government Printing Office, 2010), pp. 128–30; and U.S.-China Economic and Security Review Commission, *2009 Annual Report to Congress* (Washington, DC: U.S. Government Printing Office, 2009), pp. 216–18.

ganization, modeled on the European Space Agency.* These groups allow China to facilitate its cooperation agenda.

Organization

China's civil space organization includes the PLA, two state-owned conglomerates, and the China National Space Agency.

People's Liberation Army: The PLA plays a central role in civil space activities such as exploration. Consequently, "China does not have a fully separate civil space program in the model of NASA [National Aeronautics and Space Administration] and U.S. civil space activities," according to Dr. Pace. Manned space is also an essentially military function. Ms. Krolikowski testified that "[i]n civil space, the [General Armaments Department] acts mainly in and through the Manned Space Engineering Office, the entity responsible for the human spaceflight program." She also testified that individual military services serve certain functions. For example, the PLA Air Force conducts astronaut training and medical activities.[264]

China National Space Agency: Created in 1993 under the State Council, the China National Space Agency was intended by Chinese planners to become a National Aeronautics and Space Administration equivalent.[265] However, the China National Space Agency never gained control of many research and development, production, and operations functions executed by the military and defense industry.[266] The agency now mainly facilitates and executes international agreements and other aspects of international cooperation.[267]

Space industrial base: China's space industrial base is composed of two primary state-owned conglomerates: the Chinese Aerospace Science and Technology Corporation and the China Aerospace Science and Industry Corporation. The two organizations took their present form in 1999 when Beijing reorganized the space sector to create greater competition, according to a Commission-sponsored report on China's defense industries.† [268]

- *China Aerospace Science and Technology Corporation*. The formation of this corporation brought together scores of research institutes and production complexes. China's National Medium- to Long-Term Plan for Development of Science and Technology (2005 to 2020) designated the corporation as one of 15 select, state-owned enterprises to receive special policy incentives and extra funds for research and development, accord-

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* Seven dues-paying members compose the Asia-Pacific Space Cooperation Organization: China, Bangladesh, Iran, Mongolia, Pakistan, Peru, and Thailand. According to Dr. Moltz, the group "engages in joint research and data-exchange efforts, as well as formal training courses for scientists and engineers from the Asian-Pacific region in space technology and remote sensing."

† Both China Aerospace Science and Technology Corporation and China Aerospace Science and Industry Corporation (described below) are currently subordinate to the umbrella organization, State Administration for Science, Technology, and Industry for National Defense, which, in turn, is subordinate to the "super"-Ministry of Industry and Information Technology. See U.S.-China Economic and Security Review Commission, *Hearing on the Implications of China's Military and Civil Space Programs*, written testimony of Clay Moltz, May 11, 2011. Additionally, like other major state-owned enterprises, both entities are administratively subordinate to the State-owned Assets Supervision and Administration Commission of the State Council.

ing to a Commission-sponsored report on China's science programs.[269] The industrial giant primarily focuses on powerful launch vehicles and large satellites.[270] It includes entities such as the China Great Wall Industry Corporation, the organization that markets launch services and satellite systems to international clients, and the China Satellite Communications Corporation, which operates telecommunications satellites.[271]

- *China Aerospace Science and Industry Corporation:* Although smaller than its counterpart, this corporation is composed of 180 enterprises and employs over 100,000 people. It specializes in "tactical ballistic missiles, anti-ship and land attack cruise missiles, air defense missile systems, direct ascent anti-satellite (ASAT) interceptors, small tactical satellites and associated tactical satellite launch vehicles," according to a report by the Project 2049 Institute. The China Aerospace Science and Industry Corporation appears to be the lead entity behind China's efforts to develop an antiship ballistic missile program, which seeks the ability to target moving vessels at sea.[272] (For more information on the antiship ballistic missile program, see the "Military Space Activities" subsection, below, as well as sec. 1 of this chapter.)

Most of these organizations operate within tightly controlled, vertically structured bureaucracies. Ad hoc steering groups, called "Leading Small Groups," composed of prominent individuals from the leadership of relevant Chinese Communist Party, Chinese government, and corporate organizations, provide guidance and make decisions.[273] Chinese officials generally do not disclose the existence of such groups or their membership. However, space-specific, leading small groups reportedly exist for "lunar projects, human spaceflight, Earth observation satellites, and heavy-lift launch vehicle development," according to Ms. Krolikowski.[274]

