CHAPTER 2

SECURITY AND FOREIGN POLICY ISSUES INVOLVING CHINA

SECTION 1: YEAR IN REVIEW: SECURITY AND FOREIGN AFFAIRS

Introduction

The Commission's previous annual reports to Congress documented that Chinese national security and foreign policy have become more centralized and focused under President and Chinese Communist Party (CCP) General Secretary Xi Jinping, who took power in 2012.[1] This trend continued in 2015, as the Xi Administration took further steps to articulate and pursue China's priorities and objectives in both the security and foreign policy realms. President Xi continues to position himself at the apex of the security and foreign policy decision-making apparatus in Beijing, and appears to be successfully advancing a foreign policy and security agenda that reinforces CCP rule and seeks to enable China to achieve great power status.[2]

Meanwhile, China's military modernization continues apace, with impressive new systems and capabilities coming online that augment China's ability to defend its stated interests and field a globally active, world-class military. In some cases, China is deploying the People's Liberation Army (PLA) in ways that contribute to regional peace and security, such as antipiracy operations in the Gulf of Aden, noncombatant evacuation operations, and humanitarian assistance and disaster relief operations. At the same time, however, the PLA is deploying weapons and honing capabilities that will allow it to hold at risk U.S. and allied forces in the Western Pacific. Also of concern are China's aggressive actions in the South and East China seas and its relentless use of cyber espionage to seek economic and military advantage over the United States.

This section—based on Commission hearings, discussions with outside experts and U.S. government officials, and open source research and analysis—reflects on these trends and examines major developments in China's national security and foreign policy, military modernization, global security activities, and U.S.-China security relations, since the publication of the Commission's 2014 Annual Report.

Major Developments in China's National Security and Foreign Policy in 2015

"One Belt, One Road" and the Continued Emphasis on Peripheral Diplomacy

Collectively referred to as the "One Belt, One Road" initiative, the "Silk Road Economic Belt" and "21st Century Maritime Silk Road" have become key components of the Xi Administration's foreign policy agenda.[3] Focused respectively on Eurasia and maritime Asia, the Silk Road Economic Belt and 21st Century Maritime Silk Road encompass approximately 60 countries and seek to enhance regional connectivity and economic, cultural, and diplomatic exchange. The initiatives, for which Beijing has already promised enormous political and financial resources, are designed to advance China's objectives to facilitate trade and boost exports, provide opportunities for Chinese companies, facilitate access to natural resources, and relieve overcapacity in China's construction-oriented sectors. They also appear designed to enhance China's influence among its neighbors and project an image of China as a powerful and responsible regional, even global, power.[4]

The One Belt, One Road initiative is emblematic of the Xi Administration's focus on "peripheral diplomacy," which was highlighted at two major CCP meetings on foreign affairs held in 2013 and 2014.[5] According to Michael D. Swaine, senior associate at the Carnegie Endowment for International Peace's Asia Program,

> *[Peripheral diplomacy initiatives] imply a higher level of Chinese pro-activism in foreign and defense policy and a broader definition of [China's] national interests toward its periphery than has characterized Beijing's approach during most of the reform era. In particular, they suggest at the very least a decreased emphasis on Deng Xiaoping's long-standing exhortation for China to remain modest and maintain a low profile in its external relations. They also raise many questions and potential problems for China's external relations going forward. This includes, most importantly, how Beijing will reconcile the potentially contradictory policy imperatives of deepening positive relations with neighboring countries while more resolutely advancing or protecting China's territorial and resource interests and claims.*[6]

(For a detailed discussion of how the One Belt, One Road initiative and China's renewed focus on peripheral diplomacy inform China's relations with its neighbors, see Chapter 3, Section 1, "China and Central Asia," and Chapter 3, Section 2, "China and Southeast Asia.")

New and Proposed Laws on National Security

China under the Xi Administration is advancing legal infrastructure to more tightly control its national security policies and processes. This includes a National Security Law (enacted in July 2015) that broadly expands the CCP's control over "security" in a wide range of fields including culture, education, cyberspace, and international seabeds;[7] a draft cybersecurity law (introduced in July

2015) that provides the Chinese government broad powers to control and restrict online information and activity;[8] and a draft counterterrorism law (introduced in November 2014 and again in February 2015) that provides the state sweeping authority to investigate, deter, and punish terrorists.[9] All three laws contain provisions that would broaden and deepen the authority and power of the government, expand the reach of China's security state, and further limit the freedom of citizens already living under political repression. Moreover, due to provisions in each law to control the flow of information on the Internet, they could have negative implications for U.S. and other foreign information and communications technology companies operating in China.[10] (See Chapter 1, Section 4, "Commercial Cyber Espionage and Barriers to Digital Trade in China," for more details on how these laws can impact U.S. companies.)

These developments are just the latest in a series of steps President Xi has taken to streamline and centralize China's security policymaking apparatus, and to solidify his personal role at the helm of that apparatus. According to Cheng Li, director of the John L. Thornton China Center at the Brookings Institution and prominent scholar of elite Chinese politics, "The continuing consolidation of power has been the most noticeable trend under the leadership of Xi Jinping" since 2012.[11] For example, in late 2013, China established the Central National Security Commission, led by President Xi, "to perfect national security systems and strategies in order to ensure national security."[12] Though little is known about the workings of the Central National Security Commission, it appears to have a broad mandate encompassing both domestic and foreign national security matters as well as issues such as "economic security," "ecological security," and "societal security," among others.[13]

White Paper on "China's Military Strategy"

In May 2015, China published the latest iteration of its biennial defense white paper.*[14] The new defense white paper tracks closely with the previous defense white paper, released in 2013, and contains no major revelations about China's military strategy or modernization; however, it does provide insight into Chinese leaders' perceptions of the country's evolving security and defense priorities by including some new guidance and emphasizing or clarifying certain aspects of existing strategy.[15] Highlights of the 2015 defense white paper include the following:

- The new defense white paper decisively elevates the maritime domain in China's strategic thinking as China assesses that its most likely conflict scenarios will be at sea, asserting that "the traditional mentality that land outweighs sea must be abandoned."[16] The defense white paper emphasizes that the PLA Navy needs to transition from a primarily coastal force to one capable of global operations.

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* Defense white papers—China's most authoritative statements on national security—are published by the State Council Information Office and approved by the Central Military Commission, Ministry of National Defense, and State Council. Beijing primarily uses these documents as a public relations tool to help ease deepening international concern over China's military modernization and to answer calls for greater transparency.

- In contrast to past defense white papers, which have emphasized offshore defense as the primary focus of the PLA Navy, the new defense white paper notes “the PLA Navy will gradually shift its focus from ‘offshore waters defense’ to the combination of ‘offshore waters defense’ with ‘open seas protection.’ ”[17] The PLA Navy’s recent acquisitions, training, and operations—including longer-endurance patrols by PLA Navy surface ships and submarines—reflect this priority shift. (For more information on China’s overseas military activities, see “China’s Global Security Activities in 2015,” later in this section.)
- With respect to maritime territorial disputes, the defense white paper says China will “strike a balance between rights protection and stability maintenance” and strive to “prevent crises.”[18] This suggests Beijing will continue to employ an incremental approach designed to enable China to successfully realize its territorial ambitions while avoiding conflict and limiting forceful reactions from the other claimants or the United States. (See Chapter 3, Section 2, “China and Southeast Asia,” for an examination of recent developments in the South China Sea dispute.)
- The defense white paper asserts that “space and cyberspace have become the new commanding heights in strategic competition,”* and that China will seek to achieve sufficient defense capabilities in both realms to protect its economic and strategic interests. The paper refers to China as a purely defensive actor in both realms. China’s reliance on space and cyberspace will continue to grow as the PLA’s most sophisticated long-range weapons—which will require unimpeded access to these domains for C4ISR † and targeting—come online.[19]
- The defense white paper emphasizes the need for a more unified, coordinated, and streamlined mechanism for defense policymaking by China’s civilian and military leadership through “in depth development of civil-military integration,” and announces the PLA will “set up a system and a working mechanism for overall and coordinated programming and planning.”[20] This is consistent with other steps taken by the Xi Administration to centralize and tightly control national security decision making in China.[21]

China’s Maritime Disputes in the South China Sea

China is aggressively advancing its territorial claims in the South China Sea by using land reclamation and construction on land features to vastly expand its civilian and military presence in contested waters. For a discussion of developments in China’s South China Sea maritime disputes in 2015, see Chapter 3, Section

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* This in part echoes a 2009 interview with then PLA Air Force commander General Xu Qiliang, in which he said that “the domain of space and air have become the new commanding height for international strategic competition.” Kevin Pollpeter, “The PLAAF and the Integration of Air and Space Power,” in Richard P. Hallion et al., eds., *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, National Defense University Press, 2012, 165.

† C4ISR stands for command, control, communications, computers, intelligence, surveillance, and reconnaissance.

2, "China and Southeast Asia." See also, "U.S.-China Tensions in the South China Sea," later in this section.

China's Maritime Dispute in the East China Sea

Although the South China Sea dominated headlines in 2015, China also sought to strengthen its position vis-à-vis Japan in its maritime dispute over the Senkaku Islands (called the Diaoyu Islands in Chinese) in the East China Sea.* Tensions in the East China Sea had reached a high point in November 2013 when China established an Air Defense Identification Zone (ADIZ)† over contested waters to "[protect] state sovereignty and territorial and airspace security."‡ [22] Since then, bilateral ties have improved somewhat, and no single event has ratcheted up tensions.[23] Nevertheless, China continues to quietly build up its military and civilian presence in the East China Sea.

- In July 2015, the Japanese government reported that "China has accelerated its development activities of natural resources in the East China Sea," identifying 16 freestanding structures China had erected "on the Chinese side of the geographical equidistance line between Japan and China" to facilitate the development of subsea natural gas resources (see Figure 1).§ According to Japanese officials, 7 of the 16 structures had begun drilling activities by September.[24] Although the structures are on the Chinese side of the "equidistance line," the Japanese government has asked China to stop construction of the platforms, noting "it is extremely regrettable that China is advancing unilateral development."[25] Japanese Minister of Defense Gen Nakatani suggested China "could install a radar system on the platform, or use it as an operating base for helicopters or drones conducting air patrols."[26]
- Satellite imagery analysis conducted by *IHS Jane's* in January 2015 suggests China is upgrading existing military infrastructure on Nanji Island, part of an island chain off the coast of Zhejiang Province about 160 nautical miles (nm) from the Senkaku Islands. The island now appears to host a heliport with ten landing pads and wind turbines, in addition to previously built radar and communications infrastructure.[27] According to Li Jie, a senior researcher from the PLA-affiliated Chinese Naval Research Institute, the island is "a strategically important location because [of its] proximity to the Diaoyu Islands, [because] it can provide support to the East China Sea

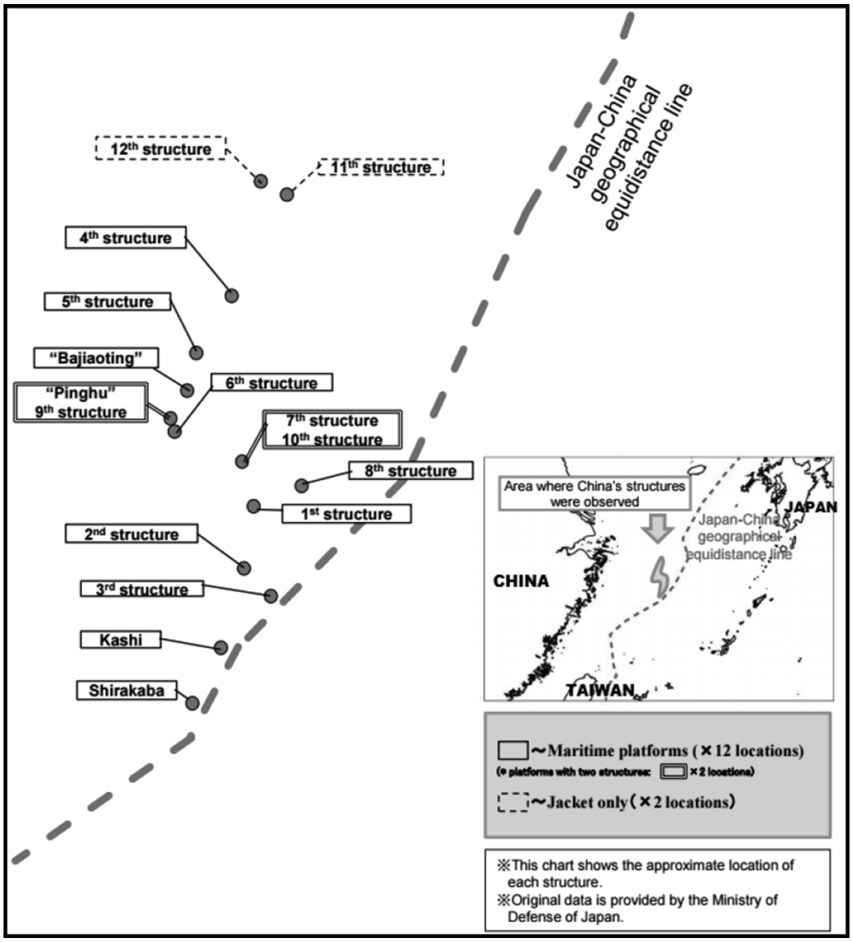
* Taiwan is a claimant in the East China Sea dispute as well.

† An ADIZ is a publicly declared area established in international airspace adjacent to a state's national airspace in which civil aircraft must be prepared to submit to local air traffic control and provide aircraft identifiers and location.

‡ China does not appear to have used its East China Sea ADIZ as a tool of aggression against Japan since it was established in 2013. Interestingly, the only publicly reported incident of China requiring a civilian aircraft to leave the ADIZ was in July 2015, when a Lao Airlines plane en route from South Korea to Laos was denied permission to enter Chinese airspace over the East China Sea and was forced to return to South Korea. Jeremy Torr, "China Turns Back Lao Airlines Flight for Failing to Comply with ADIZ Rules," *Air Transport World*, July 27, 2015.

§ In the absence of delimited maritime territory in the East China Sea, Japan takes the position that "maritime delimitation should be conducted based on the geographical equidistance line between Japan and China." Japan Ministry of Foreign Affairs, *The Current Status of China's Unilateral Development of Natural Resources in the East China Sea*, July 22, 2015.

Figure 1: China's Natural Gas Infrastructure in the East China Sea



Note: A jacket is a support structure for a drilling platform.
Source: Japan Ministry of Foreign Affairs, *The Current Status of China's Unilateral Development of Natural Resources in the East China Sea*, July 22, 2015.

> [ADIZ], and [because] it's a major naval point on the Chinese coastal defense lines. . . . It's unarguable that China would like to enhance the existing military presence there." [28]

- Chinese aircraft and China Coast Guard ships continue to patrol contested waters. The Japanese Ministry of Defense reported 706 scrambles * against Chinese aircraft flying near the Senkaku Islands between January 2014 and June 2015 (latest data available).[29] A commanding officer from a Japanese Self-Defense Force squadron based at Naha, the closest Japanese base to the Senkakus, told reporters, "It's practically every day. . . . It's absolutely extraordinary to ask one squadron to

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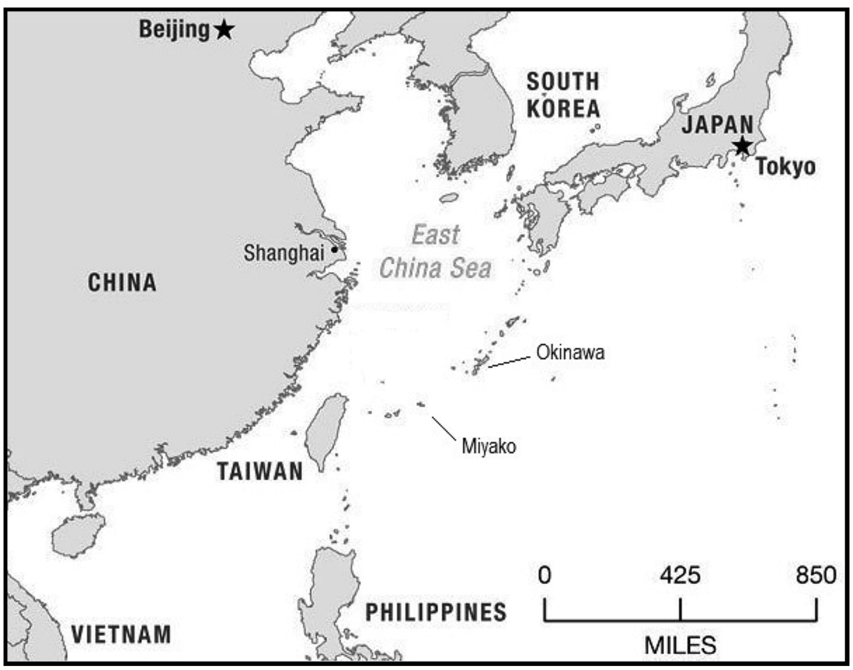
* In military aviation, scrambling refers to directing the immediate takeoff of aircraft from a ground alert condition of readiness to react to a potential air threat.

deal with more than 400 scrambles a year. It's an extremely heavy burden."[30] Japan's Ministry of Defense also reported that China Coast Guard ships entered the territorial sea* of the Senkaku Islands between seven and nine times per month during the same timeframe.[31]

- In May 2015, a PLA Air Force squadron, which included at least one bomber, transited from the East China Sea to the Western Pacific through Japan's Miyako Strait† for the first time (see Figure 2).[32] This is one of several indicators that the PLA Air Force is enhancing its capabilities to conduct over water operations far from China's coast, including in the East China Sea (see "PLA Training and Exercises," later in this section).

Figure 2: Map of Miyako Strait



Source: NPR, "The Role for the US in the East China Sea Dispute," January 30, 2013.

Corruption in the PLA

As part of President Xi's ongoing nationwide anticorruption campaign, China is conducting a campaign against corruption in the PLA. This campaign is widely understood to be aimed at mitigating growing public disillusionment with politics and governance in China, as well as ending practices such as graft and paying for promotion, which could reduce the quality of officers, perpetuate oppo-

* The UN Convention on the Law of the Sea defines "territorial sea" as a 12-nautical-mile zone extending from a country's coastline or island shore over which that country enjoys full sovereignty. UN Convention on the Law of the Sea, "Part 2: Territorial Sea and Contiguous Zone."

† The Miyako Strait runs between the Japanese islands of Miyako and Okinawa.

sition to reforms, and threaten PLA modernization and readiness.[33] Aside from these objectives, the anticorruption campaign also appears to be a useful political tool for President Xi to marginalize his political opponents and consolidate power.[34]

The scale of PLA corruption has potentially serious implications for U.S. security interests. According to a RAND Corporation report sponsored by the Commission, "China's Incomplete Military Transformation: Assessing the Weaknesses of the People's Liberation Army":

> *If the assessment that the PLA is highly corrupt is accurate and if the PLA's corruption seriously limits its warfighting capabilities, it may mean that the United States might be inclined to assume China has more sway in international affairs than its actual combat power merits. On the other hand, if the PLA is a highly capable fighting force despite its problems with corruption, the United States might risk overestimating the hollowness of the Chinese armed forces and be insufficiently cautious of confrontation with a PLA that is actually more capable than stories about widespread corruption in the ranks might suggest.*[35]

Measuring the scale and location of corruption in the PLA and evaluating the progress of China's anticorruption campaign is a difficult task.[36] Statements by current and retired PLA officials, Chinese state media, and some foreign analysts frame corruption as a serious threat to PLA combat readiness.[37] A *PLA Daily* editorial in April 2015 emphasized China faced "national humiliation" on the battlefield if it did not address PLA corruption.[38] However, some analysts, such as former U.S. Army attaché in Beijing Dennis Blasko, suggest the effect of institutional PLA corruption on China's combat readiness is relatively small. Mr. Blasko writes, "To date, very few (if any) operational combat unit (i.e., divisions, brigades, regiments, etc.) commanders and staff officers are known to have been caught in the corruption dragnet."[39] Moreover, he notes:

> *From the evidence available, the vast majority of corruption in the PLA is found within the political officer system (mostly involving promotions and assignments), the logistics and armaments systems (among those who handle official funds and property and are involved in the procurement of supplies and equipment), and potentially in low-level local headquarters responsible for conscription/recruitment (but likely involving relatively small sums of money). There is little indication that the PLA's frontline operational leaders, those in command of the units tasked to do the fighting, have been smitten by the scourge of corruption to the degree that some rear area personnel have been.*[40]

Major developments in the PLA anticorruption campaign from late 2014 to 2015 include:

- In November 2014, the Central Military Commission, China's highest military decision-making body, made the auditing office of the PLA directly responsible only to the Central Military Commission. The auditing office had been subordinate to the

PLA General Logistics Department, which analysts and media reports suggest is a hotbed of corruption.* [41] By taking direct oversight of the PLA auditors, the Central Military Commission likely intends to reduce institutional obstacles to its reforms and increase its control over PLA discipline.[42]

- Former Central Military Commission vice chairman Xu Caihou, one of the highest-ranking PLA officials to fall in the anticorruption campaign, died of cancer in March 2015 before he could be brought to trial on corruption charges.[43]
- In March 2015, Chinese state media announced 14 PLA generals, including Guo Zhenggang, the son of former Central Military Commission vice chairman Guo Boxiong, had been arrested for corruption.[44]
- In July 2015, Guo Boxiong himself was expelled from the CCP and placed under investigation for graft. General Guo was the highest-ranking PLA official to fall in the anticorruption campaign.[45]
- According to a January 2015 report from state-run *China Daily*, China's anticorruption campaign has led to the arrests of more than 4,000 officers with the rank of lieutenant colonel and above, including about 100 generals, since January 2013.[46]

China's Military Parade

In September 2015, China held its largest-ever military parade to commemorate the 70th anniversary of the end of World War II, which China refers to as the Chinese People's Resistance against Japanese Aggression and World Antifascist War. The parade featured 12,000 Chinese troops (as well as military units from 17 other countries),† 500 pieces of military equipment, and close to 200 aircraft.[47] Among these were many of China's most advanced weapons, some of which had not previously been publicly revealed.[48] Although Chinese officials insist the parade was not aimed at any particular country or countries,[49] it signaled clearly how China could employ its military might against potential adversaries. For example, among the nine classes of ballistic and cruise missiles on display—all of which were prominently labeled—were missiles that pose obvious threats to U.S. forces in the Pacific: the DF–21D "carrier killer" antiship ballistic missile, capable of targeting U.S. ships at sea, and the DF–26 ballistic missile, capable of targeting Guam (thus its nickname, the "Guam killer").‡

In a pre-parade speech commemorating end of the war, President Xi announced the PLA would reduce the number of its troops by

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*Some of the most powerful PLA officers to fall in the anticorruption campaign include Gu Junshan, former deputy director of the General Logistics Department (charged with corruption in March 2014) and Liu Zheng, also former deputy director of the General Logistics Department (expelled from the CCP in January 2015). Reuters, "China Military Official Booted from Parliament in Anti-Graft Drive," February 28, 2015; BBC, "China Ex-General Gu Junshan Charged with Corruption," April 1, 2014.

†The following countries sent military units to China's parade: Afghanistan, Belarus, Cambodia, Cuba, Egypt, Fiji, Kazakhstan, Kyrgyzstan, Laos, Mexico, Mongolia, Pakistan, Russia, Serbia, Tajikistan, Vanuatu, and Venezuela. Andrew S. Erickson, "China Military Parade—3 September 2015—Your Complete Hardware and Logistics Guide (Updated Version)," *Andrew S. Erickson Blog*, September 2, 2015.

‡Other missiles on display at the parade were the DF–10, DF–15B, DF–16, DF–5B, DF–31A, YJ–12, and YJ–83. Andrew Erickson, "Missile March: China Parade Projects Patriotism at Home, Aims for Awe Abroad," *China Real Time Report* (*Wall Street Journal* blog), September 3, 2015.

300,000,[50] which would bring the number of China's total troops down to approximately two million, according to state-run news service Xinhua.[51] The announcement, couched in language about China's commitment to "carry out the noble missions of upholding world peace,"[52] seemed intended to reassure global audiences that China's rise will continue to be peaceful. According to Dean Cheng, research fellow on Chinese political and security affairs at the Heritage Foundation, the troop reduction "is consistent with the longer-term effort by the PLA to both pare down its size and shift from a military focused on quantity to one more focused on quality" and "will presumably free up resources that can be reallocated to better pay, better quality of life, additional training, and/or equipment acquisition."[53]

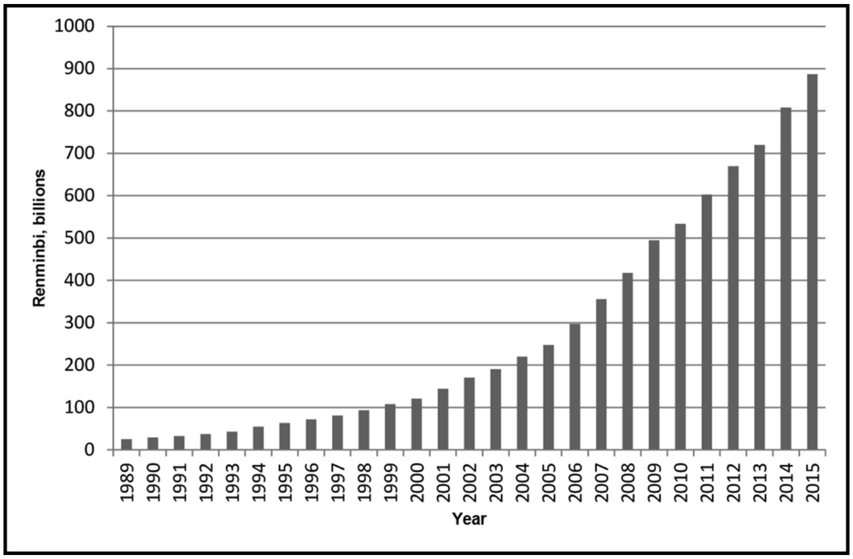
Major Developments in China's Military Modernization in 2015

Since the publication of the Commission's 2014 Annual Report, China's national security and foreign policy apparatus has made new military budget announcements, developed and acquired new military platforms and weapons, engaged in large-scale training and exercises, and conducted significant overseas military operations. Many of these developments are detailed below. (For an in-depth examination of China's space and offensive missile forces modernization programs, which are not covered here, see Chapter 2, Section 2, "China's Space and Counterspace Programs" and Chapter 2, Section 3, "China's Offensive Missile Forces.")

China's 2015 Defense and Security Budget

China's announced annual defense budget rose 10.1 percent to $141.9 billion (RMB 886.9 billion) in 2015.[54] Although the 2015 spending increase is down from a 12.2 percent increase in 2014, in real terms it is roughly consistent with defense spending increases in recent years because China's inflation rate is near a five-year low.[55]

Figure 3: China's Announced Defense Spending, 1989–2015



Source: This figure reflects Commission judgments based on several sources, each of which provides data for part of the period 1989–2014. The most recent source is used when these sources disagree. For 1989–1993, David Shambaugh, *Modernizing China's Military: Progress, Problems, and Prospects*, University of California Press, 2002, 189; for 1994–2001, Dennis J. Blasko et al., "Defense-Related Spending in China: A Preliminary Analysis and Comparison with American Equivalents," *United States-China Policy Foundation*, 2007, 19; for 2002–2012, Andrew Erickson and Adam Liff, "Demystifying China's Defense Spending: Less Mysterious in the Aggregate," *China Quarterly*, December 2013, 805–830; for 2013, Jeremy Page, "China Raises Defense Spending 12.2% for 2014," *Wall Street Journal*, March 5, 2014; for 2014, Andrew Erickson and Adam Liff, "The Budget This Time: Taking the Measure of China's Defense Spending," *Asan Forum*, March–April 2014; and for 2015, Andrew Erickson and Adam Liff, "China's Military Spending Swells Again despite Domestic Headwinds," *Wall Street Journal*, March 5, 2015.