Notable Developments

China's civil space activities have progressed at a cautious but steady rate. China's leadership values manned missions and focuses on that area. According to Dr. Pace, "It is not a question of whether China will have a full range of human space flight capabilities, but a question of when and what they intend to do with those capabilities."[275] After successful manned missions in 2003, 2005, and 2008, the last of which included a space walk, China's space planners have identified a range of increasingly ambitious plans through the mid-2020s. China is currently developing a series of three small space laboratory modules that it plans to launch over the coming decade. The first of the series, "Tiangong-1," launched in September 2011.[276] These laboratories will conduct research for, among other things, a future permanent space station. Though modest in size and scope in comparison to the International Space Station, China's planned space station will require substantial capabilities to orbit. The station will be composed of three separate modules—slated to launch in 2020, 2021, and 2022—that will need to rendezvous in space.[277] Like other aspects of China's manned space activities, the space station will be run by the PLA.[278]

China's leadership also places a high priority on lunar missions, which it views as perhaps the most visible and prestigious space-related accomplishment. Chinese experts and foreign observers anticipate several breakthroughs in China's lunar exploration activities over the next decade. Chinese planners describe lunar exploration in terms of three discrete stages. Stage one, which lasted from 2002 to 2007, involved orbiting the moon. Stage two, which began in 2008 and is set to conclude in 2014, involves a moon landing and the use of a rover to collect data from the lunar surface. Stage three, scheduled to take place from 2015 to 2020, involves the collection of samples from the lunar surface and their return to Earth.[279] A manned lunar mission (perhaps as "stage 4") may also take place as soon as 2024.[280] Dr. Pace testified that although "China does not publicly have a formal program for sending humans to the moon," they are "making progress toward acquiring the capabilities necessary to conduct such missions."*

Limitations

China's civil space endeavors face various constraints, including substantial bureaucratic and organizational inefficiencies. Chinese planners have yet to complete major systemic reforms, the most recent round of which began in 2008 and sought to "inject greater civilian management and innovation" into China's space industries, according to Dr. Moltz.[281] However, according to China space expert Eric Hagt, China's space industries remain "dispersed, bloated, and located in geographically isolated regions."[282] This is consistent with other Chinese state-run industries that, according to Dr. Moltz, "continue to suffer from legacy inefficiencies of the socialist economy."[283] These characteristics limit the potential for China's space developments to benefit other Chinese industries.[284]

The Advantages of State Control

The numerous reorganizations of China's space sector indicate persistent dissatisfaction with industrial performance. However, state control provides China's space industrial base with certain advantages. For example, the entire sector "has been insulated from many of the pressures affecting the rest of the economy, mainly by its status as a strategic sector and its largely non-market internal relationships," according to Ms. Krolikowski. Benefits of this special status include "direct public investment in research and development; fiscal, tax, and financial policies to support major national [science and technology] projects and indigenous innovation; measures to improve market access; concessional pricing systems for land and utilities; and government oversight of mergers and acquisitions." Finally, benefits extend to predictable procurement trends, which allow China's space industrial base to forecast staffing, investment, and research and development needs. Ms. Krolikowski testified that:

*For example, China's spacesuit "has boots with heels—and other features for walking on a surface as well as floating outside a spacecraft." See U.S.-China Economic and Security Review Commission, *Hearing on the Implications of China's Military and Civil Space Programs*, written testimony of Scott Pace, May 11, 2011.

The Advantages of State Control—*Continued*

[China's] space industry enjoys stable, predictable demand for its products from government customers and a stable space policy environment. CASC [China Aerospace Science and Technology Corporation] and CASIC's [China Aerospace Science and Industry Corporation] near- and long-term demand expectations are based on the Five-Year Plans and even longer-term national strategies. These companies do not contend with abrupt program changes and fluctuating budgets in the way firms in other countries do.[285]

With respect to commercial activities, China faces potential obstacles for satellite sales and launch services. Notwithstanding China's efforts to replace a satellite it built for Nigeria, which failed in November 2008, the incident may cause reluctance on the part of future partners. Ms. Krolikowski testified that despite a "string of recent deals, expectations for Chinese satellite exports, especially beyond developing markets, remain modest. China's satellite-manufacturing industry is not yet internationally competitive."[286] China has also experienced setbacks in its launch services. While China's launch tempo increased substantially starting in 2010, failed Chang Zheng launches in August 2009 and August 2011 tarnished somewhat the impressive success rate that vehicle had achieved since the mid-1990s. Future deals based on these systems may be subject to higher insurance rates, which could marginalize the cost benefits of using Chinese systems.* Higher costs, when combined with persistent delays in China's follow-on launch vehicle, may drive potential customers to look elsewhere for launch services, such as to Russia, Europe, or perhaps the United States.†

China's relative isolation from other major spacefaring nations serves as a further strategic limitation. Export controls, such as International Traffic in Arms Regulations, complicate China's participation in international space markets.‡ This includes foreign technology acquisition as well as China's ability to provide launch services for systems that contain controlled technologies. However, several International Traffic in Arms Regulations-free initiatives are underway or under discussion.§ Another factor that isolates

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* Roger Cliff, Chad J.R. Ohlandt, and David Yang, "Ready for Takeoff: China's Advancing Aerospace Industry," (contracted research paper for the U.S.-China Economic and Security Review Commission, 2011), p. 112. *http://www.uscc.gov/researchpapers/2011/RAND_Aerospace_Report%5B1%5D.pdf*. However, representatives of China Great Wall Industry Corporation told the Commission during the Commission's 2011 trip to China that the firm's insurance rates are comparable to those of international competitors.

† Representatives of China Great Wall Industry Corporation also told the Commission that potential international competitors for launch services include firms such as Proton, Arianne, and SpaceX.

‡ The International Traffic in Arms Regulations, administered through the U.S. Department of State, control the permanent and temporary export (and temporary import) of certain defense articles and services. See U.S. Department of State, "The International Traffic in Arms Regulations (ITAR)," (Washington, DC: updated January 21, 2009). *http://www.pmddtc.state.gov/regulations_laws/itar.html*.

§ For different assessments about the state of (and prospects for) the "ITAR [International Traffic in Arms Regulations]-free" industry, see U.S.-China Economic and Security Review Commission, *Hearing on the Implications of China's Military and Civil Space Programs*, written testimony of Clay Moltz, May 11, 2011; and U.S.-China Economic and Security Review Commission, *Hearing on the Implications of China's Military and Civil Space Programs*, written testimony of Alanna Krolikowski, May 11, 2011.

China, according to Dr. Moltz, is the nation's lack of close allies and partners in space endeavors. He testified that "[w]hile [China] cooperates with Russia, the two sides do not share strategic interests, and the bulk of China's cooperative agreements involve developing countries."[287] As a result, China could not necessarily rely on any other country to provide support in the event of a crisis.[288]

Military Space Activities

This subsection describes China's military space activities. It discusses China's strategic approach to military space operations and the Chinese military's organizational features as they relate to space operations. It also describes China's recent developments and initiatives. Finally, it highlights some current limitations on China's military space programs.

Strategy

Several obstacles prevent outsiders from truly understanding China's military space activities. According to testimony by Bruce MacDonald, senior director of the Nonproliferation and Arms Control Program at the U.S. Institute of Peace, "[a] fundamental problem we face is that China says little at an official level about its military space policy and doctrine."[289] It is clear, however, that China's leadership recognizes the growing importance of space, as well as the domain's military utility. For example, President Hu Jintao in late 2004 issued a new set of missions to the PLA, which included the requirement to protect China's expanding national interests in space.[290] Official operational information is similarly rare. According to testimony to the Commission by Dean Cheng, research fellow at The Heritage Foundation, the lack of available information is so complete that "there is still no indication of whether the PLA has developed a formal space doctrine governing military operations in space.[291]

Authoritative Chinese military publications, however, provide some insight into China's strategic thinking. The book *Military Astronautics*, by Chang Xianqi, a major general in the PLA, serves as a key example. The text explains two critical, space-related "guiding ideas."* First, China should seek "space supremacy," defined as "the power to control a certain area of space for a certain period of time."† In this context, the PLA would use communications, reconnaissance, and related activities for the purposes of enhancing its ability to conduct operations. Simultaneously, China would conduct offensive and defensive space operations to attack and defend space-based and terrestrial military targets. The text subsequently describes space supremacy as a "precondition to seizing air suprem-

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* Chang Xianqi, *Military Astronautics*, 2nd ed. (Beijing, China: National Defense Industries Press, 2005) OSC ID: CPP20091231572001. The source describes these guiding ideas as "anticipatory in nature." However, China's counterspace programs increasingly provide tools to implement such concepts. For a fuller description of these ideas and their implications, see U.S.-China Economic and Security Review Commission, *Hearing on the Implications of China's Military and Civil Space Programs*, written testimony of Dean Cheng, May 11, 2011.

† The source alternatively uses the term "space control." Major General Chang characterizes space supremacy as relative, asserting that "the side which has space supremacy usually can only expect that the other side's interference will not undermine its operational plan, but cannot expect that the other side will be completely unable to respond." Chang Xianqi, *Military Astronautics*, 2nd ed. (Beijing, China: National Defense Industries Press, 2005). OSC ID: CPP20091231572001.

acy, sea supremacy, and ground supremacy, and a key to seizing and maintaining the initiative on the battlefield, thus directly affecting the process and outcome of the war."[292]

Second, China's military should seek to integrate all available means into military space operations, according to *Military Astronautics*. This idea manifests in numerous ways. For example, with respect to actors, China "should break the boundaries between the military and the civilian, and implement unified planning, unified commanding, and unified coordinating of the military, civil, and commercial space powers." In addition, it means China should strive to conduct simultaneous and mutually reinforcing offensive and defensive actions.*

These guiding ideas are supplemented by several "basic principles" for space operations. Notably, these principles advocate that China take the initiative in offensive space operations; attack key points in vulnerable systems; and use stealthy, abrupt actions, among other things. According to analysis by Mr. Cheng, these concepts and principles "suggest that, in the event of a Sino-American confrontation, the PLA would seek to engage American space systems early in the crisis."[293] Conceptually, these strategies align with China's larger military imperatives for area control. (For more information, see chap. 2, sec. 1: "China's Area Control Strategy.")