China's actual aggregate defense spending is higher than the official budget because Beijing omits from its official figures some major defense-related expenditures, such as research and development programs, purchases of advanced weapons, and local government support to the PLA. The U.S. Department of Defense (DOD) estimates China's actual defense spending in 2014 exceeded $165 billion, approximately 25 percent higher than China's announced defense budget of $131.6 billion;[56] the Stockholm International Peace Research Institute estimates China's actual defense spending in 2014 was $216 billion, approximately 64 percent higher than China's announced defense budget.*

*There is no consensus on which items should be included in a country's "official" defense budget. Every major power—including the United States and major allies—spends money on defense not captured in its official defense budget. When evaluating China's actual defense spending, some observers, such as the Stockholm International Peace Research Institute, include China's spending on the People's Armed Police in their calculations, which can increase budget estimates by as much as one-fifth of the official figure. DOD does not disclose its methodology for calculating actual Chinese defense spending. Sam Perlo-Freeman et al., "Trends in World Military Expenditure, 2014," *Stockholm International Peace Research Institute*, April 2015, 2; Sam Perlo-Freeman, "Deciphering China's Latest Defense Budget Figures," *Stockholm International Peace Research Institute*, March 2014; U.S.-China Economic and Security Review Commission, *Hearing on China's Military Modernization and its Implications for the United States*, written testimony of Andrew Erickson, January 30, 2014; Andrew Erickson and Adam Liff,

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China's defense spending increases appear sustainable in the short term. Although China's official nominal defense spending has grown by double digits almost every year since 1989, the rapid growth of China's economy has kept defense spending at a relatively low percentage of China's gross domestic product (GDP): official defense spending in 2015 will account for only 1.34 percent of China's GDP, and even high-end foreign estimates put Beijing's actual aggregate defense spending at a moderate 2–3 percent of China's GDP.[57] Furthermore, increases to overall state expenditures have outpaced increases to official defense spending in recent years,[58] which has probably insulated Chinese leaders from potential criticism that they are spending too much on the military. Because China's economic growth has slowed, further double-digit increases to military spending will continue to generate opportunity costs as government spending strains to meet other national priorities.[59] However, there is no indication China's government is slowing the growth rate of military spending in response to growing opportunity costs.

PLA Navy

In 2015, the PLA Navy's acquisitions continued to reflect China's efforts to transform it from a coastal force into a technologically advanced navy capable of projecting power throughout the Asia Pacific and beyond.* Significant developments in China's naval forces from late 2014 to 2015 include the following:

- China launched its fifth Type 815 DONGDIAO-class intelligence-gathering ship in January. China's continued production of DONGDIAOs suggests it will increase intelligence activities in what China considers its near and far seas † and conduct more frequent ISR ‡ missions farther from the Chinese mainland in coming years.[60] China sent a Type 815 DONGDIAO to spy on the 2014 Rim of the Pacific exercises off Hawaii, even as China was participating in the exercises for the first time.[61]
- In February, China introduced into service its first advanced antisubmarine warfare aircraft, an indigenously built Y–9.[62] Although China is expanding the PLA Navy's antisubmarine warfare capability, Stratfor, a security-focused consulting firm, asserts China is likely at least ten years from deploying enough antisubmarine warfare aircraft to challenge U.S. submarines in the Western Pacific.[63] The Y–9 has antisubmarine warfare technology roughly comparable to the U.S. P–3C Orion.[64]

"Demystifying China's Defense Spending: Less Mysterious in the Aggregate," *China Quarterly*, December 2013; and Dennis J. Blasko et al., "Defense-Related Spending in China: A Preliminary Analysis and Comparison with American Equivalents," *United States-China Policy Foundation*, 2007.

* For a comprehensive discussion of trends in PLA Navy modernization, including order of battle and acquisition information, see U.S.-China Economic and Security Review Commission, *2014 Annual Report to Congress*, November 2014, 299–308.

† China typically defines its "near seas" as waters within the Yellow Sea, East China Sea, and South China Sea. China typically describes its "far seas" as waters outside of its near seas.

‡ ISR refers to intelligence, surveillance, and reconnaissance.

- In January, China commissioned two Type 054A JIANGKAI II-class missile frigates.[65] China has now commissioned 18 of its planned 22 JIANGKAI IIs.[66] The JIANGKAI IIs each likely carry 32 HHQ–16 surface-to-air missiles and 8 YJ–82 antiship cruise missiles, and have served a variety of missions, including antipiracy missions in the Gulf of Aden and patrols in China's near seas.[67]

- China launched its 27th Type 056 JIANGDAO-class corvette in early May.[68] China's JIANGDAOs most likely will be used primarily for near-seas surface patrols because their armaments are not sufficient for deep-water combat operations.[69] China expects to field an additional 5 to 15 ships.[70]

- In July, China commissioned its second Type 052D LUYANG III-class destroyer.[71] According to the U.S. Office of Naval Intelligence report, *The PLA Navy: New Capabilities and Missions for the 21st Century*, the LUYANG III's advanced air defense radar "allows the PLA [Navy] surface force to operate with increased confidence outside of shore-based air defense systems, as one or two ships are equipped to provide air defense for the entire task group."[72] The LUYANG III carries a variant of the advanced, long-range YJ–18 antiship cruise missile. The YJ–18's supersonic speed and assessed maximum range of 290 nautical miles will improve the antiaccess/area denial* capabilities of the PLA Navy.[73] In the next five years, China expects to deploy ten LUYANG IIIs in total.[74]

- In late 2014, China for the first time landed several production-line J–15 fighters on its Soviet-built KUZNETSOV-class aircraft carrier, the *Liaoning*.[75] As China's naval aviators and the *Liaoning*'s crew gain experience operating aircraft from the *Liaoning*, China will make progress toward developing a potent expeditionary aircraft carrier force. Among other things, a fully operational *Liaoning* could contribute significantly to the PLA's combat capabilities in the South China Sea, where the short range of China's fighter fleet limits its power projection capabilities.[76]

- In July, Chinese state media published an internal document of the China Shipbuilding Industry Corporation that confirmed China's first indigenous aircraft carrier is under construction.[77] If construction began in 2013, as U.S. analysts widely reported, it could reach initial operational capability† by 2020.‡[78] China

* According to DOD, "antiaccess" actions are intended to slow deployment of an adversary's forces into a theater or cause them to operate at distances farther from the conflict than they would prefer. "Area denial" actions affect maneuvers within a theater, and are intended to impede an adversary's operations within areas where friendly forces cannot or will not prevent access. China, however, uses the term "counterintervention," reflecting its perception that such operations are reactive. U.S. Department of Defense, *Military and Security Developments Involving the People's Republic of China 2013*, 2013, i, 32, 33; U.S. Department of Defense, *Air Sea Battle: Service Collaboration to Address Anti-Access & Area Denial Challenges*, May 2013, 2.

† According to DOD, a system achieves initial operational capability when some units in the force structure scheduled to receive a system have received it and have the ability to employ and maintain it. Defense Acquisition University, *Glossary: Defense Acquisition Acronyms and Terms*, December 2012, B–107.

‡ One unattributed Chinese source suggests the carrier could be launched as early as December 2015. David Tweed, "China Aircraft Carrier Launch by End-2015 Plausible, Experts Say,"

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appears to be building a second indigenous carrier,* and probably intends to build an additional one or two indigenous carriers.[79] Boasting a more sizable hull, which will likely allow it to accommodate a larger air wing than the *Liaoning*, China's new carrier will also feature engine and launch system improvements.

- China launched three new Type 093 SHANG-class nuclear attack submarines in May, according to Chinese media reports.[80] The new submarines are reportedly the first SHANGs to carry a vertical missile launch system capable of firing the long-range YJ–18 antiship cruise missile.† [81] The increasing number of Chinese submarines and the growing range of Chinese submarine-launched munitions will greatly complicate the threat environment for U.S. ships operating near China.
- *Popular Science* reported in May that the PLA Navy has built a simulator to begin training the crew of its Type 095 guided-missile, nuclear-powered submarine, which is still under development.[82] Jesse L. Karotkin, senior China analyst at the U.S. Office of Naval Intelligence, testified to the Commission that the Type 095 may "provide a generational improvement in many areas such as quieting and weapon capacity" and carry the PLA Navy's first submarine-launched land-attack cruise missile.[83]
- In May, a report from Chinese state-run *People's Daily* claimed China has developed a highly efficient air-independent propulsion (AIP) system for diesel-electric submarines. Because AIP-equipped diesel-electric submarines need to surface to recharge their batteries less frequently, this will allow China's AIP-equipped submarines to operate for longer periods while limiting their chance of detection.[84]
- Media reports suggest China launched its fifth Type 903 FUCHI-class auxiliary replenishment oiler in June.[85] China now fields nine auxiliary replenishment oilers, and its growing fleet better equips the PLA Navy's surface fleet, including future aircraft carrier task groups and expeditionary forces, to sustain high-tempo operations at longer ranges.[86] The demands of the PLA Navy's expanding missions in far seas have placed its auxiliary replenishment oiler fleet on near-constant deployment status.[87]
- In July 2015, China commissioned the *Donghaidao*, the PLA Navy's first semisubmersible mobile landing platform.[88] The *Donghaidao* is a logistics ship capable of transporting troops, cargo, and some naval craft in the relatively shallow waters

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Bloomberg, September 30, 2015; Open Source Center, "PRC Internet: China's First Indigenously Built Aircraft Carrier to Float out in December 2015," September 24, 2015. ID: CHR20150924 59609733.

* A Taiwan Ministry of Defense report on the PLA reportedly notes China's second indigenous carrier is currently under construction in Shanghai. Reuters, "China Building Two Aircraft Carriers: Taiwan Defense Ministry Report," September 3, 2015.

† The YJ–18 has a much longer range than the YJ–82, which was previously China's only indigenous submarine-launched antiship cruise missile. U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, May 2015, 10; U.S. Office of Naval Intelligence, *The PLA Navy: New Capabilities and Missions for the 21st Century*, April 2015, 16.

near contested land features in the South China Sea. It is capable of embarking China's POMORNIK hovercraft, which will significantly extend the range of the hovercraft and increase their usefulness in contingencies in the East and South China seas and those involving islands held by Taiwan.[89]

China's Amphibious Forces

The PLA's continued investment in amphibious forces reflects China's perception of a rising need to meet security challenges in its maritime domain. Although amphibious forces, including amphibious lift, amphibious infantry, and auxiliary transport vehicles, would be crucial in an invasion of Taiwan, China does not appear to be building the amphibious lift capability necessary to conduct such a large campaign.[90] China would more likely use its amphibious forces in contingencies in the East and South China seas and those involving islands held by Taiwan. Significant developments in China's amphibious forces from late 2014 to 2015 include the following:

- With the conversion of two mechanized infantry divisions into amphibious mechanized infantry divisions from 2007 to 2012, China doubled its total amphibious mechanized infantry division personnel from about 30,000 soldiers to 52,000–60,000 soldiers and reorganized its amphibious mechanized infantry forces from two to four divisions.[91] The primary role of China's amphibious mechanized infantry divisions is to supplement the PLA Marine Corps as China's main infantry force in amphibious invasions.

- China launched its fourth Type 071 YUZHAO-class landing platform dock in January 2015.[92] China will eventually field six Type 071s, each of which can carry up to 60 armored vehicles and 800 troops, and up to four helicopters.[93] The expanding landing platform dock fleet will improve China's ability to move troops and equipment in South and East China sea missions.[94]

- By early 2015, China had acquired two Ukrainian-built and one indigenously built POMORNIK hovercraft, the largest military hovercraft in the world.[95] China would deploy its hovercraft on amphibious lift ships to provide quick transport of infantry, tanks, and heavy equipment to shore during amphibious invasions. China plans to have a total of four POMORNIKs in service by the end of 2015.[96]

China's Amphibious Forces—*Continued*

- Images of a model of a landing helicopter dock appeared on Chinese military web pages in April.[97] Although the model is not necessarily authoritative, it fits the description of a landing helicopter dock rumored since 2013 to be under construction.[98] A landing helicopter dock based on the model would be significantly larger than China's current landing platform docks, and as a mobile platform would increase China's ability to launch helicopters and move troops and equipment in East and South China seas contingencies.[99]
- In March, China announced the completion of the front fuselage assembly for the prototype of its AG600 seaplane. The AG600 will be China's largest seaplane, and with a range of 2,970 nm it could improve China's troop transport and patrol capabilities throughout the South China Sea.[100] In addition to civilian uses, China will likely use the AG600 to carry supplies by air to South China Sea islands without an airstrip, and could use the AG600 to transport up to 50 troops at a time.[101] Some analysts believe the AG600 could also conduct intelligence missions.[102]

PLA Air Force

China's PLA Air Force modernization in 2015 included the development of cutting-edge force projection equipment and additions and upgrades to forthcoming and deployed weapon systems.* Significant developments in PLA Air Force modernization from late 2014 to 2015 include the following:

- In February 2015, documents emerged detailing the characteristics and flight test records of China's Divine Eagle unmanned aerial vehicle. These documents suggest the Divine Eagle is equipped with seven radars, including five active electronically scanned array radars, which could allow it to monitor stealth aircraft, such as the United States' B–2 bomber and F–35 fighter.[103] The Divine Eagle is well equipped to track incoming aircraft, ships, and cruise missiles and help coordinate interceptors from the Chinese mainland during a contingency. The vehicle's array of stealth features and 25-kilometer flight ceiling could degrade the ability of U.S. forces to detect and engage it.[104]
- China introduced its first KJ–500 airborne early warning and control aircraft into service in early 2015, according to media reports.[105] China is expanding its fleet of approximately 13 airborne early warning and control aircraft to improve high-fidelity and time-sensitive tracking for China's air and maritime forces.[106] The KJ–500 will reportedly carry radar comparable to China's KJ–2000 airborne early warning and control plane,

*For a discussion of long-term trends in PLA Air Force modernization, including order of battle and acquisition information, see U.S.-China Economic and Security Review Commission, *2014 Annual Report to Congress*, November 2014, 308–314.

which "employs radar technology two generations ahead of that used by the U.S. Air Force's E–3C [airborne early warning and control aircraft]," according to Carlo Kopp, an Australia-based military analyst and editor of *Air Power Australia*.[107] The KJ–500 uses the indigenous Y–8 airframe.

- Satellite imagery from October 2014 confirms China has received one of three ordered Ilyushin IL–78 MIDAS air refueling tankers from Ukraine.* The plane is the first modern addition to China's small and outdated fleet of air refueling aircraft, which previously consisted of about 20 modified H–6 bombers operated by the PLA Air Force and the PLA Naval Air Force.[108] In addition to the two IL–78 tankers still due from Ukraine, China purchased up to 8 IL–78 tankers from Russia in the mid-2000s, but production issues have prevented Russia from delivering any planes to date.[109] Moreover, China may build new tankers based on the airframe of the indigenous Y–20 transport aircraft, which is still in development.[110] Over the next decade, these air refueling tanker acquisitions could significantly extend the combat reach of some of China's attack aircraft. However, the PLA will need to modernize its fleet of attack aircraft—most of which cannot refuel in the air—to take advantage of its expanding air refueling fleet.[111]

- Media reports suggest China has built two new fifth-generation J–20 fighters, bringing its J–20 fleet to six aircraft. The two aircraft reportedly conducted their first flights in late 2014.[112] The J–20 could reach initial operational capability in 2017–2018, and China reportedly hopes to build 24 J–20s by 2020.[113] The PLA Air Force views the J–20 as key to improving China's ability to conduct offensive operations to deny an enemy's chance to mobilize defensive forces.[114] The J–20's stealth features and electronic warfare capabilities would degrade the ability of U.S. forces within the first island chain to detect and engage it.†

- China's prototype J–11D fighter had its first flight in April 2015. The J–11D has better radar and stealth features than previous fighters in the J–11 line, and almost certainly is capable of carrying China's most advanced air-to-air and antiship missiles.[115] The J–11D reportedly will feature a turbofan engine with improved thrust and reliability.[116] The J–11 is a modern fighter comparable in performance to fourth-generation U.S. jets.[117]

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*For more information on China's expanding air refueling fleet, see Michael Pilger, "First Modern Tanker Observed at Chinese Airbase," *U.S.-China Economic and Security Review Commission*, November 18, 2014.

†The first island chain refers to a line of islands running through the Kurile Islands, Japan and the Ryukyu Islands, Taiwan, the Philippines, Borneo, and Natuna Besar. The second island chain is farther east, running through the Kurile Islands, Japan, the Bonin Islands, the Mariana Islands, and the Caroline Islands. PLA strategists and academics have long asserted the United States relies primarily on the first island chain and the second island chain to strategically "encircle" or "contain" China and prevent the PLA Navy from operating freely in the Western Pacific. Open Source Center, "PRC Article Surveys China's Naval Rivals, Challenges," January 6, 2012. ID: CPP20120109671003; Bernard D. Cole, *The Great Wall at Sea* (Second Edition), Naval Institute Press, 2010, 174–176.

- The Aviation Industry Corporation of China may be developing a high-altitude hypersonic unmanned aerial vehicle for regional strategic reconnaissance operations. Taiwan press reporting suggests that the drone would be launched from H–6 bombers, capable of achieving speeds up to Mach 3 to 3.5; operating at a range of 5,500 kilometers (km) (3,417 miles (mi)) and a height of 95,140 feet (18 mi); and returning to an airbase.[118]

PLA Training and Exercises

The PLA conducts exercises and training to enhance warfighting competencies, integrate new weapon systems and tactics, develop and refine integrated joint operations command structures and concepts, evaluate crew and platform proficiencies, and demonstrate China's ability to project power in Asia and beyond, among other objectives.

Implementing President Xi's emphasis on real-combat military training was a top priority for all large-scale PLA military exercises in 2015.[119] The Xi Administration frequently emphasizes the importance of military training under realistic combat conditions. The 2015 defense white paper states the PLA will begin to "intensify training" in complex scenarios and establish a "training supervision and inspection system, so as to incorporate real-combat requirements into training."[120] The PLA's military training appears to be growing more complex as it increasingly emphasizes joint exercises between diverse combat arms types. According to Xinhua, the PLA planned to conduct more than 100 joint exercises involving more than 50 corps in 2015.[121]

Major military exercises from late 2014 to 2015 included the following:

- From August to October, all four PLA services participated in the Joint Action 2015 exercises, a series of live-fire drills reportedly involving more than 140,000 troops.[122] Joint Action is designed to integrate all Chinese armed forces to operate together across the spectrum of war. The exercises took place in several simultaneous or overlapping phases in different regions of the country, and emphasized testing troops' "joint operations using digitized commands and information."[123]

- From July to September 2015, the PLA conducted the Firepower 2015 exercises, a series of cross-region base training exercises for artillery and air defense brigades.[124] The Firepower exercises are designed to link sensors to strike systems for joint target engagement. Firepower 2015 subjected participating brigades to "red versus blue" combat simulations.* One

* "Red versus blue" exercises in the U.S. military pit a "red" force that simulates a potential foe's capabilities against a "blue" force that simulates the capabilities of friendly forces. Chinese media reports suggest that in Chinese red versus blue exercises, the red force represents friendly forces and the blue force represents an enemy force. Open Source Center, "CCTV–7: Jinan Air Defense Unit Holds Ground-Air Confrontations in 'Firepower-2015 Shandan D' Drill," August 9, 2015. ID: CHO2015081029855809; Open Source Center, "CCTV-Xinwen: Lanzhou MR Units Hold Confrontations in 'Firepower-2015 Qingtongxia C' Exercise," August 4, 2015. ID: CHO2015080513756969; and Open Source Center, "People's Liberation Army Daily: PRC Air Force's First Blue Team Makes Debut in Firepower-2015-Shandan A Exercise," July 6, 2015. ID: CHR2015070623165581; Open Source Center, "JFJB Photo: 'Stride 2015-Zhurihe Military Drill Kicks Off,'" June 2, 2015. ID: CHN2015060221884644.

feature of these exercises has been the use of opposing force electromagnetic warfare * operations by blue forces to train PLA units to operate under conditions that simulate U.S. tactics.[125] This raft of brigade-level exercises likely will increase the ability of commanders at the brigade level and lower to innovate and take the initiative in combat, and reduce the tendency among front-line PLA commanders to push decisions up the chain of command.[126] The PLA will use Firepower 2015 to evaluate and rank all units to ensure the highest-performing PLA units will be deployed at the front lines of future conflicts.[127]

- China held the Stride 2015 military exercises from June to September. Stride 2015 subjected 29 brigades to red versus blue simulated combat drills at six training sites across China, with most of the drills occurring in the Inner Mongolia Autonomous Region. According to a *China Military Online* report, Stride 2015 emphasized "the commanders' planning for combat operations, command [and] control training, . . . ground-air coordination training, harmonious training between 'new type' forces [such as special operations forces] and traditional forces and the transformation and application of new combat methods and results." [128] As the PLA develops its command and control and joint operations capabilities in simulated combat, it will become increasingly capable of integrating its evolving military forces to conduct large-scale military operations involving diverse combat arms types.
- In March, Chinese long-range bombers traversed the Bashi Channel between Taiwan and the Philippines to conduct the first known PLA Air Force drill in the Western Pacific.[129] The planes involved were reportedly H–6K bombers, which can carry long-range land attack cruise missiles capable of reaching Guam.[130] The PLA Air Force conducted another drill through the Bashi Channel in August, with "multiple types of aircraft . . . reaching 1,000 kilometers [540 nm] beyond the First Island Chain," according to Chinese state-run media outlet Xinhua.[131] These drills provided pilots with maritime flight experience and reflect the PLA Air Force's growing role in support of the PLA's strike missions into the second island chain.[132] China most likely intended these drills to develop its far-seas power projection capabilities, and to demonstrate its ability and intention to exert influence farther from the Chinese mainland.
- In May 2015, the PLA Air Force for the first time successfully airdropped heavy artillery into "enemy" rear areas during a drill.[133] According to Chinese media, the artillery airdrop "indicates a major leap forward for [the PLA's] airborne operation capability." [134] This capability could have applications in a Taiwan conflict scenario.

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* Electromagnetic warfare involves the use of focused energy, usually radio waves or laser light, to confuse or disable an enemy's electronics and protect the electronics of friendly forces. Raytheon, "Electronic Warfare"; Lockheed Martin, "Electronic Warfare."

PLA Navy Sails through U.S. Arctic Waters

On September 2, five PLA Navy ships sailed through Alaska's Aleutian Island chain. This marked the first time the PLA operated in the Bering Sea, and the first time it operated in the United States' territorial sea (i.e., within 12 nm of U.S. territory) during a far sea deployment without a U.S. port call. According to U.S. defense officials, the PLA Navy flotilla (which included three combat ships, a supply ship, and an amphibious ship) operated in accordance with international law as articulated in the UN Convention on the Law of the Sea (UNCLOS), which allows for "innocent passage" within the territorial sea, as well as "transit passage" through straits.[135] The PLA Navy ships sailed through the area following a military exercise with Russia in the Sea of Japan.[136]

The PLA Navy's transit was significant in part because, while it was consistent with international law, it contravened China's unconventional policy on foreign militaries' operations in its own exclusive economic zone and territorial sea.[137] China asserts that it has the right to require foreign ships to obtain permission or provide notification before conducting innocent passage, although UNCLOS does not include such a provision.[138] It is unclear whether the PLA Navy's transit through U.S. territory reflects a shift in China's long-standing policy.

The unprecedented transit came as China has indicated a growing interest in the Arctic, particularly in opportunities for new shipping routes and natural resource exploitation.[139] U.S. Pacific Command Commander Admiral Harry Harris testified to Congress that he believed the PLA Navy passed through the Aleutian Islands in part to "demonstrate their capability to operate that far north."[140] The timing of the transit coincided with President Obama's visit to Alaska, which included, among other events, a U.S.-led conference of global leaders (including from China) and stakeholders in Arctic issues.[141] When asked whether the PLA transit was timed to coincide with President Obama's visit, Adm. Harris replied, "I think it was coincidental, but I don't know that for a fact."[142]

China's Global Security Activities in 2015

China's global security engagement continued to expand in 2015, reflecting China's maturing international security interests and the PLA's improving capacity to operate in unfamiliar environments far from China's shores.

China Seeks Arrangements for Overseas Military Facility

In its 2015 defense white paper, China said its "growing strategic interests" would require an expansion of overseas military engagement to safeguard its overseas interests.* [143] It is widely understood that China will use the PLA to protect these overseas interests, which include growing overseas expatriate populations and commercial interests.[144] The PLA Navy already operates routine patrols of busy shipping lanes vulnerable to piracy in the Gulf of Aden † and has been involved in Chinese noncombatant evacuation operations overseas. Moreover, China appears to be working to establish military facilities in strategically important parts of the world, especially in the greater Indian Ocean region. These facilities would support logistical requirements and greatly assist the PLA Navy in increasing its global presence.[145]

According to statements by Djibouti President Ismail Omar Guelleh, the governments of China and Djibouti are in talks to establish a Chinese military facility in Djibouti.[146] These negotiations follow a 2014 defense cooperation agreement between Djibouti and China that allowed PLA Navy ships to dock at the Port of Djibouti and brought hundreds of millions of dollars in Chinese investment to the country.[147] To date, PLA Navy ships have visited the Port of Djibouti more than 50 times to resupply food, perishables, and water.[148] A permanent Chinese military facility could allow China to offer its ships a more comprehensive set of resupply services in Djibouti while supporting China's antipiracy operations in the Gulf of Aden. Moreover, Djibouti occupies a strategic position at the Bab-el-Mandeb—a chokepoint for sea lines of communication between the Red Sea and Indian Ocean—through which travels a large portion of hundreds of billions of dollars in trade between China and the Middle East and Europe.[149] A military foothold in Djibouti would boost China's power projection capabilities in an area of the world crucial to China's economic interests. The United States, France, and Japan each have a permanent military presence in Djibouti. The United States military's Camp Lemonnier in Djibouti is a hub for U.S. counterterrorism operations in Africa and the Middle East.[150]

China may seek to establish military facilities elsewhere in the region as well. Over the last few years, China has played a large role in financing and constructing civilian port infrastructure in the Indian Ocean, including the Port of Colombo and Port of Hambantota in Sri Lanka, and Gwadar Port in Pakistan.[151] Furthermore, PLA Navy antipiracy task groups have made port calls in at least 12 regional countries for resupply and replenishment and military-to-military engagements.[152] Chinese investments in commercial ports in the Indian Ocean and Chinese naval diplomacy with countries in the region will likely improve the PLA Navy's ability to replenish using regional ports, and could lay the groundwork for future logistics hubs in the Indian Ocean.

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* This reflects the PLA's New Historic Mission to protect China's expanding national interests. In December 2004, then Chinese President Hu Jintao outlined four "New Historic Missions" for the Chinese military. According to Daniel Hartnett, analyst at CNA Corporation, the missions are "to ensure military support for continued Chinese Communist Party rule in Beijing; to defend China's sovereignty, territorial integrity, and national security; to protect China's expanding national interests; and to help ensure a peaceful global environment and promote mutual development." U.S.-China Economic and Security Review Commission, *Hearing on China's Military and Security Activities Abroad*, written testimony of Daniel Hartnett, March 4, 2009.

† The Gulf of Aden is a gulf between the Horn of Africa and the south coast of the Arabian Peninsula. It is a crossroads for trade between the Indian Ocean and Mediterranean Sea.

China's Submarine Deployments

In late 2013, China began its first known submarine deployment to the Indian Ocean. Chinese officials have claimed these submarines support China's antipiracy activities in the Indian Ocean.[153] The more likely purpose of these deployments, though, is to collect intelligence on U.S., Indian, and other forces in the Indian Ocean; test and enhance the ability of China's submarine crews to operate for long durations at extended distances from the Chinese mainland; prepare for potential crises and wartime operations in the Indian Ocean; and demonstrate China's growing strategic interests in the region.[154] According to Adm. Harris:

> *We're seeing Chinese submarine deployments extend farther and farther [from China], almost with every deployment. It has become routine for Chinese submarines to travel to the Horn of Africa region and North Arabian Sea in conjunction with their counterpiracy task force operations. We are seeing their ballistic missile submarines travel in the Pacific at [longer] ranges, and of course all of those [deployments are] of concern.*[155]

These deployments demonstrate China's growing ability to conduct small-scale, long-distance naval operations for extended durations despite its lack of overseas military facilities. Moreover, these deployments suggest Chinese submarine commanders and crews are becoming familiar with the operating environment of the Indian and Pacific oceans. With the visit of a PLA Navy submarine to the Port of Karachi, Pakistan, in May 2015, China has now conducted at least four submarine deployments in the Indian Ocean region since December 2013.[156] China's submarine deployments in the Indian Ocean include the following:

- From December 2013 to February 2014, a SHANG-class nuclear attack submarine conducted China's first known submarine patrol in the Indian Ocean.[*] [157]
- In September 2014, a Chinese SONG-class diesel-electric submarine [†] made a port call in Colombo, Sri Lanka.[158] Another port call to Colombo by a Chinese submarine was reported in October 2014.[‡] [159] These visits highlight what have been generally positive relations between China and Sri Lanka in recent years, including contracts for billions of dollars in Chinese investment in Sri Lanka. In February 2015, however, the

* The SHANG nuclear attack submarine carries torpedoes (range of 15 nm) and YJ–82 antiship cruise missiles (20 nm) and will likely be equipped with the YJ–18 antiship cruise missile (290 nm) in coming years. The SHANG is designed for antisurface warfare and intelligence, surveillance, and reconnaissance operations, and likely will escort future nuclear deterrent patrols and aircraft carrier task groups. U.S.-China Economic and Security Review Commission, *2014 Annual Report to Congress*, November 2014, 301.

† The SONG's weaponry, expected missile upgrades, and role in PLA Navy operations are similar to those of the SHANG nuclear attack submarine. *IHS Jane's*, "Jane's Fighting Ships: Song Class (Type 039/039G)," February 13, 2015; U.S.-China Economic and Security Review Commission, *2014 Annual Report to Congress*, November 2014, 301.