Organization

The PLA dominates China's space activities. According to Mark Stokes, executive director of the Project 2049 Institute, "[w]ithin a broad and fragmented [Chinese Communist Party] and government policy framework, the PLA plays a central role in coordinating, defining, and managing national space requirements."[294] On an operational level, "[c]ritical space infrastructure, including existing launch facilities, and the day-to-day management of civil space operations, especially in the human spaceflight program, are the responsibility of PLA organs," according to Ms. Krolikowski.[295] Select PLA administrative ("headquarters-level") entities and service-level entities play a role in China's space programs.

Headquarters-level entities: The PLA headquarters organization consists of four components: the General Staff Department, the General Political Department, the General Logistics Department, and the General Armaments Department. Specifically, the General Staff Department and the General Armaments Department have space interests. According to Mr. Stokes, "[f]unctional offices within the [General Staff Department] shape operational requirements for militarily relevant space-based sensors, aerospace surveillance systems, and communications satellites."[296] In addition, "[t]he PLA's [General Armaments Department] oversees the development and acquisition of technical solutions to satisfy [General Staff Department] operational requirements, and manages launch, tracking, and control of civilian and military satellites and other orbital systems."[297] Ms. Krolikowski testified that "[w]ithin the PLA, the

*Note that in Chinese usage, the terms "offensive" and "defensive" describe mission types rather than specific means. For example, both types of missions might leverage reconnaissance assets or antisatellite weapons. This differs from typical western usage, which considers most counterspace weapons to be offensive tools.

[General Armaments Department] plays the most important role in space activities."[298]

Service-level entities: The PLA Air Force, the Second Artillery,* and the PLA Navy are primary customers of space-based systems.[299] Although they do not currently control China's space assets, the PLA Air Force and Second Artillery in particular appear to seek some degree of operational control over military space activities. Roger Cliff, senior political scientist at the RAND Corporation, testified in 2010 that while "[t]he ultimate outcome of this bureaucratic contest is difficult to predict," any change could alter the balance of space-related responsibilities within the PLA.[300]

Congressional Remarks on China's Space Programs

In testimony to the Commission, Representative Frank Wolf (R–VA) discussed the importance of space and the character of China's space programs. He stated that:

> *Space is the ultimate 'high ground' that has provided the U.S. with countless security and economic advantages. . . . It should not be surprising that many countries have taken notice of the tremendous benefits that the American space program has yielded. It is clear that we are now entering an era of much greater civil, defense and commercial competition in space. Most countries expanding their space programs are strong U.S. allies that are primarily interested in advancing science research or building a commercial space industry. The Chinese [space programs], however, do not fall into this category.*
>
> *What concerns me most about the Chinese space program is that . . . it is being led by the People's Liberation Army (PLA). There is no reason to believe that the PLA's space program will be any more benign than the PLA's recent military posture.*[301]

Notable Developments

China's military space-related activities appear focused on two areas: using space assets and other advanced sensors for guided weapons applications ("reconnaissance-strike complexes") and using various means to disrupt, degrade, deny, and destroy adversary space assets ("counterspace" weapons). In each area, China's military has demonstrated substantial improvements in the past several years.

Reconnaissance-strike complexes. China is developing combinations of advanced sensors and guided weapons to form systems commonly referred to as "reconnaissance-strike complexes."† Spe-

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*Also known as the "Strategic Rocket Forces," the Second Artillery is a service-level entity under the direct control of China's Central Military Commission.

†U.S.-China Economic and Security Review Commission, *Hearing on the Implications of China's Military and Civil Space Programs*, written testimony of Barry D. Watts, May 11, 2011. For a more thorough explanation, see Barry D. Watts, "Six Decades of Guided Munitions and Battle Networks: Progress And Prospects" (Washington, DC: Center for Strategic and Budgetary

Continued

cifically, China's military is working to "fuse data from an extensive and diverse sensor network," according to testimony by Wayne A. Ulman, China issue manager at the U.S. Air Force National Air and Space Intelligence Center.[302] This sensor network appears to include layers of systems: over-the-horizon radars, unmanned aerial vehicles, and remote-sensing satellites.* Chinese analyses envision that satellites will play an important role in this architecture, as they would cue, or direct, other sensors in the network. Data from each layer, particularly once integrated, could be used to provide targeting data to guided weapons.[303]

Although the United States has the world's only combat-proven global precision strike capability, China is "the country that appears to be making the greatest strides toward fielding regional [reconnaissance-strike complexes]," according to Barry D. Watts, senior fellow at the Center for Strategic and Budgetary Assessments. Space plays a key role in this effort. For example, Mr. Watts testified that "to provide accurate, real-time target information for the . . . antiship ballistic missile (ASBM), the Chinese [military has] been considering the integration of data from a variety of space-based sensors, including electro-optical (EO), synthetic-aperture radar (SAR), electronic reconnaissance, and ocean surveillance satellites" (see table 2, below).[304] China seeks to use data inputs from these systems, combined with data from other platforms within its sensor architecture, to correct antiship ballistic missiles' course after launch in order to target moving ships at sea. This system appears to be operational.†

Table 2: Select Chinese Satellites with Potential Capabilities for Reconnaissance-strike Integration

Satellite function	Explanation	Potential examples *(quantity) type*
Electro-optical	Collects imagery. Different platforms have different capabilities, but the Yaogan type may have a resolution of up to 0.8 meters.	(5) Yaogan (1) Shijian (1) CBERS [1]
Synthetic-aperture radar	Uses a microwave transmission to image objects. Effective on land or maritime targets day or night and in all-weather conditions. Can image ship wakes to determine speed and heading.	(4) Yaogan
Electronic reconnaissance	Potentially collects electromagnetic, acoustic, infrared, and/or radar signatures. Can be used to identify ships on that basis.	(6) Shijian [2] (1) Yaogan

Assessments, March 2007). *http://www.csbaonline.org/wp-content/uploads/2011/06/2007.03.01-Six-Decades-Of-Guided-Weapons.pdf*.

* Unmanned aerial vehicles would include "conventional" platforms, perhaps on the model of the U.S. Global Hawk, as well as a separate class of promising high-altitude, long-endurance airships optimized for reconnaissance functions. See Mark Stokes, untitled draft research paper (prepared by the Project 2049 Institute for the U.S.-China Economic and Security Review Commission, forthcoming.)

† For more on China's antiship ballistic missile, see section 1 of this chapter.

Table 2: Select Chinese Satellites with Potential Capabilities for Reconnaissance-strike Integration—*Continued*

Satellite function	Explanation	Potential examples *(quantity) type*
Ocean reconnaissance	Also detects electronic emissions. Utilizes a combination of infrared sensors and collection antennas. The use of three satellites could locate an emitter based on triangulation.	(1) Yaogan (includes two subsatellites)

Note: This table is an attempt to assemble, collate, and analyze the limited available information on these platforms. Satellite types recur when different series within a given type are thought to host different sensors. Some of these satellites may host multiple types of sensors.

[1] This satellite is nominally under civilian control, but one electro-optical sensor has a high enough resolution to be militarily useful.

[2] Some of these satellites may have signals intelligence functions.

Sources: Roger Cliff, Chad J.R. Ohlandt, and David Yang, "Ready for Takeoff: China's Advancing Aerospace Industry," (contracted research paper for the U.S.-China Economic and Security Review Commission, 2011). *http://www.uscc.gov/researchpapers/2011/RAND_Aerospace_Report%5B1%5D.pdf*; Mark Stokes, untitled draft research paper (prepared by the Project 2049 Institute for the U.S.-China Economic and Security Review Commission, forthcoming.)

Counterspace activities. China seeks the capabilities to attack an adversary's space systems in the event of conflict. In written testimony to the Commission, United States Air Force Lieutenant General (Retired) David A. Deptula described the rationale for this trend:

> *China's leaders probably view [antisatellite weapons] and offensive counterspace systems as force multipliers. As one Chinese defense analyst noted: 'For countries that can never win a war with the United States by using the method of tanks and planes, attacking the US space system may be an irresistible and most tempting choice.'*[305]

To this end, the Chinese military has initiated numerous counterspace systems. On the basis of several tests over the past decade, some of the programs appear to be currently operational (see text box, below).

China's Antisatellite Capability Demonstrations

September 2005: Media reports indicate that China has conducted satellite jamming tests.[306]

August–September 2006: China used a laser to temporarily blind (or "dazzle") U.S. reconnaissance satellites, according to media reports.* More recently, China dazzled French satellites, according to a European Space Agency official.[307]

* For the original source, see Muradian Vago, "China Attempted To Blind U.S. Satellites With Laser," *Defense News*, September 28, 2006. For an alternative interpretation, see Union of Concerned Scientists, "Satellite Laser Ranging in China" (Cambridge, MA: UCS Working Paper, January 8, 2007). *http://www.ucsusa.org/nuclear_weapons_and_global_security/space_weapons/technical_issues/chinese-lasers-and-us.html*. Note that even satellite laser ranging activities have counterspace applications.