‡ Sources disagree about whether the October 2014 port call involved the same SONG-class submarine that visited Colombo in September, or a HAN-class nuclear attack submarine. Atul Aneja, "China Says its Submarine Docked in Sri Lanka 'for Replenishment,'" *Hindu*, November 28, 2014; Shihar Aneez and Ranga Sirilal, "Chinese Submarine Docks in Sri Lanka despite Indian Concerns," Reuters, November 2, 2014.

newly elected Sri Lankan government ruled out future Chinese submarine visits and stopped work on the $1.5 billion Chinese development of the Port of Colombo pending an investigation into rumors of impropriety surrounding the contract.[160] Although in June Sri Lanka outlined steps for the project to resume, this development suggests the new Sri Lankan government may be taking a more skeptical view of economic and security cooperation with China than did its predecessor.[161]

- In April 2015, a Chinese submarine finished a two-month deployment to the Gulf of Aden. According to media reports, it was a HAN-class nuclear attack submarine.* [162]
- In May 2015, a Chinese YUAN-class diesel-electric submarine visited the Port of Karachi, Pakistan,[163] one month after China reportedly agreed to sell eight YUANs to Pakistan.† [164]

PLA Navy Evacuates Citizens from Yemen

From March 29 to April 6, 2015, China conducted a noncombatant evacuation operation ‡ (NEO) in war-torn Yemen, marking the first Chinese NEO conducted exclusively by the PLA.[165] China's Gulf of Aden antipiracy task force, consisting of two PLA Navy frigates and a replenishment ship, brought about 600 Chinese citizens and more than 200 foreign nationals across the Gulf of Aden to the port of Djibouti. The PLA Navy conducted the evacuation without encountering hostile forces. The Yemen operation was a significant symbolic milestone as China works to build its reputation as a responsible global power.[166] According to Deputy Chief of the PLA's General Staff Department Sun Jianguo, the Yemen NEO is an example of China's "unique role in the effort to create a peaceful, stable, prosperous neighborhood and [provide] public services to address global problems and challenges." [167]

China has conducted more than a dozen NEOs since 2006, including NEOs in Chad, Haiti, Kyrgyzstan, Lebanon, the Solomon Islands, Thailand, Timor-Leste, Tonga, Egypt, Libya, Japan, Iraq, and Vietnam. These NEOs involved the evacuation of 59,600 Chinese nationals in total.[168] Generally, Chinese civilian government agencies—not the PLA—led these NEOs, usually by marshaling commercial ships and aircraft.[169] Significant recent Chinese noncombatant evacuation operations include the following:

- In 2011, the PLA Air Force and Navy deployed four cargo aircraft and one surface combatant, respectively, to support and protect the Ministry of Foreign Affairs-led evacuation of 35,000 Chinese nationals from Libya. This marked the first use of

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* China's aging HAN nuclear attack submarines have weaponry similar to the SONG diesel-electric submarine, but because China has already begun to decommission its older HAN boats and probably will phase out this class as more modern submarines are incorporated into the fleet, the HAN nuclear attack submarine is unlikely to receive substantial armaments upgrades in the near future. *IHS Jane's*, "Jane's Fighting Ships: Han class (Type 091/091G)," February 13, 2015.

† The YUAN's weaponry, likely missile upgrades, and role in PLA Navy operations are similar to those of the SHANG nuclear attack submarine and SONG diesel-electric submarine. *IHS Jane's*, "Jane's Fighting Ships: Yuan Class (Type 041)," February 13, 2015.

‡ Noncombatant evacuation operations involve the extraction of civilians from a foreign country amid a dangerous security situation.

PLA military platforms in a Chinese NEO.[170] China's ministries of Commerce and Public Security, the Civil Aviation Administration of China, Chinese companies operating in Libya, and Chinese shipping companies also participated in the evacuation and coordinated closely with the PLA.[171]

- In May 2014, Chinese civilian government and embassy personnel worked with the Vietnamese government to coordinate the evacuation of 3,553 Chinese nationals from Vietnam following violent anti-Chinese riots. Representatives of the state-owned Metallurgical Corporation of China—the employer of most of the evacuees and a target of the riots—also helped to coordinate the evacuation. The Chinese government used chartered planes to evacuate the roughly 100 people injured in the riots and four chartered ships to evacuate the rest.[172]

The Yemen NEO furthers China's goal to develop NEO capabilities in far seas.[173] The size and projected growth of China's expatriate population and overseas economic assets motivates this mission. Chinese citizens made more than 100 million trips abroad in 2014, and will make 150 million trips abroad annually by 2020.[174] According to Mathieu Duchâtel, senior researcher at the Stockholm International Peace Research Institute, and Jonas Parello-Plesner, former senior policy fellow at the European Council on Foreign Relations, more than five million Chinese nationals live abroad, many working for one of the 20,000 Chinese companies operating overseas.[175] China assesses protecting overseas Chinese citizens and economic assets will require greater expeditionary capabilities, and the 2015 defense white paper suggests China will develop its NEO capabilities by expanding the PLA Navy's global presence and calling on the PLA, rather than civilian government organizations, to run future NEOs. Although the PLA Navy has demonstrated the ability to conduct a NEO in a permissive environment, its limited operational experience and planning capability and lack of overseas military assets and bases may hamper its ability to extend its NEO capabilities beyond the Asia Pacific and greater Indian Ocean regions and to operate in hostile environments. China will likely continue to acquire blue-water naval assets, seek new training and experience for its personnel, and cultivate port agreements in far seas to overcome some of these deficiencies.

China-Russia Security Relations in 2015

China and Russia continued to enhance cooperation in the security realm in 2015. This trend is likely to continue as Beijing and Moscow seek areas of shared interest on which to align while downplaying their growing competition in the economic and foreign policy realms.

Joint Sea 2015

In the first phase of Joint Sea 2015 military exercise, which took place from May 17 to May 21, two PLA Navy Type 054A frigates and a Type 903 auxiliary replenishment oiler met five Russian Navy ships for the first China-Russia joint exercise in the Mediterranean Sea.[176] The exercise featured navigation safety, underway replenishment, escort missions, and live fire training.[177] The Chinese ships docked in the Russian Black Sea port of Novorossiysk several days before the exercises.[178] China's increasing military activity in the Mediterranean Sea indicates Beijing's interest in protecting regional trade routes, maintaining its ability to conduct noncombatant evacuation operations in the region, and demonstrating the increasingly global reach of its military.[179]

The second phase of the exercise took place in the Sea of Japan from August 20 to August 28 and was reported by Chinese and Russian press to be the largest-ever exercise between the two countries.[180] One Russian Navy deputy commander noted that it was "unprecedented" in scope.[181] The weeklong exercise, which involved 7 PLA Navy surface ships, 5 PLA Air Force aircraft, and 200 Chinese marines,[182] focused on "anti-sabotage, anti-submarine, anti-vessel and anti-aircraft defense"[183] and culminated in a joint amphibious landing drill,[184] the PLA's first ever amphibious landing in a foreign country.[185]

China Purchases Russian S–400 Air and Missile Defense Systems

China will purchase S–400 air and missile defense systems from Russia, according to an April 2015 statement from the chief executive officer of Russian arms exporter Rosoboronexport. China signed a contract to purchase the S–400s in 2014.[186] Analysts say the order likely includes four to six units, at a total cost of $3 billion.[187] The S–400 will extend the range of China's surface-to-air missile force from 300 kilometers (approximately 186 miles) to 400 kilometers (approximately 249 miles)—enough to cover all of Taiwan, the Senkaku Islands in the East China Sea, and parts of the South China Sea[188]—and feature an improved ballistic missile defense capability over China's existing surface-to-air missile systems.[189] China also is developing its own next-generation surface-to-air missile, the HQ–19, which likely will have capabilities similar to the S–400.[190]

China-Russia Security Relations in 2015—*Continued*

War Anniversary Parade in Moscow

On May 9, 102 Chinese soldiers marched in a military parade in Moscow to commemorate the anniversary of the end of World War II.[191] President Xi also attended the event. China was one of only ten countries to send a delegation because many Western leaders boycotted the parade over Russia's actions in Ukraine.[192] The participation of Chinese troops in the parade may signal China's growing, if temporary, security alignment with Russia as each country deals with strained security relations with its respective neighbors.

China's Global Arms Sales

China overtook Germany to become the third-largest arms exporter worldwide in 2015, according to a Stockholm International Peace Research Institute study.[193] Between the periods 2005–2009 and 2010–2015, China's exports of major arms rose 143 percent from $3.1 billion to $7.6 billion. China's arms exports increasingly include advanced weapons and platforms, such as jet fighters and missile corvettes. The surge and growing complexity in China's arms exports reflect the maturation of China's domestic defense industry after decades of significant Chinese government investment in defense research and development, as well as China's efforts to secure foreign military technology through arms transfers and espionage.[194] China is poised to continue growing its arms exports as it increasingly offers low-cost alternatives to advanced platforms formerly available only from the United States and Russia. Moreover, these mounting arms exports will support China's military modernization program by defraying the costs of some of the country's investments in its domestic defense industry.

In the past ten years, China has sold weapons to 48 countries, all in Asia, Africa, or Latin America.[195] Several countries, including Algeria, Argentina, Bangladesh, Burma (Myanmar), and Nigeria, have acquired major naval platforms from China. China also has secured deals to supply several countries, including Pakistan, Venezuela, and Bangladesh, with jet fighter aircraft, and is likely to pursue new jet fighter transfers in the near future.[196] Major Chinese arms export deals over the past several years have included the following:

- In March 2015, Pakistan agreed to purchase eight Chinese YUAN-class submarines in a deal reportedly worth as much as $5 billion.[197] The acquisition could support Pakistan's efforts to develop a sea-based nuclear deterrent.[198] Pakistan's YUANs most likely would feature air-independent propulsion diesel engines, a standard feature of PLA Navy YUANs that increases stealth and endurance.
- In June 2015, the *Bangkok Post* reported China had won a bid to provide Thailand with three YUAN-class submarines at a

cost of about $1 billion.[199] Thailand reportedly chose the Chinese bid over bids from Germany and South Korea. Many analysts interpreted the deal as a signal that Thailand's ruling junta seeks closer security ties with China as its partnership with the United States falters.[200] However, in July, Thailand's military leadership apparently shelved the deal, most likely due to popular opposition to the allocation of funds to military acquisitions at the cost of social welfare and economic programs.[201]

U.S.-China Security Relations in 2015

U.S.-China relations were strained in 2015, with China's continued aggressive behavior in the South China Sea and its ongoing cyber espionage against U.S. targets as the two major irritants from Washington's point of view.

U.S.-China Tensions in the South China Sea

Even as China's destabilizing actions in the South China Sea alienate U.S. allies and partners and challenge lawful air and maritime transit by the U.S. military, Beijing continues to insist that the United States should not involve itself in issues related to the South China Sea.[202] In 2015, China's land reclamation activity on seven land features increased tensions between Beijing and its neighbors regarding disputes over the contested Spratly Islands. (See Chapter 3, Section 2, "China and Southeast Asia," for an in-depth examination of China's land reclamation and other activities in the South China Sea.)

U.S.-China tensions in the South China Sea began to heighten considerably in May 2015. On May 12, as more details of China's land reclamation in the South China Sea came to light, the *Wall Street Journal* reported that U.S. Secretary of Defense Ashton Carter was contemplating sending U.S. Navy surveillance aircraft and ships within 12 nm of China's land reclamation projects, citing "growing momentum within the Pentagon and the White House for taking concrete steps in order to send Beijing a signal that the recent buildup in the Spratlys went too far and needed to stop."[203] On October 27, after much deliberation by the Obama Administration, a U.S. Navy guided missile destroyer conducted a freedom of navigation patrol within 12 nm of Subi reef, an artificial island created by China from a low-tide elevation,* appearing to signal that the United States does not consider Subi Reef to have a territorial sea.[204]

Starting in May and continuing through the summer, the U.S. Navy more regularly publicized its air patrols near the land reclamation projects. On May 20, a CNN reporter accompanied the crew of a U.S. Navy P–8A Poseidon surveillance plane that flew from Clark Air Base in the Philippines to airspace near some of China's land reclamation projects. Over the course of the flight, the

*According to UNCLOS, low-tide elevations, which are submerged at high tide, may not generate a territorial sea unless they are located within the territorial sea of another island or mainland coastline. UN Convention on the Law of the Sea, "Part 2: Territorial Sea and Contiguous Zone." See also Gregory Poling, "Carter on the South China Sea: Committed and (Mostly) Clear," *Center for Strategic and International Studies Asia, Maritime Transparency Initiative*, June 3, 2015.

PLA Navy ordered the crew of the Poseidon to leave the airspace eight times.[205] CNN reported the P–8 crew had been flying such missions for months and were accustomed to similar warnings, but they noted the warnings had become more frequent and aggressive as China's land reclamation projects progressed. That same month, a U.S. defense official said U.S. Navy surveillance missions near China's land reclamation projects occur on an almost-daily basis.[206] In July, Commander of the U.S. Pacific Fleet Admiral Scott Swift told reporters he had been present on one such flight, noting that the missions were "positive and structured," and "normalized."[207]

Publicizing U.S. naval patrols and surveillance flights near China's reclaimed land features in the South China Sea appears to be part of a growing effort by the United States both to impose reputational costs on China and to reassure allies, partners, and friends in the region as China's land reclamation and construction activities continue. In his keynote speech at the 2015 Shangri-La Dialogue,* Secretary Carter asked for "a lasting halt" to land reclamation in the South China Sea and harshly criticized China's land reclamation, saying, "Turning an underwater rock into an airfield simply does not afford the rights of sovereignty or permit restrictions on international air or maritime transit."[208] He also reaffirmed the United States' right and intention to "fly, sail, and operate wherever international law allows,"[209] a statement President Obama repeated in a joint press conference during President Xi's first ever state visit to the United States in September.[210]

At the time of the writing of this Report, U.S. pressure on China to cease further land reclamation and military facilities construction appears to have largely been ineffective. In August, China's foreign minister announced China's land reclamation "has already stopped," in an attempt to assuage concerns as consensus was building between the United States and Southeast Asian countries to call for a lasting halt to all land reclamation in the South China Sea.[211] The Chinese foreign minister's assertion was false, however; although the land reclamation phase appears to be nearing completion, China continues to build, expand, and upgrade infrastructure on these reclaimed sites.[212] During the September state visit, President Xi again sought to allay concerns, stating "China does not intend to pursue militarization"[213] of the artificial islands. Absent greater specificity about what constitutes "militarization," and given the existing military infrastructure on China's reclaimed features, President Xi's pledge seems similarly disingenuous.

Memoranda of Understanding on U.S.-China Maritime Encounters

After several close encounters between the U.S. and Chinese militaries in and above the South China Sea in 2013 and 2014,†

* The Shangri-La Dialogue is a high-profile meeting of regional defense leaders held annually in Singapore.

† In December 2013, a PLA Navy ship executed unsafe maneuvers 300 feet from a U.S. Navy ship in the South China Sea, nearly resulting in a collision. On four occasions between March and August 2014, PLA Air Force planes engaged in dangerous and aggressive maneuvers against U.S. Navy aircraft over international waters in the South China Sea. Josh Chin, "Chinese Intercepts of U.S. Aircraft: Rogue Pilots or Realpolitik?" *China Real Time Report* (*Wall Street Journal* blog), August 26, 2014; Tom Cohen, "'Aggressive' Chinese Fighter Jet Flies Dangerously Close to U.S. Military Plane," CNN, August 24, 2014; Scott Neuman, "Photo Released of Chinese Fighter That Buzzed U.S. Navy Plane," *National Public Radio*, August 23, 2014; and

DOD and the Chinese Ministry of Defense completed negotiations on two voluntary memoranda of understanding (MOUs) on "Rules of Safety of Air and Maritime Encounters" and "Notification of Major Military Activities" in November 2014.

The "Rules" MOU seeks to avoid miscalculations and misunderstandings in encounters between U.S. and Chinese surface ships by establishing best practices for unplanned encounters.* [214] During the September 2015 state visit, the two countries announced an air-to-air annex to the "Rules" MOU.† [215] The "Notifications" MOU aims to increase transparency between the two militaries by providing best practices for regularly sharing information about security-related policy developments in each country and by establishing a mechanism to encourage the two militaries to invite each other to observe unilateral, bilateral, and multilateral exercises.[216] At the September state visit, the two sides announced an annex providing rules for an emergency military hotline as well.[217]

The extent to which the Chinese and U.S. militaries have followed the MOU guidance in their interactions is unclear. According to September 2015 testimony to Congress by Adm. Harris, U.S. Pacific Command has "seen very few dangerous activities by the Chinese" since August 2014.[218] Days later, U.S. National Security Adviser Susan Rice also asserted that "[w]e've seen a marked improvement in operational safety since we signed [the MOUs]." [219] One day after Ms. Rice's statement, however, the *Wall Street Journal* reported that on September 15, 2015, two Chinese fighter jets flew within 500 feet of a U.S. Air Force reconnaissance plane approximately 80 miles from China's coast in the Yellow Sea. U.S. defense officials referred to the intercept as "unsafe," but were hopeful that it was an isolated incident, noting "improvements" in the behavior of PLA pilots since last year.[220]

Chinese Cyber Espionage Continues to Damage Relations

China's unabated use of cyber espionage continues to erode trust between Washington and Beijing. Of particular concern to the U.S. government and business community is Chinese cyber-enabled economic espionage. Chinese economic espionage not only disadvantages the U.S. economy, but also can have an impact in the security realm when targeting defense contractors and sensitive tech-

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John Harper, "Hagel Calls Chinese Actions against USS Cowpens 'Irresponsible,'" *Stars and Stripes*, December 19, 2013.

*This MOU follows a similar nonbinding agreement signed in 2014, the "Code on Unplanned Encounters at Sea" between China, the United States, and 19 other Pacific countries. Neither of these agreements addresses China's policy of requiring prior permission for foreign intelligence gathering and military activity in its exclusive economic zone, contrary to international law. Referring to the 2014 code, a senior PLA Navy official stated that "whether or where or when these rules apply" had not been decided. Similarly, the "Rules" MOU allows each country their own interpretation, stating "this Memorandum is made without prejudice to either side's policy perspective on military activities in the exclusive economic zone." Jeremy Page, "China Won't Necessarily Observe New Conduct Code for Navies," *Wall Street Journal*, April 23, 2014; U.S. Department of Defense and Chinese Ministry of National Defense, *Memorandum of Understanding between the United States of America Department of Defense and the People's Republic of China's Ministry of Defense on Notification of Major Military Activities Confidence Building Measures Mechanism*, November 4, 2014, 4; and Peter Dutton and Andrew Erickson, "When Eagle Meets Dragon: Managing Risk in Maritime East Asia," *Real Clear Defense*, March 25, 2015.

†During the state visit, the two countries also announced they would pursue a parallel "Rules" MOU for the U.S. and Chinese coast guards. *White House Office of the Press Secretary*, "Fact Sheet: Chinese President Xi Jinping's State Visit to the United States," September 25, 2015.

nologies with military applications. A January 2015 internal DOD report found the U.S. defense industry to be vulnerable to cyber espionage, asserting there were "significant vulnerabilities on nearly every [DOD] acquisition program that underwent cybersecurity [operational test and evaluation] in [fiscal year] 2014."[221] (For an in-depth discussion of China's cyber-enabled economic espionage activities, see Chapter 1, Section 4, "Commercial Cyber Espionage and Barriers to Digital Trade in China.")

Chinese cyber espionage against the United States government is also of concern. Perhaps the most notable evidence of China's growing espionage against the U.S. government came in 2015 with the revelation that the personal information of more than 22 million Americans as well as millions of sensitive and classified documents had been exfiltrated from the U.S. Office of Personnel Management via a massive cyber espionage campaign.[222] Several observers, including the U.S. Director of National Intelligence James Clapper, have suggested the Chinese government was behind the campaign.[223] At the time of the writing of this Report, the U.S. government had not publicly attributed the espionage campaign to China.

In addition, China is developing capabilities to conduct offensive cyber operations—which are separate from cyber espionage—against U.S. military or civilian systems.* An updated edition of one of China's most authoritative resources on military strategy, *The Science of Military Strategy*, acknowledges for the first time the existence of offensive cyber forces within China's military, something Beijing had previously denied.† As noted earlier, China's 2015 defense white paper refers to the cyber realm as one of two "new commanding heights in strategic competition."[224] According to U.S. defense officials, the United States and China are negotiating an agreement that neither side will conduct offensive cyber operations against each other's civilian critical infrastructure in peacetime.[225]

Select U.S.-China Security-Related Visits and Exchanges in 2015

Presidents Obama and Xi Hold a Summit: As noted earlier, President Xi Jinping made his first ever state visit to the United States in September 2015. During the visit, the two countries announced several agreements and cooperative efforts, the most prominent related to climate change and cyber-enabled economic espionage. In addition to the expanded military MOU noted previously, other security and foreign policy announcements included commitments to: advance counterterrorism cooperation (particularly on countering improvised explosive devices); expand

* For an assessment of China's offensive cyber warfare capabilities and how they might interact with U.S. forces and systems in a conflict, see Evan Heginbotham et al., "The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power 1996–2017," *RAND Corporation*, September 2015, 259–282.

† The updated *Science of Military Strategy* was published in Chinese in 2013, but had not been translated into English until early 2015. Shane Harris, "China Reveals Its Cyberwar Secrets," *Daily Beast*, March 18, 2015.

Select U.S.-China Security-Related Visits and Exchanges in 2015—*Continued*

humanitarian assistance and disaster relief cooperation; establish an annual bilateral dialogue on nuclear security; and maintain cooperation in support of reconstruction and economic development in Afghanistan.[226]

U.S.-China Strategic and Economic Dialogue: At the seventh round of the Strategic and Economic Dialogue talks held in Washington on June 23–24, 2015, participants discussed over 100 issues, but accomplished little on the "Strategic Track," likely due to impasses over the South China Sea and cybersecurity.[227]

Central Military Commission Vice Chairman Fan Changlong Visits the United States: General Fan spent six days in the United States in June 2015, visiting the U.S. aircraft carrier *Ronald Reagan* in San Francisco, a Boeing factory in Seattle, and the U.S. Army Base at Fort Hood before arriving in Washington, DC, for meetings with Pentagon and State Department officials.[228] During his visit, the two sides established an Army-to-Army Dialogue.[229] China's land reclamation in the South China Sea was a prominent discussion topic, although it appears little progress was made to address either side's concerns.[230] General Fan invited Secretary Carter and Adm. Harry Harris to visit China before the end of the year.[231] General Fan visited Cuba immediately after his trip to the United States.[232]

Joint Antipiracy Exercises in the Gulf of Aden: The U.S. and Chinese navies participated in their third annual joint antipiracy exercise in the Gulf of Aden in December 2014. The two-day exercise involved a U.S. Navy guided-missile destroyer, at least two PLA Navy ships, and more than 700 personnel. The exercise included combined visit, board, search, and seizure operations (to include the landing of a PLA Navy helicopter on the U.S. ship), and communications exchanges, among other activities.[233] Captain Doug Stuffle, commander of U.S. Navy Destroyer Squadron 1, said, "These bilateral exercises help us establish clear paths for communication; they encourage transparency of trust, help us mitigate risk, and allow us to demonstrate cooperative efforts in the international community to help us work together to deal with transnational threats. In the end, we look to create a peaceful, stable and secure maritime domain."[234] The PLA, which has been undertaking antipiracy patrols in the Gulf of Aden since December 2008, began its 21st escort task force in August 2015.[235]

Joint Exercise in the South China Sea: In April, the U.S. Seventh Fleet flagship *Blue Ridge* and a PLA Navy landing craft conducted joint drills in uncontested waters of the South China Sea. The first part of the exercise focused on improving communication at sea; the second part focused on search and rescue.[236]

Other Military Exercises: The U.S. and Chinese militaries participated in several multilateral exercises together in 2015. In January, a combined U.S., Chinese, and Thai military engineer

Select U.S.-China Security-Related Visits and Exchanges in 2015—*Continued*

force built a school in Thailand as part of the multilateral Cobra Gold exercise.[237] In May, China and Malaysia led the fourth Association of Southeast Asian Nations Regional Forum Disaster Relief Exercise, which included the United States and 24 other participants and simulated a typhoon impacting Malaysia.[238] In June, China participated for the first time in "Exercise Khaan Quest," a 25-country peacekeeping drill led by Mongolia and the United States.[239] From August to September, the United States, China, and Australia conducted their second trilateral "Kowari" exercise, during which a small number of troops from each country participated in wilderness training in a remote area near Darwin, Australia.[240] From August to October, China, the United States, and the United Kingdom sent small numbers of troops to participate in New Zealand's "Tropic Twilight" humanitarian drill, which involved infrastructure construction and upgrades for schools and clinics at outlying Cook Islands atolls.[241]

Port Visits: The *Blue Ridge* visited Zhanjiang in April. There, the *Blue Ridge* hosted ship tours for Chinese military personnel, and its crew received reciprocal PLA Navy ship tours. Specific details of the ship visits were not publicized.[242] In addition, the U.S. guided missile destroyer *Stethem* visited Qingdao in July. The July port visit also involved planning for a future search and rescue exercise at sea.[243]

Quarterly Video Teleconferences between Naval Chiefs: Starting in April 2015, former U.S. Chief of Naval Operations Admiral Jonathan Greenert and his Chinese counterpart Admiral Wu Shengli, Commander in Chief of the PLA Navy, began conducting quarterly video teleconference calls to discuss a range of issues in the military-to-military relationship. During a July call, Adm. Wu invited then incoming (now acting) Chief of Naval Operations Admiral John Richardson to visit China.[244]

Other Exchanges: 27 military-to-military exchanges were planned for 2015, according to DOD's annual report to Congress on China's military for 2015.* At the time of the writing of this Report, approximately half of these exchanges appear to have occurred. In addition to the aforementioned exchanges, the following took place: U.S. Army Pacific Commander General Vincent K. Brooks visited Beijing and Haikou to meet with PLA leaders;[245] defense officials held the annual Defense Policy Coordination Talks and Asia-Pacific Security Dialogue in Washington, DC;[246] PLA Navy and PLA Air Force academic delegations visited the United States;[247] a U.S. National Defense University delegation visited the Shenyang Military Area Command;[248] and defense officials conducted the 10th U.S.-China Disaster Management Exchange, among other exchanges.[249]

*These were to include 4 high-level visits, 11 institutionalized exchanges, 5 academic exchanges, and 7 functional exchanges. U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, May 2015, 75.

Conclusions

- Three years after coming to power, Chinese President Xi Jinping has made significant progress consolidating control over China's national security and foreign policy apparatus. Two areas of particular focus for the Xi Administration are strengthening the state's power over national security matters (as exemplified in three new and proposed laws governing national security) and emphasizing "peripheral diplomacy" with China's neighbors (as exemplified in the One Belt, One Road initiative).
- U.S.-China security relations continued to deteriorate in 2015. China's aggressive behavior in the South China Sea and its unremitting cyber espionage against the United States were the key drivers of growing distrust. Further, the Chinese military's continued emphasis on developing antiaccess/area denial capabilities makes clear that China seeks the capability to limit the U.S. military's freedom of movement in the Western Pacific.
- China's military modernization program continues to bear fruit, particularly as new naval and air force platforms and capabilities come online. In particular, new developments in China's naval modernization increase its ability to deploy troops and equipment in contingencies in the East and South China seas and those involving islands held by Taiwan. Moreover, the continued production of surface combatants, along with advances in submarine and aircraft carrier programs, supports China's ability to project force in its near seas.
- China in 2015 continued to take steps to bolster its position in its dispute with Japan over islands and adjacent waters in the East China Sea by constructing 16 structures to facilitate natural gas exploitation near disputed waters; conducting near-daily patrols of contested waters and airspace; and enhancing the PLA Air Force's presence in the East China Sea with the establishment of regular oversea training flights far from China's coast and a first-ever transit flight through Japan's Miyako Strait.
- The rapid growth of China's arms exports during the last ten years reflects the maturation of China's domestic defense industry. In the coming years, Chinese arms, including advanced systems such as jet fighters, will increasingly compete with U.S. and Russian arms on the global market.
- China's noncombatant evacuation operations, far seas submarine deployments, and interest in establishing an overseas military facility reflect its willingness to use military resources to defend its growing overseas assets. China's global security activities likely will increase as the population of Chinese nationals overseas grows along with Chinese overseas economic activity.
- As a result of China's comprehensive and rapid military modernization, the regional balance of power between China, on the one hand, and the United States and its allies and associates on the other, continues to shift in China's direction.

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SECTION 2: CHINA'S SPACE AND COUNTERSPACE PROGRAMS

Introduction

China has become one of the top space powers in the world after decades of high prioritization and steady investment from its leaders, indigenous research and development, and a significant effort to buy or otherwise appropriate technologies from foreign sources, especially the United States. China's aspirations are driven by its assessment that space power enables the country's military modernization and would allow it to challenge U.S. information superiority during a conflict. As the Commission has documented in previous reports, China has asserted sovereignty over much of the East and South China seas, as well as Taiwan, and is engaged in a course of aggressive conduct to enforce those claims against its neighbors. Among other purposes, China's space and counterspace programs are designed to support its conduct as part of its antiaccess/area denial * strategy to prevent or impede U.S. intervention in a potential conflict. China also believes that space power drives the country's economic and technological advancement and provides the Chinese Communist Party (CCP) with significant domestic political legitimacy and international prestige. Although China's space capabilities still generally lag behind those of the United States and Russia, its space program is expanding and accelerating rapidly as many other countries' programs proceed with dwindling resources and limited goals.

China's rise as a space power has important national security implications for the United States, which relies on its own space capabilities to assess and monitor current and emerging threats to national security and project military power globally. Within this context, this section will examine China's space and counterspace programs, including key organizations involved in the programs; space power's contribution to China's national power; China's development of a robust and comprehensive array of counterspace capabilities; China's rapid space-based C4ISR † modernization; China's progress in space launch, human spaceflight, and lunar exploration; and U.S.-China space cooperation. The statements and assessments presented in this section are based on the Commission's February 2015 hearing on China's space and counterspace programs, unclassified briefings by U.S. and foreign government offi-

* According to the U.S. Department of Defense, "antiaccess" actions are intended to slow deployment of an adversary's forces into a theater or cause them to operate at distances farther from the conflict than they would prefer. "Area denial" actions affect maneuvers within a theater, and are intended to impede an adversary's operations within areas where friendly forces cannot or will not prevent access. U.S. Department of Defense, *Air Sea Battle: Service Collaboration to Address Anti-Access & Area Denial Challenges*, May 2013, 2.

† C4ISR refers to command, control, communications, computers, intelligence, surveillance, and reconnaissance.

cials, consultations with nongovernmental experts on China and space issues, the Commission's July 2015 fact-finding trip to China, and open source research and analysis.

Key Organizations Involved in China's Space and Counterspace Programs

China's space program involves a wide network of entities spanning its political, military, defense industry, and commercial sectors. Unlike the United States, China does not have distinctly separate military and civilian space programs. CCP leaders provide policy guidance and authorize allocations of resources for the program, and various organizations within the People's Liberation Army (PLA) execute space policy and oversee the space research, development, and acquisition process. China's military also exercises control over the majority of China's space assets and space operations.

Although China conducts civilian space activities, such as scientific research and exploration, and Chinese civilian agencies provide input into space policy and space research, development, and acquisition requirements, China does not have an official civilian space program.[1] Tate Nurkin, managing director of research and thought leadership at IHS Jane's Aerospace, Defense and Security, explained to the Commission:

> *China's space program does not have structures in place that make meaningful divisions between military and civil programs, and those technologies acquired and systems developed for ostensibly civil purposes can be applied—and most frequently are—for military purposes. This dynamic indicates that China's space program is also a critical element in the country's ongoing military modernization program.*[2]

Under this nebulous framework, even China's ostensibly civilian projects, such as human spaceflight, directly support the development of PLA space, counterspace, and conventional capabilities.[3] Moreover, although any country's satellites are capable of contributing to its military operations, the PLA during wartime would probably take direct command over all Chinese satellites.

Central Special Committee

One important coordinating body for China's major strategic research and development (R&D) projects is the Central Special Committee, which reports to the CCP Politburo Standing Committee, Central Military Commission,* and State Council.† Established in the early 1960s and led through the decades by some of China's top political leaders,‡ the Central Special Committee brings together

* China's Central Military Commission is the country's top military decision-making body. Congressional-Executive Commission on China, *China's State Organizational Structure*.

† China's State Council, headed by Premier Li Keqiang, presides over China's ministries, commissions, and direct offices. It is responsible for executing laws, supervising the government bureaucracy, and carrying out the administrative functions of the Chinese government. Congressional-Executive Commission on China, *China's State Organizational Structure*.

‡ The Committee has been chaired by Zhou Enlai, Hua Guofeng, Deng Xiaoping, Li Peng, Zhu Rongji, and Wen Jiabao, indicating today it is likely chaired by Li Keqiang. Tai Ming Cheung, "The Special One: The Central Special Committee and the Structure, Process, and Leadership

Continued

civilian and military leaders and technical experts on an ad hoc basis to evaluate and provide recommendations on strategic dual-use high-technology programs—almost certainly including China's space launch, human spaceflight, and lunar programs. The committee may play a role in important military science and technology projects as well. Although the Central Special Committee today is a government—rather than party—institution, and lacks the broad decision-making authority it had in the 1960s and 1970s, it still signifies China's state-led, top-down policy approach to science and technology development and its focus on large-scale projects.[4]

Leading Small Groups

China has established several leading small groups to help forge institutional consensus regarding its space policies and to provide high-level coordination among the array of political, military, defense industry, and commercial organizations involved. China reportedly has formed leading small groups for human spaceflight, lunar exploration, Earth observation satellites, and heavy-lift launch vehicles.[5] These groups, which are formalized fora rather than institutions, are composed of representatives from relevant organizations selected on a project-specific basis, and are led by top CCP officials.

Ministry of Science and Technology

The Ministry of Science and Technology (MOST), which is directly subordinate to the State Council, formulates and promulgates major long-term strategies for the development of science and technology. MOST's national R&D strategy for the 2006–2020 period, the *Medium-to-Long-Term Plan for the Development of Science and Technology*, coordinates state-funded R&D efforts across government, military, and commercial spheres and places heavy emphasis on funding basic research that affects multiple fields. Concerning China's space program, the strategy updates and accelerates the pursuit of space R&D objectives established in the *State High-Technology Development Plan of 1986* (also known as the 863 Program), which set China's space development on its current trajectory. The strategy for 2006–2020 identifies and funds 13 unclassified technology megaprojects, including a high-definition Earth observation system and human spaceflight and lunar probes. It also reportedly identifies and funds three classified programs, which many analysts believe to be a laser project exploring inertial confinement fusion, the Beidou satellite navigation system, and a hypersonic glide vehicle program.[6]

State Administration of Science, Technology, and Industry for National Defense

The State Administration of Science, Technology, and Industry for National Defense (SASTIND), which is subordinate to the State Council's Ministry of Industry and Information Technology, exer-

of the Chinese Defense and Strategic Dual-Use Science, Technology and Industrial Triangle" (Conference on the Structure, Process, and Leadership of the Chinese Science and Technology System, San Diego, CA, July 16–17, 2012).

cises administrative authority over China's defense industrial enterprises and serves as an intermediary among China's military, defense industry (including its space industry), government ministries, research facilities, and other stakeholders. In this capacity, SASTIND organizes and coordinates space R&D, approves space contracts, and develops standards for the space industry. SASTIND also directly manages China's lunar exploration program.[7]

China National Space Administration

The China National Space Administration (CNSA), which is subordinate to SASTIND and is led by the SASTIND director, is a small organization that is responsible for China's relations with external parties on non-commercial and non-military space-related matters. In this capacity, CNSA coordinates and executes international agreements and other aspects of China's international cooperation efforts in space.[8] Since 2014, CNSA has engaged with the space programs of a range of countries, including Algeria, Germany, India, Italy, the Netherlands, Russia, Sudan, and Turkmenistan, as well as the European Union.[9]

Although CNSA often is incorrectly referred to as China's equivalent of the U.S. National Aeronautics and Space Administration (NASA), it does not have a direct role in overseeing China's space policy; space research, development, and acquisition process; space assets; or space operations.[10]

General Staff Department

The General Staff Department serves as the PLA's headquarters.* As such, it develops short- and long-term requirements for space and counterspace technologies based on guidance from the Central Military Commission and the PLA services. The General Staff Department is also the focal point for China's space warfare operations and planning. The department houses operations, intelligence, and electronic warfare elements—among other capabilities—to assist the PLA in carrying out its functions.[11]

General Armaments Department

The General Armaments Department is responsible for supplying and maintaining the PLA's weapons systems and managing important weapons testing centers and research centers. As such, it oversees the research, development, and acquisition process for China's satellites, launch vehicles, and counterspace weapons and manages large national-level engineering projects, such as China's human spaceflight program. The General Armaments Department, through subordinate entities, is also responsible for the day-to-day operations of the majority of China's military and civilian space activities.[12] Additionally, the department is believed to advise the Central Military Commission on space and counterspace issues via its Science and Technology Committee's expert groups.[13]

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*Directly subordinate to the Central Military Commission, the highest command organ in China's military, are four General Departments: the General Staff Department, the General Political Department, the General Logistics Department, and the General Armaments Department. The General Departments are responsible for executing Central Military Commission policies and conducting the day-to-day administration of China's military.

The China Satellite Launch, Tracking, and Control General (CLTC), which is subordinate to the General Armaments Department, is the entity responsible for managing China's space launches and the telemetry, tracking, and control functions for its spacecraft systems.* In this capacity, the CLTC runs a significant portion of the General Armament Department's land-based space infrastructure, including its launch centers, control centers, telemetry and tracking stations, and naval space tracking vessels. In addition, the CLTC designs and manufactures space launch and telemetry, tracking, and control equipment, constructs China's land-based space infrastructure, and handles space launch and telemetry, tracking, and control functions for foreign customers of China's space industry.[14]

Space Launch Centers

The CLTC has four launch centers—Jiuquan, Xichang, Taiyuan, and Wenchang—each of which launches military, civilian, and commercial spacecraft. Jiuquan Space Launch Center, which became operational in 1960, is China's oldest and largest launch facility. From Jiuquan, China launches many of its intelligence, surveillance, and reconnaissance (ISR) satellites and all spacecraft involved in its human spaceflight program.[15] Xichang Launch Center is China's most active facility and the only one capable of conducting launches to geosynchronous Earth orbit.† From Xichang, China primarily launches most of the country's commercial satellites as well as government-owned communications satellites.[16] Taiyuan Satellite Launch Center is China's least active launch site. From Taiyuan, China primarily launches meteorological, Earth resource, and scientific satellites. The PLA also conducts test launches of its ballistic missiles from the complex.[17]

In late 2014, China opened the Wenchang Satellite Launch Center on Hainan Island, the southernmost province of China. Once full operations begin, Wenchang will launch all of China's future ISR satellites and manned spacecraft. According to Kevin Pollpeter, deputy director of the Study of Innovation and Technology in China Project at the University of California Institute on Global Conflict and Cooperation, "the launch center's closer proximity to the equator than China's three other launch centers can increase launch payloads by 10–15 percent and satellite life by two to three years, a factor important for developing the country's commercial launch market. Launches will also be directed over the ocean, which will permit debris from launches to land safely out to sea." [18]

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* Telemetry, tracking, and control is the process of monitoring spacecraft systems, transmitting the status of those systems to the control segment on the ground, and receiving and processing instructions from the control segment.

† Geosynchronous Earth orbit can be achieved at about 22,000–23,000 miles above the Equator. The highest orbital band within geosynchronous Earth orbit in frequent use is known as "geostationary Earth orbit." At this altitude, satellites move at the same speed as the Earth's rotation, enabling them to cover large geographic areas. Satellites in geostationary Earth orbit are used primarily for early-warning missile and nuclear test monitoring, electronic intelligence, commercial communications, and satellite television and radio.

Figure 1: China's Space Launch Centers

Source: Economist, "Space: Ready for Launch: China's Secretive Space Program Takes a Step into the Open," January 8, 2015.

Space Tracking and Control

Space operations require a substantial amount of support from land-based infrastructure. Most of this support is provided by two CLTC-managed control centers: (1) the Xi'an Satellite Telemetry and Control Center, China's main facility for controlling satellites and managing satellite data; and (2) the Beijing Aerospace Flight Control Center, China's main facility for controlling China's human and lunar missions.[19]

The Xi'an and Beijing control centers rely on a network of 10–20 telemetry and tracking stations positioned throughout China. The stations, which act as middlemen to relay information between China's spacecraft and the control centers, can only communicate with spacecraft when they are directly overhead. The centers thus are unable to maintain constant communication with spacecraft that travel beyond the area visible from China's territory. To help alleviate these coverage limits, the CLTC has built telemetry and tracking stations in Namibia, Pakistan, and Chile, and leases access to stations in Kenya and Australia.* China is constructing a sixth overseas telemetry and tracking station in Argentina, a reported investment of over $300 million, in exchange for providing Argentina a share of the antenna's usage time and access to imagery from its surveillance satellites.[20] Additionally, the CLTC operates as many as six Yuanwang naval space tracking vessels, which serve as mobile telemetry and tracking stations. The Yuanwang ships have provided critical C4ISR support to China's intercontinental ballistic missile tests and some of its human spaceflight missions.[21]

Defense Industrial Organizations

The China Aerospace Science and Technology Corporation (CASC) and China Aerospace Science and Industry Corporation (CASIC) are the primary state-owned defense industrial enterprises that support the General Armament Department in the research, development, and manufacturing of space and counterspace technologies and systems. Formed in 1999 out of a single entity, the Chinese Aerospace Corporation, these two conglomerates were established to inject competition into China's aerospace industry—a move the country's leaders hoped would spur the industry to become more efficient, more innovative, and less of a financial burden on the central and local governments.[22] Since the division, CASC and CASIC have demonstrated advancements in these areas, though their progress has resulted from improvements to internal processes rather than from expanded competition, as the two conglomerates have largely focused on different product areas with little overlap.[23]

China Aerospace Science and Technology Corporation

CASC plans and oversees the development, production, and testing of space launch vehicles, manned spacecraft, space stations, deep space exploration spacecraft, and ballistic missiles. It also heavily invests in satellite applications, information technology, and other industries to which space technology is applicable. CASC employed over 170,000 individuals in 2012, the latest year for which statistics are available. The corporation comprises 8 large research and production academies,† 14 specialized firms, and 12 companies publicly listed in either China or Hong Kong, and is home to 11 defense science and technology (S&T) laboratories, a national engineering laboratory, and 5 engineering research centers.[24] Two subordinate organizations are particularly important to China's space activities:

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* China previously operated a telemetry and tracking station in Tawara Atoll, Kirabati, but closed the station in 2003 when Kirabati recognized Taiwan. Jane's Space Systems and Industry, "XSCC-Xian Satellite Control Center"; Brian Harvey, *China in Space: The Great Leap Forward*, Springer, 2013, 65.

† The term "Academy" for these subordinate organizations should not be taken literally, as Gao Ruofei, Executive Vice President of the China Great Wall Industry Corporation, informed the Commission during its July 2015 trip to China. Instead, these should be characterized as "research, development, and manufacturing entities." Gao Ruofei, China Great Wall Industry Corporation, briefing to Commission, Beijing, China, July 22, 2015.

- The China Academy of Space Technology, one of CASC's eight academies,* is responsible for the development and production of satellites and spacecraft. The Academy developed many of China's high-profile space projects, including the Shenzhou series of manned spacecraft, the Chang'e lunar orbiter, and the Tiangong-1 space laboratory. It also designs many of China's C4ISR satellites and plays a role in the formation of China's national space technology development plans. The Academy employs over 10,000 people.[25]
- The China Great Wall Industry Corporation is one of CASC's 14 specialized firms and serves as its commercial representative for launch services and satellite systems. In this capacity, the corporation is responsible for international marketing, contracting, and export management. It is China's sole commercial entity engaged in these functions. Once contracted, the corporation conducts these commercial launches in conjunction with other CASC and PLA entities. The corporation also engages in international space cooperation efforts and provides products and services for a wide range of civilian applications that nominally utilize space technology, including satellite technology, information technology products, electronic products, and real estate.[26] China Great Wall Industry Corporation was placed under U.S. sanctions in 1991, 1993, 2004 (twice), and 2006 for exporting missile technology to Pakistan and Iran, with the last of the sanctions lifted in 2008 following the company's establishment of an internal compliance program based on U.S. training.[27] In a briefing to the Commission during its trip to Beijing in July 2015, the corporation's executives emphasized the implementation of this program and the company's promise to never engage in the import and export of missiles and their associated products.[28]

China Aerospace Science and Industry Corporation

CASIC is China's largest missile designer and manufacturer. As such, the organization plans and oversees the development, production, and testing of China's direct-ascent antisatellite assets and operationally responsive launch capability, including the associated road-mobile launchers and small satellites. CASIC employed more than 135,000 workers in 2013, the latest year for which statistics are available. It comprises five academies, two scientific research and production bases, six companies publicly listed in either China or Hong Kong, and over 570 enterprises and institutes.[29]

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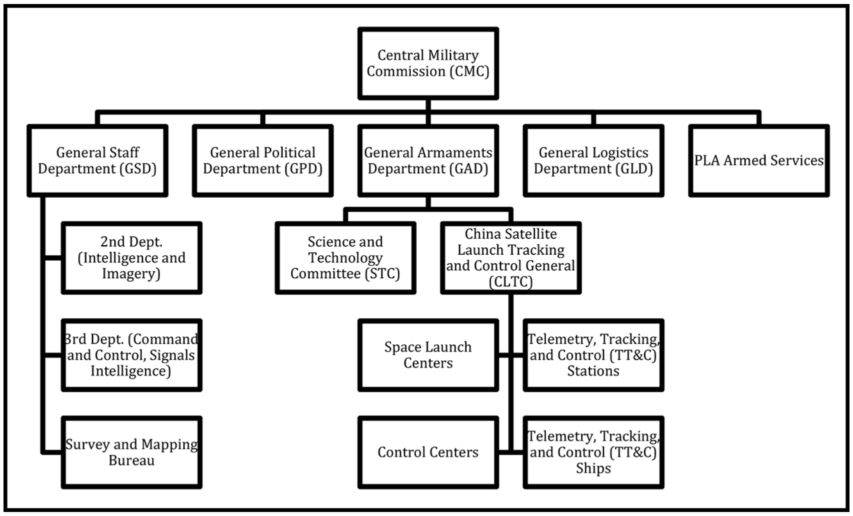
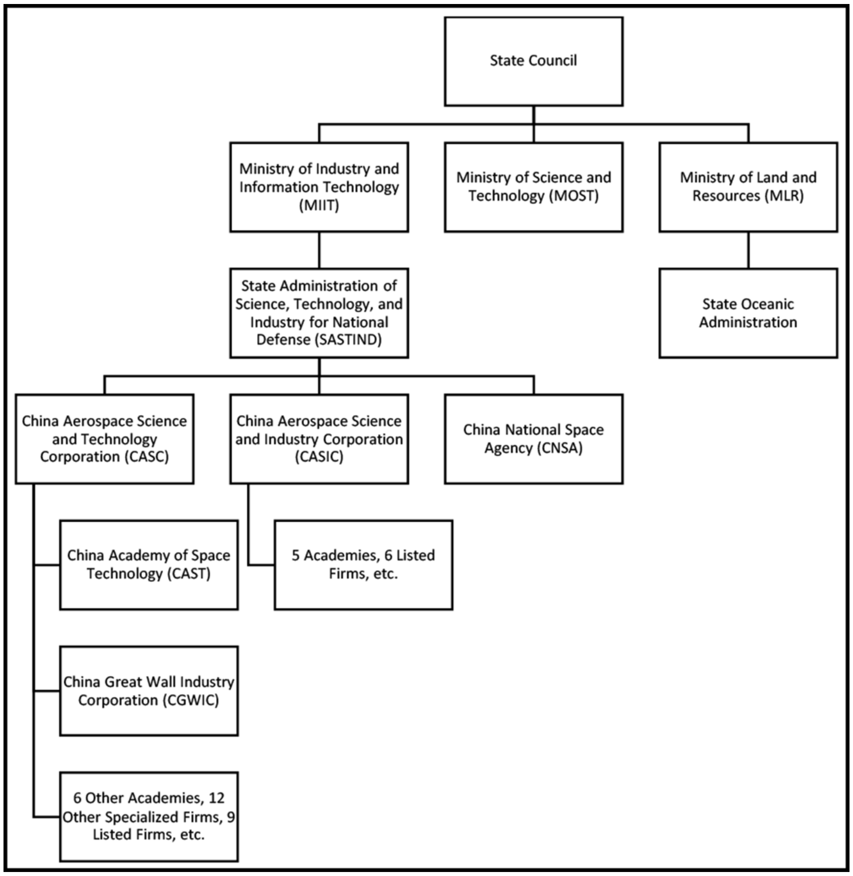
*The other seven academies are the Academy of Launch Vehicle Technology, the Academy of Aerospace Solid Propulsion Technology, the Academy of Aerospace Propulsion Technology, the Sichuan Academy of Aerospace Technology, the Academy of Spaceflight Technology, the Academy of Aerospace Electronics Technology, and the Academy of Aerospace Dynamics.

Figure 2: Select Military Organizations Involved in China's Space Program



Source: Kevin Pollpeter, *China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States* (Prepared for the U.S.-China Economic and Security Review Commission by the University of California Institute on Global Conflict and Cooperation, March 2, 2015), 96–106; Eric Hagt, "Integrating China's New Aerospace Power in the Maritime Realm," in Andrew S. Erickson and Lyle J. Goldstein, eds., *Chinese Aerospace Power: Evolving Maritime Roles*, Naval Institute Press, 2011, 386.

Figure 3: Select Civil and Defense Industry Organizations Involved in China's Space Program



Source: Kevin Pollpeter, *China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States* (Prepared for the U.S.-China Economic and Security Review Commission by the University of California Institute on Global Conflict and Cooperation, March 2, 2015), 96–106; Eric Hagt, "Integrating China's New Aerospace Power in the Maritime Realm," in Andrew S. Erickson and Lyle J. Goldstein, eds., *Chinese Aerospace Power: Evolving Maritime Roles*, Naval Institute Press, 2011, 386.

Space Power's Contribution to China's National Power

Military Contributions

In the early 1980s, China set out to transform its military from a large infantry-based army designed to fight protracted wars into a smaller, well-trained, and "informationized" force.* China accelerated this effort in 2004, when the PLA formally institutionalized the concept of "informationization."[30] Since then, the PLA has based its "preparations for military struggle" on the strategy of "winning local wars under the conditions of informationization," ac-

* In Chinese military doctrine, "informationization" refers to the application of advanced information technology to military operations.

cording to authoritative PLA documents.*[31] This requires China to narrow the technology gap between the PLA and the world's most advanced militaries through a focus on information technology and on developing and procuring new, high-tech communications and data fusion systems for battle space management and for long-range, accurate weapons. At the operational level, PLA writings identify information superiority as the key factor in all antiaccess/area denial tasks, which includes the fielding of an integrated air defense and the coordination and synchronization of strikes against an adversary's forces. According to China's most recent *Science of Campaigns*, an authoritative document on PLA campaigns published by China's National Defense University, "the struggle for . . . information superiority has infiltrated into each campaign phase . . . and become a decisive condition for seizing the battlefield initiative."[32]

PLA strategists and analysts recognize that space forces are crucial to the PLA's transformation into an informationized force as well as its ability to achieve information superiority during a conflict. According to Dean Cheng, senior research fellow for Chinese political and security affairs at the Heritage Foundation, these PLA analysts have specifically noted that "more and more essential data . . . is gathered from or transits through satellites." They assess that space systems now provide a majority of battlefield communication, battlefield surveillance and reconnaissance, weather condition assessment, and precision guidance functions, rendering "space dominance" an essential component of realizing "information dominance."[33] The PLA has accordingly developed space capabilities in pursuit of achieving these and other functions, including ISR, ballistic missile warning, space launch detection and characterization, environmental monitoring, satellite communication, and position, navigation, and timing.

- *Intelligence, Surveillance, and Reconnaissance*. Space-based systems can monitor areas of interest to help provide China's political and military leaders with information on an adversary's location, disposition, and intent; assist in tracking, targeting, and engaging an adversary's forces; and provide a means to conduct battle damage assessment. They also can provide situational awareness and warning of attack.
- *Ballistic Missile Warning*. Space-based systems, in conjunction with ground-based systems and operators, can provide China's political and military leaders with timely warning and characterization of foreign ballistic missile events and nuclear detonations to support threat/non-threat determination and follow-on decision making.
- *Space Launch Detection and Characterization*. Space-based systems, in conjunction with ground-based systems, can provide information necessary to assess both foreign and domestic space launches. Launch detection data can be used to evaluate events that could directly or indirectly threaten China's space

*China's most recent defense white paper, published in 2015, updated this term slightly to "winning informationized local wars." China Information Office of the State Council, *China's Military Strategy*, May 26, 2015, 3.

assets so the PLA can achieve timely warning and take appropriate countermeasures. This capability also can support analysis of China's domestic space launches.

- *Environmental Monitoring*. Space-based systems can provide data on meteorological, oceanographic, and space environmental factors that affect PLA operations. Additionally, space capabilities can provide data to assist the development of forecasts, alerts, and warnings regarding factors in the space environment that may negatively impact China's space assets, space operations, and their terrestrial users. Imagery capabilities can provide Chinese planners with current information on sub-surface, surface, and air conditions, allowing PLA commanders to avoid adverse environmental conditions or take advantage of other conditions to enhance operations. Such monitoring also can support intelligence preparation of the operational environment by providing PLA analysts with information necessary to assess potential adversary courses of action.
- *Satellite Communications*. Satellite communications can provide the PLA with the ability to establish or augment telecommunications in operating areas that lack suitable land infrastructure. Potential PLA applications of satellite communication technology include providing instant global connection between deployed forces and the Central Military Commission, transmitting critical intelligence between echelons of command, and tying sensors to weapons systems.
- *Positioning, Navigation, and Timing (PNT)*. Space-based PNT assets can provide information PLA forces can use to more effectively plan, coordinate, and execute operations. Precise and reliable PNT information is essential to the performance of virtually every modern Chinese weapon system.[34] The PLA can apply precision timing to synchronize operations and conduct attacks from stand-off distances, thereby allowing Chinese forces to avoid threat areas and defend against opposing naval forces from a position as far as possible from the Chinese coast.

Analysis of authoritative Chinese documents indicates Beijing believes space superiority would be critical to almost every component of its military operations (particularly long-range precision strikes) during a potential Taiwan Strait conflict and against the United States and other potential adversaries in the region.[35] In 2009, then PLA Air Force Commander and current Vice Chairman of the Central Military Commission Xu Qiliang said space had become a "new commanding height for international strategic competition" and having control of air and space "means having control of the ground, oceans, and the electromagnetic space, which also means having the strategic initiative in one's hands."[36] China's 2015 defense white paper* affirms the importance of space in China's strategic calculus:

* Defense white papers—China's most authoritative statements on national security—are published by the State Council's Information Office and approved by the Central Military Commission, Ministry of National Defense, and State Council. Beijing primarily uses these documents as a public relations tool to help ease deepening international concern over China's military modernization and answer calls for greater transparency.