China's Antisatellite Capability Demonstrations—*Continued*

January 2007: China conducted a direct-ascent antisatellite demonstration that used a ballistic missile to destroy an obsolete Chinese weather satellite, creating thousands of pieces of space debris. In April 2011, a piece of this debris came so close to the International Space Station that its occupants, concerned about the possibility of a collision, needed to take shelter in an escape capsule.[308]

January 2010: China conducted a kinetic energy (also called "hit-to-kill") ballistic missile intercept. More difficult to execute than an antisatellite attack, this technology has clear antisatellite applications and "strategic implications for U.S. security interests," according to Mr. MacDonald.[309]

June–August 2010: Two Chinese satellites conducted a series of orbital rendezvous maneuvers that appear to have included "'bumping' into each other," according to Mr. Cheng.[310] In describing this incident, General Deptula testified that "China could conceivably want to experiment with close space maneuvers, given its plans to build a space station. . . . However, the lack of official Chinese information about the maneuvers has allowed room for speculation" that China actually demonstrated a coorbital antisatellite capability.* [311]

None of these incidents involved prior notification or announcement,[312] and several have not been acknowledged officially.

Chinese military theorists take a holistic view of counterspace operations. They advocate for the use of both "soft" kill (i.e., informational, temporary, or reversible) attacks and "hard" kill (i.e., destructive or permanently disabling) attacks against every aspect of space power: ground-based systems, space-based systems, and communications links.[313]

Ground-based systems: According to *Military Astronautics*, "[d]estroying the enemy on the ground is the most effective way of seizing space supremacy." This can be accomplished in several ways. "Hard" kill attacks could include air raids, missile attacks, or sabotage by special operations forces.[314] "Soft" kill attacks could include computer network exploitations or attacks directed against key ground facilities that interact with space-based assets (see text box, below).[315] The text identifies several key aspects to target, such as launch systems and command and control facilities.[316]

Space-based systems: Military Astronautics identifies two key methods to attack satellites: kinetic attacks and directed energy attacks. Kinetic attacks could include direct ascent antisatellite

* However, it bears mentioning that western space firms are developing their own rendezvous capabilities in order to service satellites in orbit. Barry Watts testified that "these capabilities could also be used to neutralize satellites, thereby opening the door to the de facto weaponization of space." U.S.-China Economic and Security Review Commission, *Hearing on the Implications of China's Military and Civil Space Programs*, written testimony of Barry Watts, May 11, 2011.

weapons or coorbital satellite weapons. Such "hard" kill attacks, while effective, are immediately evident, easy to attribute, and create harmful debris. Therefore, the text identifies a preference for directed energy attacks, including various laser, microwave, particle beam, and low-power electromagnetic pulse weapons.[317] These attacks could take the form of either "hard" or "soft" kill, depending on the attack method and target. Key targets include power sources (e.g., batteries and solar panels), communications systems (e.g., transmission antennae), and sensors.[318]

Communications links: Critical information passes between ground- and space-based systems through electronic links, which are subject to electronic manipulation. This could take the form of either jamming or deception. Jamming includes different types of electronic interference or signals that flood communications channels, whereas deception involves the interception or forgery of transmissions to or from adversary space systems. Most of these attacks would fall into the "soft" kill category. However, deception allows the possibility for "hard" kills through self-destruction commands or measures designed to cause terminal loss of control.[319] Key targets for communications link attacks are the satellite uplink (which transmits information from ground stations to the satellite) and, more importantly from the Chinese perspective, the satellite downlink (which transmits information from the satellite to the ground station).[320]

Malicious Cyber Activities Directed Against U.S. Satellites

Malicious actors can use cyber activities to compromise, disrupt, deny, degrade, deceive, or destroy space systems. Exploitations or attacks could target ground-based infrastructure, space-based systems, or the communications links between the two.* As noted above, authoritative Chinese military writings advocate for such activities, particularly as they relate to ground-based space infrastructure, such as satellite control facilities.

Satellites from several U.S. government space programs utilize commercially operated satellite ground stations outside the United States, some of which rely on the public Internet for "data access and file transfers," according to a 2008 National Aeronautics and Space Administration quarterly report.† The use of the Internet to perform certain communications functions presents potential opportunities for malicious actors to gain access to restricted networks.

*For an informed description of several potential vulnerabilities in space-related networks, see Stephen Farrell and Vinny Cahill, "Security Considerations in Space and Delay Tolerant Networks" (paper presented to the 2nd IEEE [Institute of Integrated Electrical Engineers) International Conference on Space Mission Challenges for Information Technology, 2006, esp. sec. 5).

†Sunny Tsiao, "The Enduring Legacy of the 'Invisible Network'" (Washington, DC: NASA History Division, *News and Notes*, August 2008), p. 4. *http://history.nasa.gov/nltr25–3.pdf*.