> *Outer space has become a commanding height in international strategic competition. Countries concerned are developing their space forces and instruments, and the first signs of weaponization of outer space have appeared. . . . China will keep abreast of the dynamics of outer space, deal with security threats and challenges in that domain, and secure its space assets to serve its national economic and social development, and maintain outer space security.*[37]

The PLA also is pursuing a robust and comprehensive array of counterspace capabilities. China has not published an officially endorsed document describing its counterspace strategy and doctrine and likely is still developing its tactics, techniques, and procedures. Since the early 2000s, however, PLA doctrinal publications and military writings on space warfare * and China's demonstrated and developmental counterspace capabilities indicate China's program is primarily designed to deter U.S. strikes against China's space assets, deny space superiority to the United States, and attack U.S. satellites.[38] These purposes are likely driven by three security-related assessments:

- The PLA assesses that obtaining and demonstrating the ability to damage or destroy the satellites an adversary considers essential to its national security and military operations could deter that adversary from attacking China's space assets, potentially in the event of a conflict arising from China's coercive actions in its near seas. According to a PLA writing on space deterrence, "it is necessary to display one's own power to the enemy so that they perceive the deterrent force, and also to get them to realize that this force is capable of creating loss or consequences that would be difficult for them to accept."[39] Moreover, China's military strategists perceive counterspace capabilities to be a more credible and flexible deterrent than nuclear and conventional capabilities, as the threshold for the use of counterspace capabilities is lower because it would not involve a significant loss of life.[40]
- Beijing recognizes that its satellites are vital for its commercial and civil sectors and that disruptions to these systems—even for short durations—could contribute to internal instability by harming China's economy and government operations.[41]
- The PLA assesses U.S. satellites are critical to the United States' ability to sustain combat operations globally. PLA analysis of U.S. military operations states that "destroying or capturing satellites and other sensors . . . will deprive an opponent of initiative on the battlefield and [make it difficult] for them to bring their precision-guided weapons into full play."[42] In another study, the PLA estimated that the United States developed a comprehensive surveillance system comprising approximately 50 satellites as well as unmanned aerial vehicles and

* PLA doctrinal publications and military writings on space warfare include the following: the *Science of Service Strategy* (2013 and 2005 editions), the *Lecture on Space Operations* (2012), the *Science of Campaigns* (2006), and "Developing the Theory of Strategic Deterrence with Chinese Characteristics" in *China Military Science* (2004).

aircraft during its participation in the North Atlantic Treaty Organization campaign in Kosovo. The same study estimates space systems provided 70 percent of U.S. battlefield communications during the campaign, 80 percent of its battlefield surveillance and reconnaissance, and 100 percent of its meteorological data, and did so 24/7 through all weather conditions.[43]

Economic and Commercial Contributions

Senior Chinese government and aerospace officials publicly tout the economic and commercial benefits of China's space program, highlighting four areas in particular: market creation and spin-off technologies, satellite application technologies, commercial launch services, and satellite exports.[44]

Market Creation and Spin-off Technologies

Chinese analysts assess that China's space program has had a transformative impact on the country's national economy. In their view, the demand created by large, complex space projects involving numerous government and commercial entities and utilizing a wide range of technologies can spur advancement in areas such as computers, microelectronics, precision manufacturing, automatic control, new energy, and new materials. Moreover, they assess that China's space program provides demand for skilled labor and expanded science and engineering educational programs. These analysts point to the U.S. Apollo program as the best example of the transformative impact a national space program can have on a country's economy.[45]

Beijing has taken a concentrated and hands-on approach to ensuring its space program realizes similar effects, and Chinese analysts point to numerous benefits it has provided. In their view, Chinese investments in space technologies have their most profound impact on high-technology development, with each dollar invested estimated to yield $10 in gross domestic product growth. Furthermore, 80 percent of 1,000 new materials developed domestically are identified in one analysis as having resulted from research in space technology. More than 2,000 space-based technological achievements have reportedly been transferred to various sectors of China's national economy, and nearly 1,000 space industry products have been converted for civilian use. Chinese analysts highlight that China's human spaceflight program—which involves over 3,000 commercial enterprises—has been particularly important to China's technological progress in electronics, new materials, and automatic control.[46]

China's efforts to introduce spin-off technologies (that is, technologies originally developed for the space industry that also can be applied to commercial and civilian applications) are led by eight industrial parks known as "aerospace bases." These bases—located in Beijing, Chengdu, Hainan, Inner Mongolia, Shanghai, Shenzhen, Tianjin, and Xi'an—are the products of partnerships between the space industry and their respective provincial governments. The bases manufacture space industry products and then attempt to leverage the industry's capabilities in space technologies to build civilian products. These civilian products involve technologies in areas identified by the central government as strategic emerging industries, including high-end manufacturing equipment, alternative energy, new materials, alternative energy automobiles, and new-generation information technologies.[47]

Satellite Application Technologies

Chinese analysts emphasize the importance of China's space program in the development of satellite application technologies—that is, supplementary products that build upon the information provided by space technologies to add value for consumers. In their view, China's space program has facilitated the development of these technologies in three primary areas. First, it has led to the development of satellite communications applications such as satellite television and telecommunication services. Second, China has launched several lines of Earth observation satellites that provide remote sensing data, which have been used for functions such as agricultural use monitoring, environmental protection, and municipal planning. Many of China's civil-government agencies are dependent on this data. Third, the program has facilitated the development of satellite navigation products such as receivers for China's Beidou constellation. The Beidou system could further stimulate innovation in mobile Internet applications for consumers and in other areas of consumer, civil, or commercial application that require PNT data. In August 2015, Alibaba, a private Chinese firm, and China North Industries Corporation, a Chinese state-owned defense conglomerate, formed a joint venture worth roughly $310 million to "build applications and technology to support and work with the [Beidou] system."[48]

Commercial Launch Services

Commercial launches provide China's space industry with revenues, opportunities to measure the quality of its products and services against international competitors, and synergies through integration with its military space sector. Despite these ostensible benefits, China has struggled to develop its commercial space launch capabilities and realize desired growth in market share. According to Beijing, these shortfalls are the result of U.S. export controls, which since 1999 have prohibited U.S.-manufactured satellites and satellites containing U.S.-manufactured components from being launched by China as well as the purchase by China of these items.[49] These laws have progressed through several iterations, as explained in July 2014 by a firm specializing in international trade law:

> *Originally all satellites, whether military, commercial, or remote-sensing, were subject to controls under Cat. XV of the U.S. Munitions List in the International Traffic in Arms Regulations (ITAR). In the early 1990s most commercial satellites were moved to the Export Administration Regulations (EAR) of the Department of Commerce. Then, after some violations associated with launches in China, Congress passed legislation transferring all satellites back to ITAR. Those controls have been in place since March 15, 1999.*[50]

The Obama Administration changed satellite export control rules further in November 2014, moving many commercial satellite and satellite technology exports back to EAR jurisdiction, meaning they can now be approved for export or for launch on foreign rockets, unlike under the ITAR regime. Exports to China, however, along with North Korea and any state sponsor of terrorism, are still banned under EAR based on the FY13 National Defense Authorization Act, which permitted this rule change but included a specific clause to ensure controls remained in place for these countries.[51] In addition to exports, China is still blocked from offering launch services for U.S.-made satellites or any satellites with U.S.-made components, as launches of satellites on foreign rockets are seen as "permanent exports."[52]

Despite the obstacles posed by U.S. export control regulations, China is marketing its launch services to Europe and the developing world, aiming to capture 15 percent of the global launch services market by 2015. While China achieved this objective with roughly 19 and 26 percent market share in 2011 and 2012, respectively, it only held 11 percent in 2013, the last year for which data is available.[*] [53] Executives at the China Great Wall Industry Corporation, China's sole commercial satellite and launch services provider, stressed the continued impact of these obstacles in a briefing to the Commission during its trip to Beijing in July 2015, stating that although the company's products and practices are "just as good" as those of U.S., European, and Russian providers, it is unable to compete in the "whole market" due to U.S. export controls.[54]

China launched a Chinese-made satellite for Nigeria in 2007, the first such launch for a foreign client since 1999. In 2011, China launched a satellite for European satellite communications provider Eutelsat, its first launch of an entirely foreign-made satellite for a foreign client since 1999. Since these initial launches, China has provided launch services for Chinese-made satellites to Bolivia, Nigeria, Pakistan, and Venezuela, and has signed contracts for additional launches for Belarus, Laos, Sri Lanka, and Venezuela. For foreign-made satellites, China has provided launch services to Argentina, Ecuador, Indonesia, Luxembourg, and Turkey and signed contracts for future launch services with Algeria, Belarus, Congo, Laos, and Sri Lanka.[55]

Figures on the cost of Chinese launches are scarce. According to one source, however, the costs were in one case lower than those of Arianespace, the leading European launch company.[56] A spokesperson for the China Great Wall Industry Corporation, which handles the contracting of China's commercial launch services, predicted that going forward its launches will be offered at the same price level as those of U.S. company SpaceX, an emerging low-cost leader in the field.[57] Previously, officials from China's space industry had stated that they could not beat SpaceX's price.[58] China's

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*These figures include launches of Chinese government satellites and satellites owned by state-owned enterprises. If these are excluded, China's market share is lower, but still only surpasses 15 percent in 2011 and 2012. Additionally, data sources on the commercial launch market differ slightly; this assessment uses the highest totals reported. If the lower totals are used, China's market share still surpasses the 15 percent target in 2011 and 2012, while falling short of this number the other years. For complete market share data see: Kevin Pollpeter, *China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States* (Prepared for the U.S.-China Economic and Security Review Commission by the University of California Institute on Global Conflict and Cooperation, March 2, 2015), 21–22.

integration of its commercial and military launch infrastructures is expected to provide cost-saving effects as well, as it provides both sectors with synergies in economies of scale, "experience effects" such as increased reliability and fewer failures, and the ability to utilize modular designs.*[59]

Satellite Exports

In an attempt to increase its share of the global satellite market, China has focused on exporting commercial satellites to developing countries. Beyond valuing the revenues provided by satellite exports, China views the selection by international buyers of its satellites over Western-made ones as another indicator of the overall strength of its space industry.[60] As a relatively late entrant to the commercial satellite field, China set the goal of capturing 10 percent of this market by 2015.[61] Although data on all global commercial satellite sales are not available, China's share of geosynchronous Earth orbit satellite contracts, which represent the vast majority of commercial satellites,[62] increased from 2007 to 2013 but only achieved 10 percent in 2011 and 2012.[63]

China also likely values commercial satellite exports because these domestic-made satellites help increase demand for Chinese launch services, as they lack U.S.-made components and are thus free of restrictions that would otherwise prevent their launch on Chinese rockets.

China has exported communication satellites to Bolivia, Nigeria, Pakistan, and Venezuela and an imagery satellite to Venezuela. Moreover, China has signed contracts to provide communications satellites to Belarus, Laos, and Sri Lanka and an additional remote sensing satellite to Venezuela. In the face of stiff competition from international satellite builders, Beijing probably relied on a combination of technology transfer and preferential financing to secure these deals.[64]

Political and Diplomatic Benefits

Like other space powers, China uses its space program to enhance its international prestige and influence. Analysis of authoritative Chinese documents indicates Beijing believes successful space activities, particularly human spaceflight, provide important geo-strategic benefits, such as bolstering China's international image, promoting a role for China on the world stage commensurate with what it sees as its growing international status, and increasing China's ability to influence international policy generally and international space policy specifically.[65] For example, as China moves from a regional to global PNT service provider, Beijing could use the Beidou system as leverage to obtain more influence over PNT-related decisions in international and regional organizations such as the International Telecommunications Union,[66] the International Committee on Global Navigation Satellite Systems, the Asia-Pacific Economic Cooperation forum, and the International Civil Aviation Organization.

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*Modular designs are constructed using an approach that divides a product into parts that can be connected or combined in different ways.

The CCP also uses China's space program to rally public support, a move indicative of the party's larger strategy to legitimize itself by convincing the Chinese people it is delivering economic growth and a better quality of life while restoring China to its "rightful" place as a world leader following the country's so-called "century of humiliation" from the mid-19th to the mid-20th centuries. Mr. Pollpeter explains:

> *The CCP is now communist in name only, and its continued legitimacy is predicated on delivering economic and nationalistic benefits in an informal social contract with its citizens: the CCP agrees to increase the standard of living and develop China into an internationally respected country, and the people agree not to rebel. By developing a robust space program and participating in high-profile activities such as human spaceflight and lunar exploration, the CCP can demonstrate that it is the best provider of material benefits to the Chinese people and the best organization to propel China to its rightful place in world affairs.*[67]

China collaborates with other countries on a range of bilateral and multilateral space activities, including satellite development, space exploration, human spaceflight, space object surveillance and identification, and space R&D.[68] Many of these engagements are designed to facilitate China's acquisition of new technologies from technologically-advanced states and to promote the export of China's space technologies to states with space programs lagging behind its own.[69] Others are intended to help China achieve a level of space situational awareness that enables the PLA's offensive and defense space missions and supports China's orbital debris detection, mitigation plans, and operations.

Asia Pacific Space Cooperation Organization (APSCO)

With its headquarters located in Beijing, APSCO is China's primary entity for multilateral cooperation on space. China led the founding of the formal, membership-only organization in 2008 as a successor to the Asia-Pacific Multilateral Cooperation in Space Technology and Applications organization.[70] Aside from China, APSCO has seven other member countries,* all of which have less advanced space programs than that of China. APSCO members hold conferences, engage in joint training efforts, and cooperate on multilateral research and development projects.† [71] These efforts allow China to position itself as a purveyor of space technology and expertise to lesser-developed states; China has, for example, donated ground systems and will provide remote sensing data to other member countries.‡ [72] China's leaders also likely use Beijing's

* APSCO's member countries are China, Bangladesh, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey. Indonesia is a signatory state but not yet a full member. Asia-Pacific Space Cooperation Organization, "APSCO Member States"; APSCO, "Convention of the Asia-Pacific Space Cooperation Organization," October 28, 2005.

† Ongoing multilateral research and development projects in APSCO include a remote sensing data sharing platform, earth observation and communications satellites, a space observation network, and satellite navigation technology. APSCO, "Programs."

‡ These donations have included a data broadcasting system for China's Fengyun meteorological satellites to several member countries and a receiving station for remote sensing data to Thailand. Remote sensing data from China's Gaofen, Ziyuan, Fengyun, and Haiyang satellites

Continued

central role in APSCO to promote the export of its space technology and services in order to gain support for its space goals in the Asia Pacific region, as well as to obtain supplementary data and geographic coverage for its space situational awareness efforts.

China-Brazil Cooperation

China and Brazil have cultivated a strong cooperative relationship in space-related endeavors, particularly through joint satellite development and space launches. China and Brazil signed their first space cooperation agreement in 1984, and four years later embarked on the $300 million China-Brazil Earth Resources Satellites project to jointly develop two advanced remote sensing satellites.[73] Both countries contributed technologies for the service and payload modules of these satellites. China and Brazil extended the program and launched three additional satellites between 1999 and 2014,[74] with a sixth satellite slated for launch in 2016.[75] In addition to serving China's environmental and scientific missions, the satellites likely have provided the PLA with enhanced resolution of terrestrial strategic targets.[76] The project also probably helped Beijing lay the groundwork for its most advanced Earth observation satellite, the Gaofen series, which has military applications (see "Space-based C4ISR Capabilities" later in this section for more details on this satellite series).[77]

China-Russia Cooperation

Despite a break in cooperation between 1958 and 1997, China maintains a long-running comprehensive space relationship with Russia, its oldest space partner. In 1997, China and Russia established a space cooperation subcommittee within their bilateral prime ministers' dialogue, which resulted in the opening of a Chinese space program office in Russia and a corresponding Russian office in China, as well as collaboration on a range of human spaceflight and space exploration activities.[78] Future cooperative activities in space could include joint rocket engine development and a joint Russia-China space station, or Russia's participation in China's future space station, planned for completion around 2022.[79]

Through its space cooperation with Russia, China is able to gain valuable knowledge from one of the world's top space powers to advance its own space technology development, particularly in the area of launch vehicles—a technology critical for China's space-based C4ISR and counterspace capabilities. China also uses its space relationship with Russia to increase the geographic reach of its satellite coverage. In 2014, China and Russia signed agreements on expanding cooperation of their respective satellite navigation systems, Beidou and the Global Navigation Satellite System (GLONASS), to include building monitoring stations in each other's countries.

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will be provided to member countries. Kevin Pollpeter, *China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States* (Prepared for the U.S.-China Economic and Security Review Commission by the University of California Institute on Global Conflict and Cooperation, March 2, 2015), 24–25.

China-Ukraine Cooperation

China cooperates with Ukraine on a range of space issues. From 2001 to 2015, the two countries followed three consecutive five-year programs guiding their cooperation on large-scale space projects.[80] Under the 2006 to 2010 program, China and Ukraine collaborated on 29 long-term projects, including remote sensing satellites, space weather satellites, and space rocketry. In 2012 China and Ukraine agreed to collaborate on more than 50 additional joint projects in the areas of Earth observation and rocket and satellite technology development, including the Ionosat space system, marking a significant increase in space cooperation over previous years.* The two countries continue to discuss potential opportunities for space collaboration; future joint ventures could include engine manufacturing projects and exploratory missions to the Moon and Mars.[81] In March 2015 Ukraine's ambassador to China stated his expectation that a fourth five-year program would be approved later in the year, suggesting that bilateral space cooperation has proceeded despite the ongoing conflict in Ukraine.[82]

China likely applies technical expertise gained from Ukraine in its development of next-generation launch vehicles. Ukraine, a former Soviet republic, inherited a wealth of knowledge in ballistic missiles and launch vehicles from the Soviet Union when it dissolved in 1991.[83]

China-Europe Cooperation

Joint space cooperation between China and Europe is thriving, particularly in the areas of space science, space exploration, and human spaceflight. As long as conditions remain ripe for collaboration, China and Europe will remain motivated to cooperate in order to advance their domestic agendas: China generally seeks access to Europe's advanced space technology to improve its own space capabilities, while Europe seeks greater cooperation primarily in order to compensate for the reduced funding of the European Space Agency and to facilitate greater economic ties between China and Europe.[84]

In the mid- to late-2000s, China extracted important gains from the relationship through its early co-development work on Europe's Galileo satellite navigation network, resulting in the most divisive point in bilateral space relations to date. Europe had initially invited China to participate in the project in order to draw more funding, expand Galileo's access to the Chinese market, and distance itself from the United States for political reasons. Europe declined China's continued participation in the project, however, primarily due to concerns over the dual-use nature of satellite navigation and questions regarding China's plans for its own Beidou satellite navigation system.† The project likely provided Beijing with

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* Ionosat is a type of Earth observation satellite in the Earth's ionosphere designed primarily for scientific purposes, disaster relief, and space weather monitoring. Yuzhnoye Design Office, "Ionosat."

† The European Space Agency provided the additional rationale that legal restrictions prohibited China's involvement, following Galileo's change from public-private funding to public only. Kevin Pollpeter, *China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States* (Prepared for the U.S.-China Economic and Security Review Commission by the University of California Institute on Global Conflict and Cooperation, March 2, 2015), 28–30.

essential technology and experience needed for the development of Beidou.[85] Beidou satellites even use frequencies previously allocated to Galileo, which EU and Chinese diplomats jointly negotiated for in the early 2000s.[86]

China-Venezuela Cooperation

China and Venezuela have a robust space partnership. In 2005, the two countries signed a memorandum of understanding on space technology cooperation and established a special joint subcommittee on technology, industry, and space. Since then, China has built and launched two satellites for Venezuela, the Venesat-1 communications satellite in 2008 and the VRSS–1 remote sensing satellite in 2012. China also is helping Venezuela build small satellites, supplying Venezuela's space industry with Chinese technology, and training Venezuelan engineers.[87]

China's Counterspace Program

China is pursuing a broad and robust array of counterspace capabilities, which includes direct-ascent antisatellite missiles, co-orbital antisatellite systems, computer network operations, ground-based satellite jammers, and directed energy weapons. China's nuclear arsenal also provides an inherent antisatellite capability.

During a conflict, China likely would employ a combination of "hard attacks," which use kinetic methods to cause permanent and irreversible destruction of a satellite or to ground support infrastructure, and "soft attacks," which use nonkinetic methods to temporarily affect the functionality of a satellite or ground systems. PLA writings suggest Beijing prefers soft attacks to hard attacks because they are less likely to escalate a conflict, are less likely to broaden a conflict to include other countries, do not create debris that could damage its own satellites, and offer Beijing plausible deniability. However, Beijing almost certainly would conduct hard attacks in response to an adversary's kinetic strikes on China's satellites or when Beijing determined a crisis had progressed to the point where destructive attacks were needed and that it could accept reciprocal retaliation from or an escalation by an adversary.[88]

Direct-Ascent Antisatellite Missiles

China has tested two direct-ascent antisatellite missiles: the SC–19 and the larger DN–2. Direct-ascent antisatellite missiles are designed to disable or destroy a satellite or spacecraft using one of several possible kill mechanisms, such as a kinetic kill vehicle.* The missiles typically are launched against pre-selected targets, as they must either wait for the target satellite to pass overhead within a certain distance from the launch site, or target a stationary satellite within range of the launch site. Unlike co-orbital antisatellite systems (discussed later in this section), direct-ascent antisatellite missiles do not establish a persistent presence in space, enter into long-term orbits, or loiter to await commands to engage a target.[89]

*A kinetic kill vehicle is a maneuverable platform with the ability to detect, track, and undergo guidance to a target and destroy it through the force of a direct collision.

China destroyed an aging Chinese weather satellite using its SC–19 direct-ascent antisatellite missile in January 2007 following two non-destructive tests of the missile in 2005 and 2006. The 2007 test demonstrated China's ability to strike satellites in low Earth orbit, where the majority of the United States' approximately 549 satellites reside, including about 30 military and intelligence satellites. During a discussion of the test in 2015, General John Hyten, commander of U.S. Air Force Space Command, said: "It was a significant wakeup call to our entire military . . . until that singular event, I don't think the broader military realized that that is something [we will] have to worry about."[90] If China began series production of the SC–19 after the successful 2007 test, China could already have sufficient numbers of the missile to attack all U.S. military and intelligence satellites in low Earth orbit.

China conducted additional SC–19 tests in 2010, 2013, and 2014. In each test, the SC–19 intercepted a mock warhead launched by a ballistic missile rather than a satellite. The targets were not in orbit, so any debris generated by the interceptions quickly fell back to Earth.[91] Although China has called these tests "land-based missile interception tests,"[92] available evidence suggests they were indeed antisatellite tests. Regarding the most recent test in 2014, Assistant Secretary of State for Arms Control, Verification, and Compliance Frank Rose said, "Despite China's claims that this was not an [antisatellite] test; let me assure you the United States has high confidence in its assessment, that the event was indeed an [antisatellite] test."[93]

The non-debris-generating nature of the tests suggests China may have gained a better appreciation of the diplomatic costs of debris-generating antisatellite tests as well as the long-term consequences of such tests for China's own space assets. China received worldwide criticism for creating more than 3,400 pieces of debris during its 2007 antisatellite test, and this debris continues to threaten the space systems and astronauts of all nations, including China. More than half of the debris could still be in orbit in 2027.[94] Not all experts agree, however: according to Mr. Cheng, China may have avoided debris-generating tests since 2007 for other reasons such as changes to its testing needs, and evidence linking the shift to the previous diplomatic response is lacking.[95]

In May 2013, China fired its new DN–2 rocket into nearly geosynchronous Earth orbit, marking the highest known suborbital launch since the U.S. Gravity Probe A in 1976 and China's highest known suborbital launch to date. Beijing claims the launch was part of a high-altitude scientific experiment; however, available data suggests China was testing the ballistic missile component of a new high-altitude antisatellite capability. The nature of the test indicates China is developing an antisatellite capability to target satellites in medium Earth orbit, highly elliptical Earth orbit, and geosynchronous Earth orbit.[96] Although the DN–2 is technically capable of reaching U.S. Global Positioning System (GPS) satellites, it would likely be better suited for strikes on U.S. ISR satellites.* [97]

* There are over 30 GPS satellites in orbit, distributed across multiple planes, and many more than the four required for a "position fix" are overhead at any given time. Numerous successful direct-ascent antisatellite missle attacks would thus be required to achieve results of military

Continued

Based on China's research, development, and acquisition timelines for previous ballistic missile and antisatellite programs, China could operationally deploy the DN–2 in the 2020–2025 timeframe.

Table 1: Summary of Direct-Ascent Antisatellite Tests

Date	Orbital Debris	Missile	Notes
July 2005	No	SC–19	Rocket test
February 2006	No	SC–19	Failed intercept and destruction of an orbital target
January 2007	Yes	SC–19	Successful intercept and destruction of an orbital target
January 2010	No	SC–19	Successful intercept and destruction of a suborbital target
January 2013	No	SC–19	Successful intercept and destruction of a suborbital target
May 2013	No	DN–2	Rocket test
July 2014	No	SC–19	Successful intercept and destruction of a suborbital target

Sources: Commission analysis and judgments based on the following sources: U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, April 2015, 14; Frank Rose (Assistant Secretary of State, Bureau of Arms Control, Verification, and Compliance), "Written Remarks Delivered to the Federation of American Scientists" (Washington, DC, February 20, 2015); U.S.-China Economic and Security Review Commission, *Hearing on China's Space and Counterspace Programs*, written testimony of Richard Fisher, February 18, 2015; U.S.-China Economic and Security Review Commission, *Hearing on China's Space and Counterspace Programs*, written testimony of Kevin Pollpeter, February 18, 2015; Bill Gertz, "Stratcom: China Continuing to Weaponize Space with Latest Anti-Satellite Missile Shot," *Washington Free Beacon*, August 13, 2014; Brian Weeden, "Through a Glass, Darkly: Chinese, American, and Russian Anti-Satellite Testing in Space" *Secure World Foundation*, March 17, 2014; Brian Weeden, "Anti-Satellite Tests in Space—The Case of China," *Secure World Foundation*, August 16, 2013; Craig Murray, "China Missile Launch May Have Tested Part of a New Antisatellite Capability," *U.S.-China Economic and Security Review Commission*, May 22, 2013; Xinhua, "China Carries out Land-Based Mid-Course Missile Interception Test," January 28, 2013; Greg Kulacki, "Is January Chinese ASAT Testing Month?" *Union of Concerned Scientists*, January 4, 2013; and Xinhua (English ed.), "China Conducts Test on Ground-Based Midcourse Missile Interception," January 11, 2010.

Co-orbital Antisatellite Systems

Co-orbital antisatellite systems have not been a significant concern for the United States since the collapse of the Soviet Union. However, China's recent space activities indicate that it is developing co-orbital antisatellite systems to target U.S. space assets. These systems consist of a satellite armed with a weapon such as an explosive charge, fragmentation device, kinetic energy weapon, laser, radio frequency weapon, jammer, or robotic arm. Once a co-orbital satellite is close enough to a target satellite, the co-orbital satellite can deploy its weapon to interfere with, disable, or destroy the target satellite. Co-orbital satellites also may intentionally crash into the target satellite.[98]

utility. ISR satellites, by contrast, are relatively few in number and are thus somewhat more vulnerable, although the changing velocity and altitude inherent to their highly elliptical orbit would complicate targeting. Brian Weeden, "Through a Glass, Darkly: Chinese, American, and Russian Anti-Satellite Testing in Space," *Secure World Foundation*, March 17, 2014.

Co-orbital antisatellite systems provide several advantages over current direct-ascent antisatellite missiles, including their ability to be used to target satellites in every orbital regime, generate less debris, conduct attacks without geographic limitations, and limit escalation, as many co-orbital attack options are reversible and offer plausible deniability. Additionally, co-orbital satellites would pose significant warning challenges for the U.S. Intelligence Community because they could be launched into orbit long before an attack.[99]

Since 2008, China has tested increasingly complex space proximity capabilities. Although these capabilities have legitimate applications for China's manned space program, the dual-use nature of the technology and China's secrecy surrounding the tests suggest China also is using the tests to develop co-orbital counterspace technologies.

- During a manned space mission in September 2008, China's Shenzhou 7 spacecraft deployed the BX–1, a miniature imaging satellite, which then positioned itself into an orbit around the spacecraft. The activities of the BX–1 may have been designed to test a dual-use on-orbit inspection capability for future inspector satellites. In addition to aiding China with maintenance of its satellites, inspector satellites could approach U.S. satellites in orbit to collect detailed images and intelligence on them. Moreover, at one point the BX–1 passed within 45 kilometers of the International Space Station, apparently without prior notification, suggesting it may have been simulating a co-orbital antisatellite attack.[100]

- In June 2010, China launched the SJ–12 satellite. Over the next two months, the satellite conducted a series of maneuvers and came within proximity of the SJ–6F, an older Chinese satellite that was placed into orbit in 2008. The activities of the SJ–12 may have been designed to test a co-orbital antisatellite capability, such as on-orbit jamming. Moreover, during its maneuvers, the SJ–12 apparently bumped the SJ–6F, causing it to drift slightly from its orbital regime. This activity suggests China also could have used the test to demonstrate the ability to move a target satellite out of its intended position by hitting it or attaching to it.[101]

- In July 2013, China launched a rocket carrying the CX–3, SY–7, and SJ–15 satellites, one of which was equipped with a robotic arm for grabbing or capturing items in space. Once all three were in orbit, the satellite with the robotic arm grappled one of the other satellites, which was acting as a target satellite.[102] The satellite with the robotic arm then changed orbits and came within proximity of a separate satellite, the SJ–7, an older Chinese satellite that was orbited in 2005.[103] Robotic arms can be used for civilian missions such as satellite repair, space station construction, and orbital debris removal; they also can attach to a target satellite to perform various antisatellite missions.[104]

Computer Network Operations

Chinese military doctrine and the integration of computer network operations, electronic warfare, and counterspace reflected in certain Chinese military organizations and research programs indicate the PLA during a conflict would attempt to conduct computer network attacks against U.S. satellites and the ground-based facilities that interact with U.S. satellites.[105] According to one Chinese author:

> *A military satellite cannot connect with the Internet. Therefore, some people think "hackers" cannot attack a satellite's command and control [system]. But in actuality, the microwave antenna of the satellite control is open, so one can intercept satellite information through technological means and seize the satellite's command and control [system]. Using this as a springboard to invade the enemy's independent network systems is entirely possible.*[106]

If executed successfully, such attacks could significantly threaten U.S. information superiority, particularly if they are conducted against satellites with sensitive military and intelligence functions. For example, access to a satellite's controls could allow an attacker to damage or destroy the satellite; deny, degrade, or manipulate its transmissions; or access its capabilities or the information, such as imagery, that can be gained through its sensors.

Chinese hackers likely have been responsible for several computer network operations against U.S. space assets, though the U.S. government has not publicly attributed any of them to China. If responsible, China likely used these intrusions to demonstrate and test its ability to conduct future computer network attacks and to perform network surveillance.

- In October 2007 and July 2008, cyber actors attacked the Landsat-7, a remote sensing satellite operated by the U.S. Geological Survey, resulting in 12 or more minutes of interference on each occasion. The attackers did not achieve the ability to command the satellite.[107]
- In June and October 2008, cyber actors attacked the Terra Earth Observation System satellite, a remote sensing satellite operated by NASA, resulting in two or more minutes of interference on the first occasion and nine or more minutes of interference on the second occasion. In both cases, the responsible parties achieved all steps required to command the satellite but did not issue commands.[108]
- In September 2014, cyber actors hacked into the National Oceanographic and Atmospheric Administration's (NOAA) satellite information and weather service systems, which are used by the U.S. military and a host of U.S. government agencies. NOAA stopped the transmission of satellite images to the National Weather Service for two days while it responded to the intrusion and "sealed off data vital to disaster planning, aviation, shipping, and scores of other crucial uses," according to a U.S. media report citing a discussion with NOAA officials.[109] The U.S. government has not publicly attributed the attack to any country or actors; however, then Congressman Frank Wolf stated, "NOAA told me it was a hack and it was China."[110]

Moreover, China's large-scale, state-sponsored theft of intellectual property and proprietary information through cyber espionage has enabled future space and counterspace operations by filling knowledge gaps in China's space R&D, providing insight into U.S. space plans and capabilities, and helping to identify vulnerabilities in U.S. space systems.

In May 2015, Pennsylvania State University disclosed that two separate groups of cyber actors had been sifting through the computers of its engineering school for more than two years. The University is also home to a separate lab that specializes in aerospace issues and works primarily for the U.S. military. Although the lab's networks are reportedly separate from those of the engineering school, the length of the breach raises the possibility that the hackers may have entered the lab's networks as well, according to a source familiar with the U.S. government investigation of the intrusions, as cited in a U.S. media article. This source also alleged that China sponsored at least one of the groups, while the other is believed to be state-sponsored as well.[111]

Earlier in June 2014, Crowdstrike, a private U.S. cybersecurity firm, published a report providing detailed technical information regarding the activities of a Chinese cyber threat group, which Crowdstrike refers to as "Putter Panda." According to the report, the group supports China's space surveillance mission and is subordinate to the Third Department of the PLA General Staff Department, widely believed to be China's premier organization responsible for signals intelligence collection and analysis. Crowdstrike assesses that Putter Panda since 2007 has targeted "government, defense, research, and technology sectors in the United States, with specific targeting of space, aerospace, and communications."[112]

Moreover, Mandiant, a U.S. cybersecurity firm, has responded to multiple incidents in which at least six distinct China-based threat actors have compromised aerospace and defense companies both in the United States and other countries. These threat groups, which Mandiant assesses most likely are associated with the Chinese government, have targeted the sector since at least 2006, and frequently steal sensitive data from their victims. Stolen files include human resources records, internal business communications, marketing and sales documents, and test results and other product information pertaining to the development and operation of missile systems and military and civilian satellite technology for both communications and location tracking.[113]

Ground-Based Satellite Jammers

Since the mid-2000s, China has acquired a number of foreign and indigenous ground-based satellite jammers, which are designed to disrupt an adversary's communications with a satellite by overpowering the signals being sent to or from it. The PLA could employ jammers to degrade or deny U.S. military systems' access to GPS and most satellite communications bands if they are operating within a few hundred kilometers of China.[114] GPS is particularly easy to jam because the signals are weak; as a result, even low-power jammers can deny or degrade the acquisition of a GPS signal over long distances. Although China's employment strategy for its ground-based jammers is unknown, Mr. Pollpeter posits that "given the relatively small size and long range of GPS jammers, [the strategy] could consist of [placing] a series of vehicle-mounted jammers . . . at intervals within the theater of operations to provide overlapping jamming zones." [115]

Directed Energy Weapons

China has been committing substantial resources to R&D for directed energy weapons, including those that could be used for antisatellite missions, since at least the 1990s. Directed energy weapons can deliver concentrated energy, atomic, or subatomic particles along a line-of-sight trajectory at or near the speed of light to damage or destroy equipment, facilities, and personnel.

By 2006, China had at least one ground-based laser designed to damage or blind imaging satellites.[116] At low energies, lasers can blind or damage a satellite's optical sensors; at high energies, lasers can cause physical damage to satellites.

In 2006, China fired a high-powered laser at a U.S. satellite, resulting in a temporary degradation to the satellite's functionality. Although it is unclear whether China fired the laser to determine the location of the satellite * or to "dazzle" it, China's test demonstrated a significant new capability that it almost certainly has continued to develop and improve over the last nine years.[117]

Additionally, China is researching radio frequency weapons, which are designed to damage or destroy electronic components of satellites by either overheating or short-circuiting them. Radio frequency weapons can be surface-based, space-based, or employed on missiles; they are thus useful in achieving a wide spectrum of effects against satellites in all orbits.[118] Although China's progress in this area is unknown, such weapons could feasibly be deployed in the next five to ten years.

Nuclear Weapons

China's nuclear arsenal provides an inherent antisatellite capability, as China could detonate a nuclear warhead in low Earth orbit using a ballistic missile. The electromagnetic pulse generated by the blast would destroy unshielded satellites † that are in line of sight of the explosion, and the resulting persistent radiation environment would slowly damage unshielded satellites in low Earth orbit as they pass through the area. Although the blast would not directly affect satellites in higher orbits, the radiation could impede their communications with ground stations. China likely would only consider using nuclear weapons in space during an ongoing nuclear war, given that the detonation would also affect China's satellites as well as those of other countries.[119]

* Satellite laser ranging is used to precisely determine a satellite's location by measuring the distance from a ground station to a satellite based on the time an ultra-short laser pulse fired from the ground takes to reach and be reflected back from the satellite. Yousaf Butt, "Satellite Laser Ranging in China," *Union of Concerned Scientists Technical Working Paper*, January 8, 2007.

† Physical shielding using sheets of aluminum, sometimes supported by other materials, reduces the risk to satellites of damage from micrometeoroid and orbital debris impact. Colin Schultz, "How Do You Shield Astronauts and Satellites from Deadly Micrometeorites?" *Smithsonian.com*, June 28, 2013.

China's Space-Based C4ISR Modernization

China's initial C4ISR modernization efforts focused on developing a robust and secure terrestrial network of fiber optic cables, mobile radios, datalinks, and microwave systems. In the mid-2000s, however, China shifted the emphasis of its C4ISR modernization program to expanding and enhancing the country's space-based infrastructure. China had approximately 142 operational satellites in orbit as of September 1, 2015, compared to about 10 in 2000 and 35 in 2008.* Approximately 95 of these satellites are owned and operated by Chinese defense organizations, including the PLA, the Ministry of Defense, and various entities under the state-owned space industry conglomerates.[120]

Intelligence, Surveillance, and Reconnaissance

China is fielding sophisticated satellites that feature electro-optical (EO), synthetic aperture radar (SAR), and electronic reconnaissance (ELINT) sensors. EO sensors passively detect light images of maritime and ground-based targets. Although EO sensors can achieve the highest resolution of these types, they are adversely affected by poor weather conditions and cannot image at night. SAR sensors use a microwave transmission to create images of maritime and ground-based targets. They tend to have lower resolution than EO sensors but can image during night or day and in all weather conditions. ELINT sensors detect electronic signal emissions and then determine emitter locations.[121]

Combining these varying capabilities is crucial for locating and tracking a moving target. A study by authors affiliated with the PLA Navy Aerospace Engineering Academy illustrates the importance of integrating the information obtained from ISR satellites for long-range antiship ballistic missile (ASBM) strikes:

> *During the process of planning [to use] the fire power of an ASBM, [there is a need] for obtaining reliable target intelligence information for guiding the missile attack. This could be achieved by integrating EO imaging satellites, SAR imaging satellites, ELINT satellites, naval ocean surveillance satellites, mapping resource satellites, and highly accurate commercial remote sensing satellite imagery, which could be purchased on the international market. Through the integration of the data obtained via a number of different satellites, and with the addition of processing and data fusion, [one could] guarantee missile guidance requirements for all types of target information for a long-range ASBM strike.*[122]

China's major military-relevant ISR satellites are the Yaogan, Shijian, Gaofen, and Haiyang, each of which is examined in detail in the following paragraphs. China also has a large number of imaging and remote sensing satellites that are owned and operated by civilian or commercial entities. Given the PLA's central role in the development, launch, and operations of all of China's satellites,

* For comparison, the United States has approximately 549 active satellites in orbit and Russia has approximately 131 active satellites in orbit. Union of Concerned Scientists, "UCS Satellite Database."

these civilian and commercial satellites likely contribute to the PLA's C4ISR efforts whenever it is technically and logistically feasible for them to be so utilized,[123] and they would probably be directly subordinate to the PLA during a crisis or conflict.

Yaogan Satellites

The Yaogan series of satellites, the first of which was launched in 2006, serves as the core component of China's maritime ISR architecture. Chinese state-run press claims the satellites are used to conduct scientific experiments and carry out land surveys, among other functions.[124] Because the series is owned and operated by the PLA, however, it likely is used primarily for broad area maritime surveillance in support of the PLA's efforts to detect, track, and target foreign ships, such as U.S. carrier strike groups. China to date has launched 37 Yaogan satellites,[125] including EO, SAR, and ELINT variants.[126]

Shijian Satellites

China's Shijian series of satellites, the first of which was launched in 1971, is owned and operated by China's Academy of Space Technology. The Shijian satellites have a variety of configurations and missions. Although some have been used for strictly civilian purposes, such as crop breeding,* many appear to be military ISR satellites based on their suspected payloads, their orbital characteristics, and the secrecy surrounding their launches. Some Shijian satellites likely feature ELINT sensors used by the PLA for broad area maritime surveillance. Others probably are equipped with infrared sensors to detect ballistic missile launches in support of a future early warning system.[127] According to Mr. Pollpeter, the development of such a system could indicate a change in China's nuclear posture:

> *The deployment of a space-based ballistic missile early warning system may also signal a change in China's nuclear doctrine from "no first use" to "launch on warning." China's current nuclear force doctrine relies on retaliating only after a nuclear first strike from an opponent. A "launch on warning" system would make China's nuclear force more survivable since China would have warning that an attack is imminent, but would also present the possibility for false warnings, which could be catastrophically destabilizing during a conventional conflict.*[128]

Gaofen Satellites

The Gaofen series of EO/SAR satellites, the first of which was launched in 2013, features China's first high-definition satellite and first satellite capable of sub-meter resolution; the series also

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*According to Mr. Pollpeter, "the Shijian-8 was the world's first satellite devoted to crop breeding. Seeds were placed in the satellite and then exposed to the higher radiation levels of space in the hopes that genetic mutations [might] occur. The seeds were then removed from the satellite after it returned to Earth and grown." Kevin Pollpeter, *China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States* (Prepared for the U.S.-China Economic and Security Review Commission by the University of California Institute on Global Conflict and Cooperation, March 2, 2015), 77.

incorporates several design innovations. According to Beijing, the Gaofen-1 "has been used in land resource investigation, mineral resource management, atmospheric and water environment quality monitoring, and natural disaster emergency response and monitoring," and its imagery has supported "tens of national ministries and agencies, local governments, research institutions, universities, enterprises and organizations in China."[129] China also employed the Gaofen-1 to assist in the search for missing Malaysian airliner MH370 in 2014, demonstrating its ability to conduct broad maritime surveillance that could be useful for the PLA. China launched the second Gaofen in 2014 and two more in 2015, and is expected to launch as many as four more by 2016.[130]

Haiyang Satellites

The Haiyang series of satellites, the first of which was launched in 2002, is owned and operated by the State Oceanic Administration. The series primarily supports China's civilian and scientific organizations involved in monitoring the characteristics of the ocean environment, including pollution, topography, wind fields, surface temperatures, and currents. The fact that the State Oceanographic Administration oversees China's maritime law enforcement organizations, however, suggests these satellites also play a role in monitoring and enforcing China's maritime claims in the East and South China seas. Indeed, in 2012 a Chinese official said future Haiyang satellites will be used to monitor the disputed Senkaku Islands and Scarborough Reef. To date, China has launched three Haiyang satellites (two of which are operational) and plans to launch five more by 2020.[131]

Remote Sensing Commercial Satellites and Microsatellites

China launched the four-satellite Jilin-1 constellation in October 2015. These have been described as the country's first "self-developed" remote sensing satellites intended for commercial use and were reportedly developed by a company subordinate to a research institution of the Chinese Academy of Sciences.[132]

Since 2000, China has launched at least 28 microsatellites*, including Chuangxin/Banxing, Fengniao, Naxing, Tiantuo, and Xinyan types, most of which belong to civil users.[133] China launched Tiantuo-2, which carries four video cameras for data transmission and live tracking of moving objects on Earth, in September 2014.[134] Most recently, China reportedly launched 20 microsatellites assembled by universities and research institutes in September 2015.[135] Although their small size often limits their capabilities, microsatellites are significantly cheaper and easier to develop and manufacture than larger satellites that serve similar functions. Microsatellites also have lower observable signatures than larger satellites, making them harder for an adversary to track in space.[136]

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* "Microsatellites" are satellites with a mass between 10 and 100 kilograms. Kevin Pollpeter, *China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States* (Prepared for the U.S.-China Economic and Security Review Commission by the University of California Institute on Global Conflict and Cooperation, March 2, 2015), 23.

Positioning, Navigation, and Timing

In December 2012, China's Beidou regional satellite navigation system * became fully operational. Using 19 satellites and a network of ground stations, Beidou provides subscribers, including the PLA, with 24-hour regional position, navigation, and timing (PNT) services. Unlike other PNT systems, Beidou offers a short message service that can accommodate up to 120 Chinese characters per transmission. Beidou reportedly provides positioning accuracies of 10 meters or better, depending on the location, for civilian users. In comparison, GPS has 31 satellites and can provide positioning accuracies of several meters, depending on the location, for civilian users.† China intends to construct thousands of additional ground stations and launch additional satellites to improve Beidou's positional accuracies within China.[137]

Beijing plans to expand the Beidou constellation from 19 to 35 satellites by 2020 in order to provide global coverage. If successful, China will become the third country in the world after the United States and Russia to field an independent global satellite navigation system. China launched its 18th and 19th Beidou satellites in July 2015.[138]

China's Satellite Navigation Office has emphasized Beidou's importance to the PLA and to China's commercial interests, stating the system meets the "demands of China's national security, economic development, technological advances and social progress ... safeguard[s] [China's] national interests ... enhance[s] [China's] comprehensive national strength ... promote[s] the development of [China's] satellite navigation industry ... make[s] contributions to human civilization and social development ... [and] serve[s] the world and benefit[s] mankind." [139]

Although Beidou has a wide and growing range of civilian applications that will benefit China's economic development,‡ China developed its indigenous PNT system primarily for military purposes. Prior to the deployment of Beidou, most PLA units used GPS for positioning and maneuver and most PLA precision weapon systems used GPS for guidance. The PLA has considered this dependence on a foreign PNT system to be a strategic vulnerability since at least the mid-1980s. These fears were exacerbated during the 1995–1996 Taiwan Strait Crisis. According to a retired PLA general, the PLA concluded that an unexpected disruption to GPS caused the PLA to lose track of some of the ballistic missiles it fired into the Taiwan Strait during the crisis. He then said that "it was a great shame for the PLA ... an unforgettable humiliation. That's how we made up our mind to develop our own global [satellite] navigation and positioning system, no matter how huge the cost. Beidou is a must for us. We learned it the hard way." [140]

The PLA in the early 2000s began to gradually incorporate Beidou into its ground, air, and naval forces, and by the late 2000s

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* The regional Beidou system, which China refers to as Beidou-2, grew out of an earlier satellite constellation, known as Beidou-1. Beidou-1 provided limited position, navigation, and timing services in China and a small portion of East Asia but served primarily as a developmental platform for future projects.

† Beidou and GPS provide higher positional accuracies for the PLA and U.S. military, respectively.

‡ Civilian applications include road transport, aviation, shipping and rail transport, science, surveying and mapping, geophysics, telecommunications, financial services, and social activities.

was using Beidou for positioning and maneuvering, friendly force tracking,* and secure communications. Public information about China's incorporation of Beidou into its weapons systems is scarce, but China almost certainly is equipping its ballistic and cruise missiles to operate with both GPS and Beidou. If this is true, PLA operators could switch to Beidou to guide a missile to its target if GPS were (1) denied by the United States during a conflict or (2) deemed unusable by PLA commanders due to operational security concerns. Additionally, the availability of Beidou would allow China to attack an adversary's access to GPS without disrupting the PLA's own capabilities.[141]

China is attempting to make the Beidou system more prevalent in its domestic economy in order to compete with GPS, which dominates 95 percent of market share for satellite navigation products in China due to its earlier introduction, better known brand name, superior accuracy, and cheaper receiver costs. By 2020, China aims to gain 70–80 percent of the domestic satellite navigation market, which is estimated to reach $65 billion. To achieve this goal, China has announced several measures to encourage or force its citizens to adopt Beidou, including the requirement that, in order to receive transportation certificates, all new heavy trucks manufactured in any of nine Chinese provinces must be equipped with Beidou. Already more than 50,000 Chinese fishing boats—many of which are supporting China's efforts to advance its maritime claims—have been equipped with the system.[142]

Beijing has also taken several steps to promote Beidou to countries throughout Asia, where it currently occupies only 1 percent of the market, and to position the service to break into the global PNT market in 2020.

- China released the technical specifications of Beidou's open signal to allow for the production of ground receivers and offers free Beidou service for civilian and commercial users throughout Asia.[143]
- China has reached agreements with Brunei, Laos, Pakistan, and Thailand to provide Beidou for government and military customers at heavily subsidized costs. These agreements include provisions allowing Beijing to build satellite ground stations in each country; the stations will be used to increase Beidou's range and signal strength.[144] China already has built three ground stations in Thailand, and plans to build more than 220 additional stations in the country. According to a senior Chinese industry official involved in the development of Beidou stations in Thailand, "with these stations, Beidou could better service local customers and will be able to gradually squeeze GPS's market share."[145] China ultimately aims to build a vast network of ground stations throughout Asia.
- China reportedly is pursuing various cooperative arrangements involving Beidou with other countries, including Israel, Malaysia, Mexico, North Korea, Russia, Singapore, and Sweden.[146]

* Beidou provides automatic position reporting back to PLA command and control centers, allowing the PLA to constantly monitor the location of PLA units as well as Beidou-equipped Chinese fishing boats. U.S. Office of Naval Intelligence, *The PLA Navy: New Capabilities and Missions for the 21st Century*, 2015, 22.

Additionally, according to official Chinese press citing an interview with the spokesperson for Beidou, "the Beidou satellite navigation system will tap into opportunities brought by the Belt and Road Initiative,* and will engender further cooperation with other satellites. . . . During the process, China will step up cooperation with researchers working with other satellite navigation systems." [147]

- In November 2014, Beidou won approval from a United Nations' maritime body that sets standards on international shipping, joining GPS and Russia's GLONASS as the only navigational systems recognized for operations at sea. This formal recognition could help to further promote Beidou's use around the world by boosting brand awareness and signaling that Beidou can achieve its stated accuracy.[148]

Communications

China in 2000 began launching dedicated military communications satellites to provide secure voice and data communications for PLA users. Today, the PLA operates at least four communications satellites: Chinasat-1A, Chinasat-2A, Chinasat-20A, and Chinasat-22A. To meet bandwidth or geographic requirements or add resilience, the PLA could leverage communications satellites owned by China's civilian agencies or Chinese-controlled telecommunications corporations, as well as communication satellites owned by international corporations.[149]

China's commercial communications satellites include the Apstar-7, which is owned and operated by a Hong Kong-based subsidiary of the state-controlled China Satellite Communication Company. From 2012 to 2014, the U.S. Department of Defense (DOD) leased the Apstar-7's services to satisfy satellite communications requirements from U.S. Africa Command.[150] Following media and Congressional scrutiny of the deal, however, DOD did not renew the lease for 2015. According to Doug Loverro, DOD's deputy assistant secretary for Space Policy: "Working with [the Office of the Secretary of Defense], U.S. Africa Command has made significant progress over the last year in moving DOD [satellite communication] leases from the Chinese Apstar system to other commercial satellite providers in the region. We have already transitioned over 75 percent of the Apstar bandwidth to other satellites, and our intent is to be completely transitioned by May of [2014]." [151]

China plans to launch the world's first experimental quantum communications † satellite in 2016. This technology could eventu-

* China's Silk Road Economic Belt initiative is aimed at enhancing economic and cultural integration between China and Central Asia. The land-based Silk Road Economic Belt has a maritime counterpart, the "21st Century Maritime Silk Road," which will run from China's coast through Southeast Asia and the Indian Ocean to Africa and the Mediterranean Sea. Together, they are commonly referred to as the "One Belt, One Road" initiative. For more information on the initiative, see Chapter 3, Section 1, "China and Central Asia."

† Quantum communications, a subset of quantum information science, refers to the transmission of a quantum state (i.e., using quantum data rather than bits) from one place to another. A quantum communication network's key characteristic is its use of the quantum key distribution method which is, in theory, unbreakable—any attempt to intercept the encryption key would alter the physical status of the data (otherwise in a state of "superposition," existing in two states at the same time) and trigger an alert to the communicators. Quantum communication has thus far been limited to short distances due to the technological difficulty in maintaining the quantum data's fragile state over a long distance. Giuseppe Vallone et al., "Experimental

ally enable the PLA to instantaneously send, receive, and decipher messages around the world using a virtually unbreakable encryption key to provide secure electronic transmission of sensitive information.[152]

China also has announced plans to launch its first communications satellite that uses electric propulsion around 2020, following previous demonstrations of this technology by the Unites States, Russia, Europe, and Japan.[153] By using electric-powered engines instead of chemical propellant, such satellites will allow China to launch larger payloads at a fraction of the cost of traditional launch vehicles and improve communications satellites' lifespan from 15 to 20 years. The main drawback of this technology will be the longer time required to bring a satellite into orbit—up to eight months instead of several weeks.[154] According to a deputy chief designer of China's communications satellites at the China Academy of Space Technology, the technology will also be important for future manned spaceflight missions, including China's future space station around 2022.[155] The PLA could eventually use the technology to launch more advanced remote sensing ISR satellites into high Earth orbit, as well as for military missions in deep space.[156]

China's network of military communication satellites will be assisted by its Tianlian data relay satellite constellation, which was completed in 2012. As China orbits relay-capable satellites,* the Tianlian constellation will reduce the time the PLA must wait to receive data from its ISR satellites and thus enhance its ability to provide near-real-time ISR data to locate, track, and target U.S. ships operating in the Western Pacific. Without a data relay system, Chinese satellites must wait until they come into view of ground stations in China before sending ISR data, potentially causing a time lag of up to several hours and thus reducing the PLA's ability to receive time-sensitive intelligence on mobile targets.[157] Mr. Pollpeter explains:

> *A remote sensing satellite at an altitude of 600 [km], such as China's Yaogan series, can communicate with ground stations at a range of around 2,800 km. Beyond this range, they must retain their data until they come in range of a ground station. With the use of data relay satellites operating in geosynchronous [Earth] orbit above ISR satellites, an ISR satellite can transmit its data to a data relay satellite, which will then transmit the data to a ground station. In this way, time-sensitive data and communications can be immediately downloaded to a ground station for processing. They can also be used to assist with data transmission from launch vehicles to ground stations and can transfer data between aircraft, space tracking ships, and other craft*.[158]

Satellite Quantum Communications," *Physical Review Letters* 15:4 (July 20, 2015): 1; Yu Dawei, "In China, Quantum Communications Comes of Age," *Caixin*, February 6, 2015; Stephen Chen, "China to Launch Hack-Proof Quantum Communication Network in 2016," *South China Morning Post* (Hong Kong), November 4, 2014; and Michael A. Nielsen and Isaac L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press, 2000, 14.

* The number of China's current ISR satellites that are relay-capable is unknown. However, China almost certainly will add this capability to all of its future ISR satellites.

China's Space Launch Capabilities

Since approximately 2000, China has significantly enhanced its ability to launch military, civilian, and commercial satellites. China conducted 83 known space launches from 2010 to 2014, only 10 fewer than the United States during this period (see Table 2).[159] This growth is expected to continue as China expands and improves its ground-based space infrastructure and launch vehicles.

Table 2: Chinese versus U.S. Space Launches, 2010–2014

	2010	*2011*	*2012*	*2013*	*2014*
Chinese Launches (Satellites Deployed)	15 (20)	19 (18)	19 (25)	14 (17)	16 (19)
U.S. Launches (Satellites Deployed)	15 (41)	19 (39)	16 (35)	20 (85)	23 (110)

Note: Estimates of the number of space launches and satellites deployed vary by source due to a number of judgment decisions involved in the calculations, such as how to determine the ownership of a satellite company belonging to a certain country, whether to count objects as satellites or as space junk, and whether to include small satellites that can separate from an object already in orbit. For the number of new Chinese satellites deployed since 2010 by type, see U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, May 8, 2015, 70.

Source: Jonathan McDowell (Astrophysicist, Harvard-Smithsonian Center for Astrophysics), interview with Commission staff, June 17, 2015.

China has eight Long March (LM) liquid-fuel space launch vehicles that provide lift capacities ranging from light- to heavy-lift and the capability to deploy payloads at altitudes ranging from low Earth orbit to geosynchronous Earth orbit. These vehicles consist of the LM–2C, LM–2D, LM–2F, LM–3A, LM–3B, LM–3C, LM–4B, and LM–4C. China has conducted more than 205 launches since its first rocket flew in 1970.[160]

In tandem with efforts to upgrade its current launch vehicles, China is developing a new generation of liquid-fuel rockets designed to meet the country's future launch requirements. Once operational, this new generation—which will consist of the LM–5, LM–6, and LM–7—will substantially increase China's payload capacity while offering improved reliability, increased flexibility, and reduced costs.[161] China conducted the debut launch of the LM–6, reportedly using a safer and more efficient liquid propellant, in September 2015. The rocket carried 20 microsatellites and will primarily be used to launch microsatellites in the future, according to state-run media.[162]

The LM–5 will be one of the largest and most powerful space launch vehicles in the world and will more than double the size of payloads China can launch into low Earth orbit and geosynchronous Earth orbit. Although China publicly advertises the LM–5 as beneficial to its human spaceflight program, the rocket likely will also launch advanced C4ISR satellites, space station modules, and potentially reusable orbital vehicles that could be used for counterspace and ISR missions. The first LM–5 launch, which has been repeatedly delayed by manufacturing issues, could occur by the end of 2015.[163]

China also is conducting preliminary research on a super-heavy-lift launcher—the LM–9—that could be used to send large payloads, such as a manned lunar lander, to the Moon; the LM–9 also would be capable of launching into deep outer space. According to a senior rocket engineer at the China Aerospace Science and Technology Corporation, which is responsible for producing China's LM series, "estimates show the LM–5 will have to use four launches to fulfill a manned mission to the Moon while the LM–9 will need only one." [164]

In addition to these liquid-fuel launch vehicles, China is developing at least three types of solid-fuel rockets: the LM–11, the Kuaizhou, and the Feitian. China successfully conducted the inaugural launch of the LM–11, the largest of the developmental solid-fuel rockets, in September 2015.[165] China has tested the smaller Kuaizhou rocket twice, most recently in November 2014, and revealed the existence of the similarly-sized Feitian at China's Zhuhai Airshow in November 2014.[166] Solid-fuel rockets lack the payload capacity of liquid-fuel rockets but are cheaper to manufacture, simpler to operate, and can be released with less preparation. Furthermore, the launchers are transportable or "road-mobile," meaning they do not rely on fixed launch structures and are thus less vulnerable to attack. China likely is developing these new solid-fuel launch vehicles to put microsatellites into orbit on short notice. Such a capability would allow the PLA to rapidly replace or augment its satellite deployments in the event of any disruption in coverage during a conflict.[167]

China debuted the Yuanzheng-1, described by a Chinese state-run media outlet as an "independent aircraft" or "space shuttle bus" that is "installed on [a] carrier rocket with the ability of sending one or more spacecraft into different orbits in space," in March 2015.[168] The spacecraft, more accurately described as a type of potentially reusable orbital transfer vehicle (termed a "space tug" if reusable or an "upper stage" if expendable),* [169] uses a small thrust engine with a 6.5-hour lifetime and will be utilized with Long March-3A, 3B, and 3C vehicles primarily to insert Beidou satellites into medium Earth orbit and geostationary Earth orbit. In both the March 2015 launch and a second in July 2015, Yuanzheng-1 was used to successfully deploy Beidou satellites. As it can reportedly transfer multiple spacecraft into separate orbits, the vehicle has the potential to improve the efficiency of China's space launches.[170]

China's Civilian Space Activities

Although it lacks a designated civilian space program, China since the mid-1990s has incrementally developed a series of ambitious space exploration programs, ostensibly for civilian purposes, with high-level backing and sustained financial support. China already has achieved milestones that few other countries have reached, including sending a manned mission to space and conducting a soft landing of a spacecraft on the Moon. However, China

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*An orbital transfer vehicle (OTV) is defined as "a propulsion system used to transfer a payload from one orbital location to another—as, for example, from low Earth orbit to geostationary Earth orbit. Orbital transfer vehicles can be expendable or reusable . . . a reusable OTV is sometimes called a space tug." Joseph Angelo, *Dictionary of Space Technology*, Routledge, 2013, 286.

is still largely catching up to the two premier space powers, the United States and Russia, which accomplished these feats decades ago. Nonetheless, China has made rapid progress in developing its space capabilities—exceeding regional rival space programs such as those belonging to Japan and India—and is gradually closing the technological gap with the United States and Russia.[171]

Nearly all of the technologies used in China's civilian space activities also have military applications and are therefore dual-purpose, as is the case with other countries' space programs. Alanna Krolikowski, Princeton-Harvard China and the World Program postdoctoral fellow at Harvard University, explained to the Commission:

> *Particular items of commercial space hardware can be repurposed for defense applications with only minor modifications. These items include entire systems, such as launch vehicles, which can launch both civil-commercial and defense payloads. They also include sub-systems, such as sensors and robotic arms on spacecraft, which can in some measure be applied or adapted to intelligence or counterspace missions. Finally, dual-use technologies also include many smaller components, such as radiation-hardened electronic elements*.[172]

Human Spaceflight

China's human spaceflight program is one of the country's largest and most technologically-advanced projects, involving some 3,000 organizations and several hundred thousand personnel.[173] China is only the third country behind the United States and Russia to have independently launched a human into space.