Malicious Cyber Activities Directed Against U.S. Satellites—*Continued*

Notably, at least two U.S. government satellites have each experienced at least two separate instances of interference apparently consistent with cyber activities against their command and control systems: *

- On October 20, 2007, Landsat-7, a U.S. earth observation satellite jointly managed by the National Aeronautics and Space Administration and the U.S. Geological Survey, experienced 12 or more minutes of interference. This interference was only discovered following a similar event in July 2008 (see below).†
- On June 20, 2008, Terra EOS [earth observation system] AM–1, a National Aeronautics and Space Administration-managed program for earth observation, experienced two or more minutes of interference.‡ The responsible party achieved all steps required to command the satellite but did not issue commands.
- On July 23, 2008, Landsat-7 experienced 12 or more minutes of interference. The responsible party did not achieve all steps required to command the satellite.
- On October 22, 2008, Terra EOS AM–1 experienced nine or more minutes of interference. The responsible party achieved all steps required to command the satellite but did not issue commands.

The National Aeronautics and Space Administration confirmed two suspicious events related to the Terra EOS satellite in 2008 and the U.S. Geological Survey confirmed two anomalous events related to the Landsat-7 satellite in 2007 and 2008.§

If executed successfully, such interference has the potential to pose numerous threats, particularly if achieved against satellites with more sensitive functions. For example, access to a satellite's controls could allow an attacker to damage or destroy the satellite. The attacker could also deny or degrade as well as forge or otherwise manipulate the satellite's transmission. A high level of access could reveal the satellite's capabilities or information, such as imagery, gained through its sensors. Opportunities may also exist to reconnoiter or compromise other terrestrial or space-based networks used by the satellite.

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* Unless otherwise noted, the following information is derived from a briefing the U.S. Air Force provided to the Commission on May 12, 2011.

† For information on the Landsat program, see James R. Irons, "The Landsat Program" (Washington, DC: National Aeronautics and Space Administration, updated September 20, 2011). *http://landsat.gsfc.nasa.gov/*.

‡ For information on the Terra program, see Marc Imhoff, "Terra" (Washington, DC: National Aeronautics and Space Administration, updated September 23, 2011). *http://terra.nasa.gov/*.

§ Name withheld (staff member, National Aeronautics and Space Administration), email interview with Commission staff, November 8, 2011; and Name withheld (staff member, U.S. Geological Survey), email interview with Commission staff, November 8, 2011.

Malicious Cyber Activities Directed Against U.S. Satellites—*Continued*

These events are described here not on the basis of specific attribution information but rather because the techniques appear consistent with authoritative Chinese military writings. For example, according to *Military Astronautics*, attacks on space systems "generate tremors in the structure of space power of the enemy, cause it to suffer from chain effects, and finally lose, or partly lose, its combat effectiveness." One tactic is "implanting computer virus and logic bombs into the enemy's space information network so as to paralyze the enemy's space information system."[321]

Limitations

Despite pockets of considerable capabilities, China has weak or moderate military space capabilities in other areas. China has few communications satellites available for military purposes, even assuming that the PLA would appropriate Chinese government-controlled assets during a crisis. Many PLA military platforms have modest bandwidth requirements, which, when combined with the PLA's heavy reliance on buried fiber-optic military communications networks, may offset this disadvantage in the context of a potential, near-term U.S.-China contingency on China's periphery. However, naval forces at sea and ground forces operating outside the Chinese mainland (even as close as Taiwan) would still require secure, mobile communications for military functions such as command and control.[322] New communications satellites or some functional equivalent, like unmanned aerial vehicles, could potentially fill this gap in coming years, depending on PLA investment priorities.

China has limited capabilities in other areas. It operates few weather satellites, which could pose a problem for Chinese military operations, particularly in the absence of information from other nations. China still lacks comprehensive satellite navigation capabilities, even within its own region, though the Beidou system is poised to close this gap over the next several years. China's optical imagery satellites, while sufficient for many military applications, still offer lower resolution imagery than is available in commercial markets. Finally, several satellite and launch failures over the past few years have led to various program delays.[323]

Implications for the United States

The U.S. Department of Defense's current approach to space, according to testimony by Gregory L. Schulte, deputy assistant secretary of Defense for space policy, "is designed to confront the 'three C's'—a space environment that is increasingly congested, contested, and competitive. China has contributed to all three."[324]

Congested

Space, particularly low Earth orbit, is beset with natural and manmade objects. Quantities of manmade objects, including debris,

have increased dramatically over the past five years, beginning with China's 2007 antisatellite test. According to Ambassador Schulte, that test produced 14 percent of the approximately 22,000 manmade objects in orbit tracked by the U.S. Strategic Command, the entity responsible for U.S. space situational awareness. Strategic Command issues "conjunction warnings," or notices about potential collisions between these objects, to numerous commercial entities and foreign governments. Of the 1,983 conjunction warnings issued in 2010, approximately 700 related to potential collisions with debris from China's 2007 antisatellite test.[325] Even absent further kinetic antisatellite tests, China's increased space activities will continue to add to the congested nature of space. Launches leave behind rocket bodies, and satellites have finite life spans. These items can clutter useful orbits long after their operational lives.

Contested

Space is a domain of warfare in its own right and bolsters operational capacity in all other domains of warfare: land, air, sea, and cyberspace. In this context, China's advancements in military space functions present two primary implications for the United States. First, China increasingly leverages space assets for the purposes of force enhancement. As Mr. Cheng testified, "With each passing year, China's satellite constellations will provide better information to military users."[326] This information will benefit most aspects of China's military capabilities but will enhance in particular China's communications as well as intelligence, surveillance, and reconnaissance activities. As a corollary, China's reconnaissance-strike complexes, already advanced in some areas, appear poised to improve. This will lead not only to greater accuracy and reliability but also to the ability to attack a geographically extended range of targets. According to Mr. Stokes, "In a future contingency requiring U.S. intervention, space-enabled long-range precision strike assets could seek to suppress U.S. operations from forward bases in Japan, from U.S. aircraft battle groups operating in the Western Pacific, and perhaps over the next five to 10 years from U.S. bases on Guam."[327]

Second, China's counterspace programs seek the capability to compromise, disrupt, deny, degrade, deceive, or destroy U.S. space assets. These efforts could prevent the U.S. military's use of space for functions such as communications; intelligence, surveillance, and reconnaissance; and guided weapons applications. Notwithstanding China's increasing reliance on space for military and civil purposes, Chinese military planners still view space assets as an attractive target. Ambassador Schulte testified that with "geography the way it is, we are probably always going to find ourselves more reliant on space than [China] . . . so for the foreseeable future, that's an asymmetry they're going to look to exploit as they pursue an antiaccess/area denial approach."[328] According to General Deptula, "Continued Chinese investment in the design, development, deployment and employment of space and counterspace systems will increasingly challenge our traditional space dominance and could dramatically reduce our freedom of action in the event of a conflict in the region."[329]

Competitive

According to Ambassador Schulte, "China's nascent commercial space ambitions and increasing outreach to emerging spacefaring nations is a part of the more competitive nature of space."[330] Additionally, China has several substantial goals for the mid-2020s. Some characterize as too modest U.S. plans over the same period. For example, Dr. Pace testified that:

> *The United States appears to have forgotten the strategic value of a national human space flight program regardless of the existence of successful private endeavors. This may not have a near-term economic impact on the United States, as a robust range of unmanned programs will continue. However, the lack of visible U.S. leadership in human space flight may have serious foreign policy and international security impacts. It is a long-standing truism that the rules of international relations in new domains are created by those who show up and not by those who stay home.*[331]

Additionally, as noted above, China's initiatives for the political, economic, science and technology-related, and diplomatic aspects of space yield a comprehensive view of the space domain and its prospects. For this reason, Dr. Moltz testified that:

> *[V]iewing China's space program solely from the perspective of its military activities is misleading. While China is active in the military sector and is seeking to check current U.S. advantages in the area, China's challenge to the United States in space may eventually be equally significant in the civil space sector, where China's expanding infrastructure, growing cadre of space scientists and engineers, and active international outreach puts it in a favorable position for long-term competition.*[332]

Conclusions

- China is one of the top space powers in the world today. The nation's capabilities, which are state of the art in some areas, follow from decades of substantial investment and high prioritization by China's top leaders. The prestige of space exploration and the national security benefits of space systems serve as primary motivators for Chinese decisionmakers.
- China views all space activities in the context of "comprehensive national power." This concept includes many dimensions, but military aspects are fundamental. The PLA's primacy in all of China's space programs, including nominally civil activities, illustrates this emphasis.
- China's civil space programs have made impressive achievements over the past several decades. If Chinese projections hold, these programs are poised for continued accomplishments over the next ten to 15 years, such as the development of a space laboratory and eventually a space station. As part of an active lunar exploration program, China may attempt to land a man on the moon by the mid-2020s.

- China seeks new opportunities to sell satellites as well as satellite and launch services in international commercial space markets. Chinese firms' prospects for greater success in this field remain uncertain over the near term. However, China's international space-related diplomatic initiatives and their firms' ability to offer flexible terms on sales to developing countries may provide additional opportunities.
- In the military sphere, China appears to seek "space supremacy." The PLA aims to implement this policy through two tracks. First, they increasingly utilize space for the purposes of force enhancement. The best example is China's integration of space-based sensors and guided weapons. Second, they seek the capabilities to deny an adversary the use of space in the event of a conflict. To this end, China has numerous, active, counterspace weapons programs with demonstrated capabilities. China's military space and counterspace activities are part of a larger strategy for area control.