China's human spaceflight program consists of three phases. In phase one (1992–2005), China launched several unmanned Shenzhou spacecraft to develop technologies necessary for its first manned spaceflights in 2003 and 2005. In phase two (2005–2013), China conducted both manned and unmanned docking maneuvers between the Shenzhou spacecraft and the Tiangong-1 space lab. In phase three, scheduled for completion by 2022, China plans to launch a permanent manned space station into orbit.[174]

- China has conducted 10 Shenzhou missions and plans to conduct the 11th in 2016. The Shenzhou spacecraft, which was designed by the China Academy of Space Technology, weighs approximately 7.8 tons and measures about 8.86 meters in length, and is able to support up to three people for up to seven days. It consists of three sections: an orbital module, a descent module, and a propulsion module.[175]
- China launched the Tiangong-1 space lab into orbit in 2011. The lab, which was developed by the China Academy of Space Technology, weighs approximately 8.5 tons and has an area of about 15 cubic meters, allowing it to hold up to three astronauts. China is expected to launch the follow-on to the Tiangong-1, the Tiangong-2, in 2016.[176] Following the Tiangong labs, China plans to launch a permanent manned space station in several phases beginning with an experimental

"core module" in 2018. Two additional modules are scheduled for launch in 2020 and 2022.[177] At 60 tons, the space station will be similar in size to the United States' first space station, Skylab, which was launched in the 1970s; it will be much smaller than the approximately 450-ton International Space Station, which is operated by the United States and Russia.[178] China expects to complete its space station launch around 2022, while the International Space Station is currently scheduled to complete its mission and be deorbited in 2024, potentially leaving China with the world's only active space station.[179]

Table 3: China's Human Spaceflight Missions

Spacecraft	Launch Date	Flight Time	Purpose
Shenzhou-1	November 20, 1999	21 hours	Test
Shenzhou-2	January 10, 2001	7 days	Test
Shenzhou-3	March 25, 2002	8 days	Test
Shenzhou-4	December 30, 2002	7 days	Test
Shenzhou-5	October 15, 2003	21 hours	Manned (1 crew)
Shenzhou-6	October 12, 2005	4+ days	Manned (2 crew)
Shenzhou-7	September 25, 2008	2+ days	Manned (3 crew); Extravehicular activity
Tiangong-1	September 29, 2011	36 months (ongoing)	Prototype space lab
Shenzhou-8	November 1, 2011	16 days	Unmanned docking
Shenzhou-9	June 16, 2012	14 days	Manned (3 crew) docking
Shenzhou-10	June 11, 2013	15 days	Manned (3 crew) docking

Source: Kevin Pollpeter, *China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States* (Prepared for the U.S.-China Economic and Security Review Commission by the University of California Institute on Global Conflict and Cooperation, March 2, 2015), 46.

Lunar Exploration Program

China's space experts proposed a lunar exploration program in 1991, and Beijing approved the first lunar orbiting mission in 2004.[180] According to the State Administration of Science, Technology, and Industry for National Defense, the program is a "major strategic decision by the CCP Central Committee, State Council, and Central Military Commission taking a broad look at [China's] overall modernization and construction by grasping the world's large [science and technology (S&T)] events and promoting [China's] space enterprise development, promoting [China's] S&T advancement and innovation, and improving [China's] comprehensive national power." [181]

China's lunar exploration program consists of three phases involving the Chang'e spacecraft and several lunar landing vehicles.

- In phase one (2004–2007), the Chang'e-1 and the Chang'e-2 spacecraft orbited the Moon to map the lunar surface. The missions also tested China's ability to control objects in deep space.

- In phase two (2007–2014), the Chang'e-3 spacecraft landed a lunar vehicle on the Moon. The vehicle deployed a rover, designated "Jade Rabbit," * to study the lunar surface and analyze its soil. Jade Rabbit has far exceeded its expected lifespan of three months; after mechanical failures throughout the mission, the rover was still communicating with Earth as of July 2015 despite being unable to move.[182] With the successful landing of the Chang'e-3, China became only the third country behind the former Soviet Union and the United States to conduct a soft landing on the Moon and the first to do so since 1976. Later in the second phase, China employed the Chang'e-5 spacecraft to test technologies required to retrieve and return a lunar sample to Earth.[183]
- In phase three, China plans to send a rover to the Moon and bring it back to Earth after it collects soil samples. The mission, scheduled for 2017, will use the Chang'e-6 spacecraft and be launched from China's new Wenchang launch center on Hainan Island.[184]
- In a potential fourth phase, China announced in September 2015 that it would send the Chang'e-4 spacecraft—originally designed as a backup for Chang'e-3—to land on the moon's "dark side" before 2020, which China would be the first nation to accomplish. The stated objective of this mission is to study geological conditions on the dark side, which could eventually lead to the placement of a radio telescope for use by astronomers.† [185]

Jeffrey Plescia, the chairman of NASA's Lunar Exploration Analysis Group, compared the lunar programs of China and the United States:

> *China has had a well-developed, focused plan, and they are using incremental steps to [carry out] lunar exploration. I would guess that, given the pieces they have tested, [they] have a high probability of success [in phase three]. . . . They are demonstrating that they have the technical capability [to conduct] the most sophisticated deep-space activities. They have a program, and they can keep to the schedule and accomplish mission goals on time. [By comparison] the United States has been floundering around for decades, trying to figure out what to do.*[186]

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* Jade Rabbit is equipped with a set of cameras to analyze the lunar surface and a robotic arm to gather samples of lunar soil. It has less than 16 percent of the mass of NASA's Mars rovers. Kevin Pollpeter, *China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States* (Prepared for the U.S.-China Economic and Security Review Commission by the University of California Institute on Global Conflict and Cooperation, March 2, 2015), 58–59.

† The far side or "dark side" of the moon is an ideal location for sensitive instruments, as radio transmissions from Earth are unable to reach it. Associated Press, "China Sets Its Space Exploration Sights on the Dark Side of the Moon," September 14, 2015.

Although China's lunar program is motivated primarily by prestige and scientific objectives, China also may seek to use the program to exploit the Moon's natural resources. Chinese analysts have noted that the Moon contains large amounts of 14 elements in particular, including iron, titanium, and uranium, that could be useful for economic development. Helium-3—of which the Moon has 1–5 million tons—appears to be of specific interest to the analysts, who estimate that 100 tons of the element could supply all of the Earth's energy requirements for one year, and that the revenue derived would make the endeavor economically feasible.[187] Importantly, exploitation of helium-3 for energy production would require the design and production of a commercially-viable nuclear fusion reactor, a technology not yet demonstrated by any nation. Should fusion power become available, however, helium-3 provides the most promising fuel and is almost entirely unavailable on earth.[188]

Beijing has not approved a plan to send humans to the Moon. In its 2011 white paper on space, however, Beijing acknowledged it is "researching the critical technologies for manned lunar exploration," and it began a feasibility study that same year for a manned mission to the Moon with a potential launch date of 2020, 2025, or 2030.[189]

Mars Exploration

Although Beijing has not approved a mission to Mars, top Chinese scientists have expressed interest in a Mars exploration program,[190] and China's defense industry and the Chinese Academy of Sciences are conducting studies on the feasibility of landing a robotic rover on the planet.[191] Moreover, the China Aerospace Science and Technology Corporation's debut of a full-size Mars rover model at the 2014 Zhuhai Airshow suggests China has begun preliminary research into the necessary technology for such a mission.[192]

U.S.-China Space Cooperation

Limited U.S.-China space cooperation began in the late 1970s, when the two countries signed a space exchange agreement and a memorandum of understanding on space technology cooperation.[193] U.S.-China cooperative space activities increased between 1990 and 1999, when the United States looked to China for satellite launch services. Following the loss of the space shuttle Challenger in 1986, which effectively ended the United States' plan to launch future military and commercial satellites aboard space shuttles, the United States faced a shortage of satellite launch facilities and began contracting launches out to other countries, including China. During this period, China launched a total of 19 U.S.-manufactured commercial satellites. Cooperation ended in 1999 when Congress passed a law prohibiting the launch of U.S. satellites by China, following revelations that several U.S. companies involved in the Chinese launches had illegally transferred potentially sensitive military information to China and that China had stolen classified information on advanced U.S. nuclear weapons technology.[194]

Since this decision, aside from limited instances of cooperation, U.S.-China space relations have stagnated due to ongoing U.S. government concerns about China's efforts to illicitly procure U.S. space technology.* Washington also remains wary of China's intentions as a growing space power, particularly with respect to China's lack of transparency regarding its intentions in space and China's focus on developing counterspace capabilities to restrict U.S. freedom of movement in space.

Despite tensions in the U.S.-China space relationship, events prior to 2011 suggested new momentum in bilateral space cooperation. The United States and China held several high-level visits from 2004 to 2010: the administrator of the China National Space Administration visited NASA in 2004, and the NASA administrator visited the Agency in 2006 and 2010.[195] A joint statement produced during President Obama's visit to China in 2009 expressed that "China and the United States look forward to expanding discussions on space science cooperation and starting a dialogue on human spaceflight and space exploration."[196] In January 2011 the Obama Administration also invited a Chinese delegation to visit NASA headquarters and other NASA facilities later that year to reciprocate for the NASA administrator's "productive" 2010 visit to China.[197]

In November 2011, however, Congress, based on concerns regarding China's efforts to illegally acquire U.S. space technologies, passed a prohibition against NASA conducting a range of activities with China. The law states:

> *None of the funds available by this Act may be used for the National Aeronautics and Space Administration (NASA) or the Office of Science and Technology Policy (OSTP) 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 Act*.[198]

The law further applies this limitation to "any funds used to effectuate the hosting of official Chinese visitors at facilities belonging to or utilized by NASA." It only allows for NASA to engage in "activities which NASA or OSTP have certified pose no risk of resulting in technology transfer, data, or other information with national security or economic security implications to China or a Chinese-owned company," requiring the certification to be submitted to Congress 14 days beforehand.[199] Language added in 2013 requires that these activities also "not involve knowing interactions with officials who have been determined by the United States to have direct involvement with violations of human rights."[200] Under this law, NASA's administrator has still been able to meet with Chinese counterparts in China and in official multilateral settings, and visits by Chinese nationals to NASA facilities are permitted if certified and presented to Congress as required.[201] The law has notably disallowed participation by Chinese astronauts in missions to

* Among China's most effective methods for acquiring sensitive U.S. technology are cyber espionage; witting and unwitting collection by Chinese students, scholars, and scientists; joint ventures; and foreign cooperation. For more information on the subject, see the U.S.-China Economic and Security Review Commission, *2014 Report to Congress*, November 2014, 294–299.

the International Space Station, though China's noninvolvement in the program predates 2011.* [202] Additionally, a ban mistakenly placed by NASA officials on Chinese scientists' participation at an international NASA conference in 2013 was misattributed to the law.[203] China's pursuit of enhanced bilateral space cooperation has included efforts to persuade the United States to lift these restrictions, with a 2013 commentary in state-run *PLA Daily* specifically calling for the removal of the "'Wolf Clause'† that bans China-U.S. space cooperation," terming it "a huge roadblock in terms of bilateral cooperation and mutual benefits." [204]

Bilateral Space Activities beyond NASA

Although the recent Congressional regulations place strict limitations on collaboration between NASA and the Chinese space industry, the United States and China since 2012 have expanded their cooperation on space activities that do not involve NASA.

- In 2012, the U.S. Geological Survey of the Department of the Interior agreed to provide imagery from its two Landsat satellites to the Center for Earth Observation and Digital Earth of the Chinese Academy of Sciences, apparently continuing China's use of Landsat imagery since 1986. Importantly, in 2008 current and archived Landsat imagery going back to 1972 had also become available online for free to users who register with the U.S. Geological Survey. These satellites image the Earth continuously and cover each point on Earth once every 16 days, and the Chinese Academy of Science reportedly uses this imagery for its research on Chinese environmental and land-use issues. Although the Landsat imagery is not sufficient to support time-sensitive military operations, the PLA could use it for map making and broad area analysis of trends in terrestrial infrastructure.[205]
- In 2014, the Space Studies Board of the U.S. National Academy of Sciences' National Research Council and the National Space Science Center of the Chinese Academy of Sciences held the first "Forum for New Leaders in Space Science." The goals of the forum are to: (1) "identify and highlight the research achievements of the best and brightest young scientists currently working at the frontiers of their respective disciplines"; (2) "build informal bridges between the space-science communities in China and the United States"; and (3) "enhance the diffusion of insights gained from participation in the Forum to the larger space-science communities in China and the United States." [206] Despite its collaborative spirit, the forum may present opportunities for Chinese participants to collect information, whether wittingly or unwittingly, on sensitive U.S. technology on behalf of the Chinese government and military.

* In August 2015 a Houston company announced it had negotiated an agreement to carry a Chinese DNA experiment on the International Space Station, but as a commercial deal involving a U.S. business rather than a U.S. government entity, the law does not apply. Leonard David, "US-China Space Freeze May Thaw with Historic New Experiment," *Space.com*, August 21, 2015; and Eric Berger, "For the First Time Chinese Research to Fly on NASA's Space Station," *Houston Chronicle*, August 3, 2015.

† The commentary referred to the initiation of the November 2011 National Defense Authorization Act clause by then Congressman Frank Wolf.

- In late 2014, Beijing asked the U.S. Air Force to send warnings of potential satellite collisions directly to China's space operators. In the past, such information was routed from the U.S. Air Force to the U.S. State Department, passed to China's Ministry of Foreign Affairs, and finally conveyed to China's space operators—a lengthy sequence. Mr. Cheng, assessing the likely reasons for this step, stated:

  [The PLA] is most likely acting . . . to remove an unnecessary link in the chain of information, especially important since conjunction data is perishable. . . . [Additionally, China] may be [attempting] to double-check [its] own data: What are the Americans seeing that [it is] not? This may be partly a matter of [image] resolution, and partly a possible source of intelligence. There was a brouhaha a few years back where [the United States was] reporting in [its] space catalogs European satellites that the Europeans denied existed.[207]

Moreover, in late June 2015, the United States and China held the seventh round of the Strategic and Economic Dialogue in Washington, DC. The U.S. State Department spokesperson announced that the dialogue produced several areas for further space cooperation between the State Department and China:

- The United States and China stated their intention to "establish regular bilateral government-to-government consultations on civil space cooperation." As an inaugural step in these consultations, the two countries held the first "U.S.-China Civil Space Cooperation Dialogue" in China in September 2015. At this meeting U.S. and Chinese officials exchanged information on space policies and on national plans related to space exploration, and discussed cooperation opportunities related to space debris, satellite collision avoidance, civil Earth observation, space sciences, space weather, and civil satellite navigation systems.[208] As stated in the June announcement, the two countries additionally plan to hold "exchanges on space security matters under the framework of the U.S.-China Security Dialogue before the next meeting of the Security Dialogue."
- The two sides reaffirmed that avoiding orbital collisions serves their common interest in exploring and using outer space for peaceful purposes, noting that further consultation is needed on the process for resolving an "orbital close approach" and that such a consultation should aim to ensure timely resolution to reduce the probability of accidental collisions. The two countries determined to "continue bilateral government-to-government consultations on satellite collision avoidance and the long-term sustainability of outer space activities as part of the U.S.-China Civil Space Cooperation Dialogue."
- The two sides determined to undertake, among other projects, a joint project in "space security" within the East Asia Summit, the Association of Southeast Asian Nations Regional Forum, or another multilateral framework in the Asia-Pacific region, as part of their larger goal to "enhance communication and coordination" within these fora.[209]

U.S.-China Space Endeavors: Risks vs. Rewards

Although the United States and China continue to pursue opportunities to collaborate on space endeavors, such cooperation is not without its potential hazards. Mr. Cheng advised the Senate Committee on Commerce, Science, Technology, and Transportation that the United States should proceed with caution as it considers expanding space cooperation with China:

> *While the United States should not avoid cooperation with any country out of fear, at the same time, it is vital that cooperation occur with full understanding and awareness of whom we are cooperating with, and that such cooperation serve American interests. In the case of [China], the combination of an opaque Chinese space management structure, a heavy military role in what has been observed, and an asymmetric set of capabilities and interests raise fundamental questions about the potential benefits from cooperation between the two countries in this vital arena.*
>
> *To this end, it is essential to recognize a few key characteristics of China's space program. First, that China possesses a significant space capability in its own right, and therefore is not necessarily in need of cooperation with the United States. Too often, there is an assumption that [China] is still in the early stages of space development, and that we are doing them a favor by cooperating with them. Second, that the Chinese space program is closely tied to the [PLA]. . . . Therefore, any cooperation with [China] in terms of space must mean interacting, at some level, with the PLA. Third, that the Chinese space program has enjoyed high-level political support, is a source of national pride, and is therefore not likely to be easily swayed or influenced by the United States, or any other foreign actor. These three issues, in combination, suggest that any effort at cooperation between the United States and [China] will confront serious obstacles, and entail significant risks.*[210]

Other observers have suggested it is possible for the United States to improve space cooperation with China while also protecting U.S. security interests and supporting the U.S. space program's development. In his testimony to the Commission, Philip Saunders, director of the Center for the Study of Chinese Military Affairs of the Institute for National Strategic Studies at the National Defense University, argued, "there are other areas such as many scientific applications and manned space flight where the United States can share information and experiences without compromising national security and can benefit from growing Chinese investments in space capabilities and China's potential contributions to international space cooperation."[211]

Implications of China's Space and Counterspace Programs for the United States

China's improving space capabilities are challenging U.S. superiority in the information and space domains. A senior official at the PLA's Academy of Military Science underscored China's ambition to rival the world's top space powers following China's 2007 antisatellite test: "[If there is going to be] a space superpower, it's not going to be alone. . . . It will have company."[212] In 2013, Central Military Commission Chairman and Chinese President Xi Jinping said "the dream of space flight is an important part of the strong country dream" and "the space dream is an important component of realizing the Chinese people's mighty dream of national rejuvenation."[213]

Space activities are critical to the United States' technological advancement, scientific discovery, security, and economic growth. As outlined in the Obama Administration's 2010 *National Space Policy*, the utilization of space has transformed every aspect of U.S. society, and the benefits of space permeate daily life in the United States:

> *Satellites contribute to increased transparency and stability among nations and provide a vital communications path for avoiding potential conflicts. Space systems increase our knowledge in many scientific fields, and life on Earth is far better as a result. The utilization of space has created new markets; helped save lives by warning us of natural disasters, expediting search and rescue operations, and making recovery efforts faster and more effective; made agriculture and natural resource management more efficient and sustainable; expanded our frontiers; and provided global access to advanced medicine, weather forecasting, geospatial information, financial operations, broadband and other communications, and scores of other activities worldwide. Space systems allow people and governments around the world to see with clarity, communicate with certainty, navigate with accuracy, and operate with assurance.*[214]

Space capabilities also have enhanced U.S. security and have been a key element of warfighting for more than 30 years—to the extent that U.S. national security is now dependent on the space domain. According to the joint DOD–Intelligence Community *National Security Space Strategy*, published in 2011:

> *Space capabilities provide the United States and our allies unprecedented advantages in national decision-making, military operations, and homeland security. Space systems provide national security decision-makers with unfettered global access and create a decision advantage by enabling a rapid and tailored response to global challenges. Moreover, space systems are vital to monitoring strategic and military developments as well as supporting treaty monitoring and arms control verification. Space systems are also critical in our ability to respond to natural and man-made disasters and monitor long-term environmental trends.*[215]

The United States' sustained success in integrating space capabilities into its military operations has encouraged China to pursue a broad and robust array of counterspace capabilities to deny, degrade, deceive, disrupt, or destroy U.S. space systems and their supporting infrastructure. This program includes direct-ascent antisatellite missiles, computer network operations, ground-based satellite jammers, and directed energy weapons. China also appears to be developing co-orbital antisatellite systems, which have not been a significant concern for the United States since the fall of the Soviet Union.

China already has demonstrated its ability to strike U.S. satellites in low Earth orbit. As China's developmental counterspace capabilities become operational, China will be able to hold at risk U.S. national security satellites in every orbital regime. According to General Hyten, commander of U.S. Air Force Space Command, the loss of U.S. space capabilities would send the U.S. military "back to World War Two . . . back to industrial age warfare." [216]

Beijing also recognizes that command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) modernization is central to its "preparation for military struggle" and is rapidly expanding its space-based C4ISR assets accordingly. China currently has approximately 142 operational satellites in orbit, more than 97 percent of which have been launched since 2000 and 75 percent since 2008. In addition to serving China's economic goals, this modernization program is designed to improve the PLA's ability to command and control its forces; monitor global events and track the military activities of the United States and other potential adversaries; and increase the range at which Beijing can use conventional missile systems to place U.S. ships, aircraft, and bases at risk.

China's current system of C4ISR satellites likely allows the PLA to detect and monitor U.S. air and naval activity out to the second island chain * with sufficient accuracy and timeliness to (1) assess U.S. military force posture, and (2) cue land-, maritime-, and air-based collection assets for higher fidelity and time-sensitive tracking and targeting of U.S. military assets. As China continues to field additional C4ISR satellites, the country's space-based ISR coverage almost certainly will become more accurate, responsive, and timely and could ultimately extend beyond the second island chain into the eastern Pacific Ocean and Indian Ocean.[217] Nevertheless, the U.S. Office of Naval Intelligence points out that building a complete picture of all activities—which would rely heavily on additional space-based C4ISR—could remain a "formidable challenge" for China due to the sheer size of these areas:

> *Just to characterize activities in the "near seas," China must build a picture covering nearly 875,000 square nau-*

*The first island chain refers to a line of islands running through the Kurile Islands, Japan and the Ryukyu Islands, Taiwan, the Philippines, Borneo, and Natuna Besar. The second island chain is farther east, running through the Kurile Islands, Japan, the Bonin Islands, the Mariana Islands, and the Caroline Islands. PLA strategists and academics have long asserted the United States relies primarily on the first island chain and the second island chain to strategically "encircle" or "contain" China and prevent the PLA Navy from operating freely in the Western Pacific. Open Source Center, "PRC Article Surveys China's Naval Rivals, Challenges," January 6, 2012. ID: CPP20120109671003; Bernard D. Cole, *The Great Wall at Sea* (Second Edition), Naval Institute Press, 2010, 174–176.

tical miles (sqnm) of water- and air-space. The Philippine Sea—a key interdiction area in the event of a conflict over Taiwan or in the South China Sea—expands the battlespace by another 1.5 million sqnm. In this vast space, navies and coast guards from seven regional countries as well as several globally-deploying nations combine with tens of thousands of fishing boats, cargo ships, oil tankers, and other commercial vessels.[218]

In a 2015 report sponsored by the Commission, the RAND Corporation notes that the cyber infrastructure contributing to China's maritime domain awareness could at times be limited by technical challenges associated with integrating so many new technologies and complex systems, as well as by poor coordination among intelligence organizations, operators, and decision makers:

Another potential weakness for China . . . may exist in the need to integrate all the PLA's disparate ISR capabilities and incorporate them into the targeting process. Indeed, shortcomings in China's C4ISR capabilities, which could be both organizational and technological, could hamper the speed, reduce the reliability, or otherwise diminish the effectiveness of the PLA's over-the-horizon targeting capabilities. Problems with the potential to limit the effectiveness of Chinese C4ISR and targeting could include not only technical challenges associated with integrating such a variety of new technologies and complex systems but also procedural weaknesses, such as insufficient coordination among numerous intelligence organizations, operators, and higher-level decision makers.[219]

Furthermore, although China's space-based C4ISR modernization enhances the PLA's operational capabilities, it also increases PLA vulnerabilities to U.S. deception, degradation, and denial capabilities.[220]

In addition to the implications it poses for U.S. military interests, the rapid expansion of China's space industry could also have economic consequences for the United States.

First, China's persistent global marketing of its commercial satellite and space launch services has the potential to cut into U.S. market share in these areas, though it has had little effect on established satellite manufacturers or the international launch market thus far. Although China's current effort focuses on growing its satellite exports to lower-income buyers, it almost certainly will eventually expand to higher-end markets, following a business plan similar to that of Chinese telecommunications giant Huawei. China's launch service costs compare favorably with those of Arianespace, the major European provider, and may match those of SpaceX, the low-cost leading U.S. private firm, as described earlier. In addition, according to one former European space executive, China has broken into the launch services market by offering prices at as low as three-quarters of the launches' cost, suggesting heavy government assistance on top of low initial costs will enable China to successfully compete for broader market share in the future. Furthermore, China often packages its satellite exports and launch services together, and also reaps cost and experience benefits from blending its civilian and military space infrastructure, which is expected to provide additional competitive advantages. An executive for U.S. company SpaceX, which has led a resurgence in U.S. commercial launch market share after U.S. organizations were priced out of the market until recently, stated in 2013 that the company views China as its main competition. However, in a July 2015 meeting with the Commission, the China Great Wall Industry Corporation asserted that it is unable to compete with Western counterparts due to U.S. export controls, indicating that obstacles remain despite China's cost advantages.[221]

Second, China's designation of the Beidou satellite navigation system—planned to provide global service by 2020—as "national infrastructure," and introduction of preferential policies to promote its place in China's domestic satellite navigation market, will directly impact the market share of GPS and related products within China.[222] While GPS usage provides no revenues to the United States, Beidou is also intended to foster development in downstream industries such as mobile internet applications, which may affect U.S. firms' market share in these industries.[223]

Third, U.S. International Trafficking in Arms Regulations (ITAR), altered by the FY13 National Defense Authorization Act to no longer include exports of many satellites and satellite technologies but still in force for China, have prompted many European countries and their industries to pursue "ITAR-free" exports in order to reach the Chinese market—by definition necessitating the exclusion of U.S. technologies from these products. Mr. Nurkin testified to the Commission that "concern over U.S. export controls on space-related items and confusion over which items are on the list of banned items for export and, importantly, which ones will be in the future, has led international industry, especially the European space industry, which has far less severe export guidelines for space technologies, to endeavor to design ITAR-free solutions, effectively cutting out U.S. based suppliers of ITAR-restricted items from international supply chains."[224] Mr. Nurkin suggested that export control reform should "focus on increasing protection on a small number of systems and technologies that the United States is and should be unwilling to offer on the open market" instead of focusing on the many technologies that China probably already has access to from foreign partners, particularly Europe.[225] In May 2015, General James Cartwright, former vice chairman of the Joint Chiefs of Staff, and the Honorable Sean O'Keefe, former NASA administrator, reiterated that U.S. ITAR regulations are not currently in line with the pace of technological innovation and are therefore in need of reform in order to protect the U.S. space industry's global competitiveness.[226]

China's thriving space programs have important political implications as well, most importantly in their potential to present a future challenge to the United States' position as a leading space power. China's human spaceflight program may be repeating many of the same accomplishments the United States achieved in the 1970s, but it also is tempering U.S. superiority in civilian space capabilities and lessening U.S. influence in the international space community. Roger Handberg, professor at the University of Central Florida, testified to the Commission that "psychologically, momentum appears to be moving in China's favor with the possibility of actually moving ahead of the United States over the next two decades." [227] China is gaining sway among lesser space nations by sharing space technologies, supplying training and financing for developing satellites, and providing launch services. Beijing's push into new space markets could undermine U.S. efforts to prevent countries from obtaining certain dual-use space technologies. China is developing capabilities that could allow it to compete in sending humans and other payloads to the Moon and beyond, even as the United States now depends on Russian launch vehicles and sites to send humans into space.[228]

China's new space station, slated for completion in 2022 while the deorbiting of the International Space Station is scheduled for 2024, will provide Beijing greater prestige in the international system and expand its growing space presence—concurrent with declining U.S. influence in space. Not only will China have the only space station in orbit, but it also will have the ability to choose its partners and determine the countries with which it will share technologies and experimental data. In this sense, the space station likely will serve as a diplomatic tool China can leverage to execute its broader foreign policy goals. Meanwhile, given current Congressional restrictions on U.S.-China space cooperation, the United States would not participate in China's space station program barring changes to annual appropriations legislation. For the first time in decades, the United States could be without a constant human presence in space.

Conclusions

- China has become one of the top space powers in the world after decades of high prioritization and steady investment from China's leaders, indigenous research and development, and a significant effort to buy or otherwise appropriate technologies from foreign sources, especially the United States. Although China's space capabilities still generally lag behind those of the United States and Russia, its space program is expanding and accelerating rapidly as many other nations' programs proceed with dwindling resources and limited goals.

- China's aspirations in space are driven by its judgment that space power enables the country's military modernization, drives its economic and technological advancements, allows it to challenge U.S. information superiority during a conflict, and provides the Chinese Communist Party with significant domestic legitimacy and international prestige.

- China's space program involves a wide network of entities spanning its political, military, defense industry, and commercial sectors. Unlike the United States, China does not have distinctly separate military and civilian space programs. Under this nebulous framework, even ostensibly civilian projects, such as China's human spaceflight missions, directly support the development of People's Liberation Army (PLA) space, counterspace, and conventional capabilities. Moreover, Chinese civilian and commercial satellites likely contribute to the PLA's command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) efforts whenever it is technically and logistically feasible for them to be so utilized, and they would probably be directly subordinate to the PLA during a crisis or conflict. Given the PLA's central role in all of China's space activities, U.S. cooperation with China on space issues could mean supporting the PLA's space and counterspace capabilities.

- China likely has capitalized on international cooperation to acquire the bulk of the technology and expertise needed for most of its space programs. China probably will continue to pursue close cooperation with international partners to overcome specific technical challenges and to meet its research and development objectives and launch timelines.
- Chinese analysts perceive that China's advances in space technology have become an important driver for the country's economic growth. Satellite and launch service sales provide China's defense industry with a growing source of revenue. Technology spin-offs offer competitive advantages in certain sectors, such as satellite navigation products. Exports of space technology-based products pose challenges to the United States not only due to the non-market-based nature of China's economy, but also due to military and security concerns.
- As China's developmental counterspace capabilities become operational, China will be able to hold at risk U.S. national security satellites in every orbital regime.
- China is testing increasingly complex co-orbital proximity capabilities. Although it may not develop or operationally deploy all of these co-orbital technologies for counterspace missions, China is setting a strong foundation for future co-orbital antisatellite systems that could include jammers, robotic arms, kinetic kill vehicles, and lasers.
- China is in the midst of an extensive space-based C4ISR modernization program that is improving the PLA's ability to command and control its forces; monitor global events and track regional military activities; and strike U.S. ships, aircraft, and bases operating as far away as Guam. As China continues to field additional intelligence, surveillance, and reconnaissance (ISR) satellites, its space-based ISR coverage almost certainly will become more accurate, responsive, and timely and could ultimately extend beyond the second island chain into the eastern Pacific Ocean and the Indian Ocean.
- China's rise as a major space power challenges decades of U.S. dominance in space—an arena in which the United States has substantial military, civilian, and commercial interests.

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SECTION 3: CHINA'S OFFENSIVE MISSILE FORCES

Introduction

China's offensive missile forces are integral to its military modernization efforts and its objective of becoming a world-class military capable of projecting power and denying access by adversary forces to China's periphery. The People's Liberation Army's (PLA) ambitions in this area were on display in September 2015 at China's largest-ever military parade, which commemorated the 70th anniversary of the end of World War II. Nine different classes of ballistic and cruise missiles were featured, some of which had never before been publicly unveiled.* The parade highlighted the pace and sophistication of China's missile modernization, and signaled to the world China's seriousness about enhancing both its nuclear and conventional missile capabilities and its ability to hold adversary forces at greater risk.

This section examines China's modernizing missile forces, including several new methods and platforms for missile deployment. Although it includes a brief discussion of Chinese developments in long-range surface-to-air missiles and other defensive measures against adversary missiles, the focus is primarily on China's offensive missile developments. The section discusses the drivers of China's missile modernization; the capabilities and doctrines of its conventional and nuclear missile forces; selected emerging missile technologies; and the challenge of C4ISR† and targeting. Finally, it considers the implications of China's missile force modernization for the United States. This section draws on the Commission's April 2015 hearing on China's offensive missiles; consultations with experts on the Chinese military and international security affairs; and open source research and analysis.

China's Drive to Modernize the Second Artillery

Missile Warfare and the Second Artillery

The PLA's Second Artillery has been responsible for China's missile forces since its establishment in the 1960s—first as a solely nuclear force and since the 1990s as an increasingly lethal conventional missile force as well. Missile warfare is a key component of PLA "joint firepower operations," which combine strike aviation, theater missiles, and long-range artillery. The chief objective of these operations is to asymmetrically hold enemy assets at risk at

*Missiles on display at the parade included the DF–10, DF–15B, DF–16, DF–21D, DF–26, DF–5B, DF–31A, YJ–12, and YJ–83. Andrew Erickson, "Missile March: China Parade Projects Patriotism at Home, Aims for Awe Abroad," *China Real Time Report* (*Wall Street Journal* blog), September 3, 2015.

†C4ISR stands for "command, control, communications, computers, intelligence, surveillance, and reconnaissance."

long range by weakening an adversary at key nodes—such as command and control and logistics hubs—to lay the groundwork for air, sea, and information superiority in wartime. In particular, China's theater missiles—those missiles with ranges meant to support Pacific theater operations—create a more favorable environment for subsequent PLA Air Force and PLA Navy operations. According to PLA campaign theory, seizing the advantage in the air, maritime, and information domains are prerequisites for achieving operational objectives and terminating a military conflict on China's terms.[1]

China's growing conventionally-armed missile inventory is taking center stage in its strategic and warfighting calculus. The Second Artillery provides China with a decisive operational advantage over regional militaries competing with China to defend maritime claims in China's "near seas,"* as China gains a superior ability to hold its adversaries' assets at risk.[2] China's long-range precision strike capabilities also improve its ability to engage the U.S. military at longer distances from China's coastline, eroding the United States' ability to access the Western Pacific freely in the event of a conflict.[3]

China has come to view a flexible, survivable, and lethal offensive missile force as a force multiplier in achieving its strategic objectives. The Second Artillery's conventional missiles provide an increasingly robust deterrent against other military powers, and its nuclear-armed missiles serve as a guarantor of state survival. Moreover, as Mark Stokes, executive director of the Project 2049 Institute, testified to the Commission, "China's long-range precision strike capabilities . . . support the [Chinese Communist Party's (CCP)] quest for legitimacy. The PLA functions as the armed wing of the CCP, and the Second Artillery is the party's instrument for achieving strategic effects through direct targeting of enemy centers of gravity."[4]

As the Second Artillery's missions have expanded, so has its bureaucratic status within the PLA. The 2004 promotion of the Second Artillery commander, along with the commanders of the PLA Air Force and PLA Navy, to membership on the Central Military Commission, China's top military decision-making body, reflects efforts to make PLA operations more "joint" and less ground-force-dominated. As a result the Second Artillery, like the PLA Air Force and PLA Navy, has taken on an elevated bureaucratic stature in the decade since its promotion to the Central Military Commission,[5] and today it plays a key role in PLA planning and operations.[6] In addition to providing a variety of "fire support" missions for the PLA services, Second Artillery Doctrine also envisions the possibility of implementing an "independent conventional missile strike campaign" without significant coordination with the PLA services.[7] According to Andrew Erickson, associate professor at the U.S. Naval War College, China's upcoming military restructuring—outlined in 2013 and initiated by the 300,000-personnel troop cut announced at the September 2015 military parade—will likely not result in any demotion to the Second Artillery's status.[8]

* China's "near seas" are the Bohai, Yellow Sea, East China Sea, and South China Sea regions.

Context and Drivers of China's Missile Force Development

In the 1990s, China's military modernization efforts prioritized capabilities that could deter, delay, and deny the likely intervention of the United States military in a Taiwan contingency. This sole strategic emphasis has since diversified. In 2004, Beijing issued a directive to the PLA to prepare for nontraditional missions beyond China's immediate periphery, including humanitarian assistance/disaster relief, counterterrorism, and international peacekeeping operations. Such missions reflect China's strategic interest in protecting its economic development and increasing its global footprint. As the PLA's operational fluency has improved, its naval, air, and ground forces—all of which are increasingly armed with long-range missiles or integrated with the Second Artillery's missile operations—have begun to prepare for and familiarize themselves with operations beyond the Chinese mainland and near seas, demonstrating an improving ability to project power throughout the Asia Pacific region and beyond.[9]

According to Mr. Stokes, the Second Artillery's growth, modernization, and departure from its origins as a solely nuclear force have proceeded and will continue to proceed in phases. Preparation for a Taiwan contingency through the development and deployment of short-range ballistic missiles (SRBMs) with a 600 kilometer (372 mile) range along the Taiwan Strait from the late-1980s to the mid-1990s constituted the first phase. A second phase has been the expansion of SRBM ranges to 1,500–2,000 kilometers (932–1,242 miles) to develop a basic capability to strike longer-range targets on land and moving targets at sea. The next phase, which Mr. Stokes anticipates China could reach by the end of 2015, is an extension of its conventional precision strike capability to a range of 3,000 kilometers (1,864 miles) and beyond.* Finally, China could pursue an even greater extension of the Second Artillery's conventional precision strike capability to 8,000 kilometers (4,971 miles) and eventually a global conventional precision strike capability, which Mr. Stokes estimates could take place by 2020 and 2030, respectively.[10]

In the post-Cold War nuclear realm, China's chief strategic concern has been the United States, particularly the U.S. nuclear arsenal and modernization of missile defenses. (For more information on Chinese concerns about U.S. missile defenses, see "Increasing the Penetrability of Adversary Missile Defenses," later in this section.) Of note, China is surrounded by a number of nuclear-capable states, many of which experience varying degrees of instability or enmity with each other. In South Asia, India and Pakistan are relatively recently-declared nuclear states with mutual deep-seated tensions. In Northeast Asia, prospects for North Korea's denuclearization appear increasingly unlikely,† while Japan's recent defense reforms have led China to raise concerns about Japan's nuclear weapons potential.[11] Finally, although Taiwan does not itself

*The DF–26 intermediate range ballistic missile's inclusion in China's September 2015 military parade may represent the achievement of this phase; see "Ballistic Missiles: Antiship Missiles," later in this section.

†For more information on the denuclearization issue in China-North Korea relations, see U.S.-China Economic and Security Review Commission, *2014 Annual Report to Congress*, November 2014, 455–459.

maintain nuclear weapons, China recognizes that a conflict with Taiwan could involve the intervention of the nuclear-armed United States.[12]

Nuclear Strike: Doctrine and Capabilities

China's nuclear strike capabilities have modernized only gradually in comparison to its conventional capabilities. Moreover, China's nuclear doctrine remains largely unchanged since its establishment as a nuclear state in the 1960s. Although modern China's early leaders, especially Mao Zedong, appreciated the political utility of nuclear weapons as a deterrent, they did not view nuclear capability as a significant warfighting tool. This philosophy appears to have guided the development of China's nuclear doctrine as well as the size of China's nuclear arsenal, which is estimated to be of moderate size in comparison to other major declared nuclear states such as the United States and Russia.[13] Nevertheless, China is improving its nuclear-armed missile capabilities and moderately increasing the size of its arsenal. Beijing does not release official data about its nuclear arsenal and its pronouncements regarding its doctrine are limited and vague. Opacity in this area helps China maintain and strengthen strategic ambiguity, and, by extension, the value of its strategic arsenal.[14]

China's Nuclear Doctrine

Nuclear Deterrence

The chief roles of China's nuclear arsenal are to deter an adversary from undertaking a nuclear first strike and to reduce the pressure on China to yield to an adversary's demands, or desist from aggression, under threat of nuclear attack.[15] China's nuclear deterrent is premised on the concept of assured retaliation, which is the idea that "a small number of survivable weapons would be enough to accomplish deterrence by threatening retaliation and, thus, unacceptable damage on an adversary," according to M. Taylor Fravel, Associate Professor in the Department of Political Science at the Massachusetts Institute of Technology, and Evan S. Medeiros, then Director for China, Taiwan, and Mongolian Affairs at the U.S. National Security Council.* [16]

As the PLA has increasingly incorporated the Second Artillery into joint campaign planning, the Second Artillery's nuclear missile force is likely to be considered a backstop to support conventional missions. In a conventional conflict, the PLA could fight with the confidence that its nuclear weapons—and therefore the threat of nuclear retaliation—could prevent the conflict from escalating too far. In this sense, China believes the Second Artillery's nuclear arsenal could constrain an adversary's options in a conventional conflict, providing China with greater flexibility to conduct conven-

* Because China's declarations on its nuclear policy are vague and kept to a minimum, this assessment of China's nuclear strategy does not necessarily represent China's official views. Furthermore, some scholars, such as Wu Riqiang, associate professor at the School of International Studies at Renmin University, disagree that assured retaliation is what drives China's nuclear deterrent. Wu Riqiang, "Remarks" (Chinese Thinking on Nuclear Weapons, Carnegie Endowment for International Peace, Washington, DC, May 11, 2015); and Wu Riqiang, "Certainty of Uncertainty: Nuclear Strategy with Chinese Characteristics," *Journal of Strategic Studies* 36:4 (2013), 579–614.

tional military operations.[17] However, this belief could encourage China to be more risk-acceptant during a crisis because it may not fear the prospect of escalating a conventional fight into the nuclear realm as much as it otherwise would.[18]

Dr. Christopher Yeaw, founder and director of the Center for Assurance, Deterrence, Escalation, and Nonproliferation Science & Education, testified to the Commission that this doctrine has been shifting.[19] In an interview with Commission staff, he further explained:

> *I don't believe China fears nuclear coercion from the United States as it did in the Cold War years, nor does it primarily fear a highly unlikely U.S. nuclear first strike—what China fears most is losing to the United States in a "politically necessary" conventional conflict. I believe this leads [China] to desire a way to deescalate the United States out of a high-intensity regional conflict, particularly one in which the United States is imposing severe costs from a purely conventional perspective and China's victory appears elusive or in grave doubt.*[20]

Potential Reconsideration of No-First-Use

China has long pledged a policy of "no-first-use" for its nuclear weapons. As stated in Beijing's most recent defense white paper: "China has always pursued the policy of no first use of nuclear weapons and adhered to a self-defensive nuclear strategy that is defensive in nature. China will unconditionally not use or threaten to use nuclear weapons against non-nuclear-weapon states or in nuclear-weapon-free zones, and will never enter into a nuclear arms race with any other country."[21] China's no-first-use pledge appears designed to convey China's preference for using nuclear weapons for deterrence rather than warfighting purposes, as well as its stated view that nuclear warfighting is strictly firewalled from conventional warfighting.[22]

It is unclear, however, under what circumstances China would use nuclear weapons and what China would consider "first use." As a result, the outer bounds of the pledge have been under debate for some time among outside observers.[23] For example, although China's 2013 defense white paper indicates China will use nuclear weapons to respond to a nuclear *attack* but not a nuclear *threat*, it does not articulate at what point China will consider a nuclear threat to have ended and a nuclear attack to have begun.[*][24] The 2013 *Science of Military Strategy*, an authoritative PLA doctrinal source, indicates China will not wait to absorb a nuclear strike before launching a retaliatory nuclear strike of its own: "We can, under conditions confirming the enemy has launched nuclear missiles against us, before the enemy nuclear warheads have reached their targets and effectively exploded, before they have caused us

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*China's 2013 defense white paper differentiates between responses to a nuclear threat and a nuclear attack. A nuclear threat will prompt China's nuclear missile force to "go into a higher level of readiness, and get ready for a nuclear counterattack to deter the enemy from using nuclear weapons against China." In response to a nuclear attack, however, "the nuclear missile force of the [Second Artillery] will use nuclear missiles to launch a resolute counterattack either independently or together with the nuclear forces of other services." China's Information Office of the State Council, *The Diversified Employment of China's Armed Forces*, April 2013.

actual nuclear damage, quickly launch a nuclear missile retaliatory strike." [25]

No-first-use has generated debate within China as well.[26] In a 2013 opinion piece, PLA Major General Yao Yunzhu of the Academy of Military Science, the PLA's preeminent research institute, acknowledged speculation in Chinese media about a possible change to no-first-use, attributing it to two concerns:

- Ballistic missile defense systems developed by the United States and its allies "would be capable of intercepting retaliatory Chinese nuclear weapons launched after [China] has already been attacked, thus potentially negating the effectiveness of China's nuclear arsenal as a deterrent." [27]
- The United States' increasingly advanced conventional capabilities could strike China's nuclear arsenal and nullify China's no-first-use policy.[28] Both Western and Chinese scholars have suggested the threshold for China's nuclear retaliation may not be limited to a nuclear first strike, but could also include a conventional threat to its own nuclear arsenal.[29]

The U.S. Department of Defense (DOD) has also identified additional areas of ambiguity in China's no-first-use policy, including whether demonstration strikes, high-altitude bursts,* or strikes on what China considers its territory would constitute a first use.[30]

Chinese and Western experts seem to agree China officially will adhere to a no-first use policy, while allowing healthy debate about the circumstances of its applicability in unofficial channels.[31] The policy considerations shaping Beijing's decision–making regarding when to use nuclear weapons are likely to remain unknown to the public.[32]

Potential Changes to Nuclear State of Alert

Due to China's opacity about its nuclear program, the typical state of its nuclear forces is unclear to outsiders. Most analysts assume China keeps its nuclear warheads stored separately from its missiles rather than continuously deploying a number of warheads on missiles as done by France, Russia, the United Kingdom, and the United States.† This "de-alerting" ‡ policy would be in line with Beijing's preference for highly centralized command and control over its nuclear weapons but would leave room for vulnerability to a first strike: whereas it takes additional time to ready de-alerted

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* DOD is likely referring to a high-altitude nuclear explosion that creates an electromagnetic pulse, which is an intense energy field that can overload or disrupt electrical systems such as those used in critical civilian infrastructure. Non-nuclear means can also generate an electromagnetic pulse effect. U.S. Department of Defense, *Department of Defense Dictionary of Military and Associated Terms*, November 8, 2010 (as amended through June 15, 2015), 103; and Clay Wilson, "High Altitude Electromagnetic Pulse (HEMP) and High Power Microwave (HPM) Devices: Threat Assessments," July 21, 2008, *Congressional Research Service*, Summary.

† This assumption about China's nuclear policy is not unanimously held. Dr. Yeaw, for example, challenges the notion that China keeps the entirety of its forces de-alerted at all times, given the immense lengths it has gone to in order to acquire a more survivable force. Christopher Yeaw (Director, Center for Assurance, Deterrence, Escalation, Nonproliferation Science & Education), interview with Commission staff, June 15, 2015.

‡ "De-alerting" generally refers to the adoption of measures that extend the amount of time required to launch a nuclear weapon once the order to launch is given. Storing warheads separately from delivery systems, as China does, is one of a range of possible de-alerting measures. Andrew Brown and Jeffrey Lewis, "Reframing the Nuclear De-alerting Debate: Toward Maximizing Presidential Decision Time," *Nuclear Threat Initiative*, December 11, 2013.

nuclear weapons and launch them, nuclear weapons on "high alert"* could be launched within minutes of a launch order.[33]

Experts have debated the effect of de-alerting policies such as China's on strategic stability. Advocates of de-alerting express concerns about the risk of escalation, arguing that maintaining high-alert status removes the option of preparation and deliberation prior to firing a nuclear weapon. In their view, keeping nuclear weapons de-alerted also minimizes the risk of their accidental use, unauthorized use, and use due to miscalculation.[34] Advocates of high-alert status, however, reject the notion that a constant high state of nuclear readiness is destabilizing. Rather, they argue, it creates certainty for adversaries about the kind of response they should expect from a state maintaining nuclear weapons on high alert. Another argument in favor of high-alert status is that it provides the executive decision maker time to consider various responses during a crisis, knowing that nuclear weapons would be ready for launch within minutes of the decision to fire them.[35]

In testimony to the Commission, James Acton, senior associate and co-director of the Nuclear Policy Program at the Carnegie Endowment for International Peace, suggested China's presumptive de-alerting policy could change. As noted in the previous excerpt from the 2013 *Science of Military Strategy*, evidence in doctrinal writings indicates the PLA has considered the idea of a nuclear launch in response to an incoming nuclear attack prior to the missiles actually reaching their targets, or "launch on warning." This suggests Chinese nuclear forces would at least be alerted in the event of a crisis. China's stated interest in enhancing its strategic early-warning capabilities also suggests an interest in launch on warning: such capabilities, intended to provide China with the time to react to an incoming threat, would be "of little value" to a de-alerted force during a crisis, according to Dr. Acton.[36] Finally, the policy would change if China decides to mate nuclear warheads to its submarine-launched ballistic missiles (SLBMs)—a "potentially huge shakeup for the Chinese forces for command and control."[37] For more information on China's SLBMs, see "Submarine-Launched Ballistic Missiles," later in this section.

Nuclear Escalation Philosophy

Another factor that sheds light on how and when China might employ nuclear weapons is its nuclear escalation philosophy—how a state might use nuclear weapons to escalate or deescalate a conflict. Dr. Yeaw testified to the Commission that China views the use of nuclear weapons not "in a warfighting fashion intended to defeat the adversary on the battlefield," but "in the high-intensity political management of an escalating and perhaps unsustainable conflict."[38] According to this escalation philosophy, China would punctuate non-nuclear operations with tactical- or theater-level nu-

*"High alert"—often termed "hair-trigger alert" by critics—generally describes the status of nuclear weapons ready for launch within minutes, or the shortest possible length of time, of a launch order. Currently the United States and Russia maintain nuclear forces on high alert while France and the United Kingdom maintain nuclear forces on "alert" but at a lower level; the nuclear forces of China, India, North Korea, and Pakistan are believed to be de-alerted. Andrew Brown and Jeffrey Lewis, "Reframing the Nuclear De-alerting Debate: Toward Maximizing Presidential Decision Time," *Nuclear Threat Initiative*, December 11, 2013; and Hans M. Kristensen and Matthew McKinzie, "Reducing Alert Rates of Nuclear Weapons," *United Nations Institute for Disarmament Research*, 2012, 1–8.

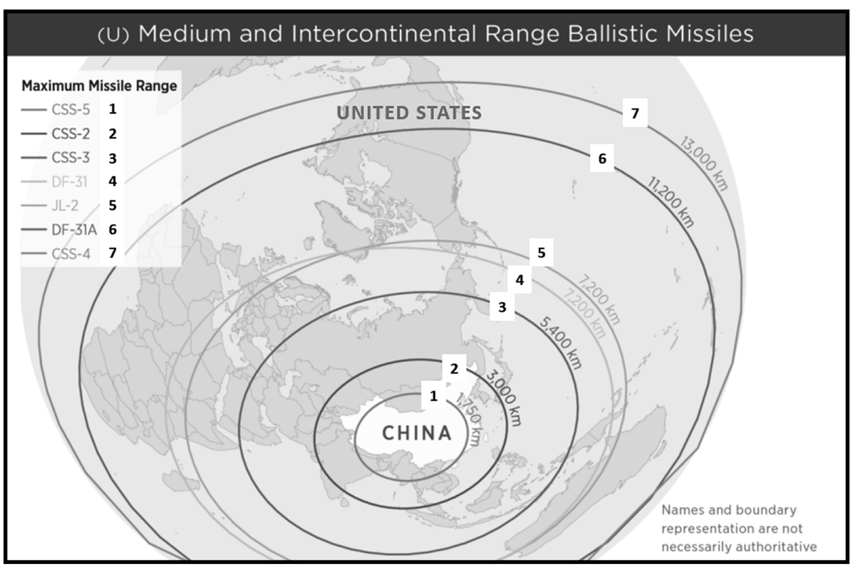
clear strikes to seek deescalation on terms favorable to China. Unlike strategic nuclear weapons, which target an adversary's homeland and population centers, tactical and theater nuclear weapons (also known as nonstrategic nuclear weapons) are designed for missions at shorter ranges, and usually carry lower-yield warheads. Because their use does not invite overwhelming nuclear retaliation in the same way as would strategic nuclear strikes on a country's homeland, tactical and theater nuclear weapons are considered to be a stronger deterrent and a more credible threat.[39]

Elbridge Colby, senior fellow at the Center for a New American Security, elaborated on the impact of China's burgeoning theater nuclear force on the nuclear escalation dynamic between China and the United States in testimony to the Commission:

> *[China's] ability to use nuclear weapons in more limited and tailored ways will make China's threats—explicit or implicit—to use nuclear forces more credible. . . . This does not mean that China will reach for the nuclear saber early or often. But a more sophisticated force will give China better options for how it might seek to use these weapons not only, as in the past, as a desperate last resort, but also to deter U.S. escalation of a conflict—escalation the United States might need to resort to if it is to prevail.*[40]

A key implication of China's approach for the United States, according to Dr. Yeaw, is that China "may escalate across the nuclear threshold at a time and manner, and for a purpose, that we do not expect."[41]

Figure 1: China's Medium and Intercontinental Range Ballistic Missiles



Note: DOD uses a mix of both Chinese and North Atlantic Treaty Organization (NATO) designators in the above graphic. See Table 2, "Ranges of China's Nuclear Ballistic Missiles (Selected)" for a list of Chinese and NATO designators of ballistic missiles.

Source: Figure adapted from U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, April 2015, 88.

China's Nuclear Strike Capabilities

China describes its nuclear force structure and composition as "lean and effective," though this guiding principle, like no-first-use, is subject to variables that enhance China's strategic ambiguity. China does not release official data on its nuclear forces, but unofficial sources estimate China has approximately 250 nuclear warheads.* [42] As a result of Beijing's pursuit of a more modern nuclear force, China's nuclear weapons are undergoing moderate quantitative increases.[43] These increases are such that the chief limitation on China's nuclear force development in the near future could be China's stockpile of fissile material (material capable of releasing nuclear energy) rather than its number of delivery vehicles.† [44]

As it seeks to maintain an "effective" nuclear force guided by a no-first-use doctrine, China is pursuing a credible second-strike capability with an emphasis on survivability against an adversary's first strike. By diversifying its nuclear strike capabilities away from liquid-fueled silo-based systems, China seeks to ensure its ability to absorb a nuclear strike and retaliate in kind.[45]

Finally, China appears to be enhancing its theater nuclear force. Such a development would facilitate the theater-range strikes envisioned in a regional de-escalatory nuclear doctrine, as described earlier.‡ [46]

Road-Mobile Ballistic Missiles

According to the U.S. Defense Intelligence Agency, China's nuclear arsenal consists of 50–60 intercontinental ballistic missiles (ICBMs).[47] China's silo-based, liquid-fueled DF–5 (12,000 kilometer/7,456 mile range) and longer-range DF–5A (13,000 kilometer/8,078 mile range) have formed the core of China's nuclear arsenal since the early 1980s.[48] With the deployment of the DF–31 in 2006 and DF–31A in 2007, the Second Artillery fielded a second generation of road-mobile, solid-fueled ICBMs.[49] The road mobility of these missiles would make it more difficult for an adversary to target them with a first strike. Solid-fueled missiles provide advantages over the liquid-fueled missiles of past generations because they do not require lengthy fueling time and their fewer and more stable fueling elements enjoy greater safety and stability over long periods of storage.[50] While the range of the DF–31 at 7,200 kilometers (4,474 miles) does not quite reach the continental United States, the DF–31A has an estimated range of 11,200 kilometers (6,959 miles), giving it the ability to target almost all of the continental United States from launch areas in China.[51] Beyond these

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*The Commission discussed other estimates on the size of China's nuclear arsenal—some as high as 1,800, some as low as 100—in the 2012 *Annual Report to Congress*. U.S.-China Economic and Security Review Commission, *2012 Annual Report to Congress*, November 2012, 176–177.

†This view is not universally held. For example, in 2012, Mark B. Schneider, senior analyst at the National Institute for Public Policy, testified to the Commission, "I do not think the availability of fissile material will be a significant constraint on China. . . . With the massive Chinese nuclear energy program now underway, China should be able to produce as many nuclear weapons as needed." U.S.-China Economic and Security Review Commission, *Hearing on Developments in China's Cyber and Nuclear Capabilities*, written testimony of Mark B. Schneider, March 26, 2012.

‡The United States maintained a theater nuclear strike capability in the 1980s with its ground-launched cruise missiles, but withdrew these missiles under the terms of the Intermediate Range Nuclear Forces Treaty. U.S.-China Economic and Security Review Commission, *Hearing on China's Offensive Missile Forces*, written testimony of Christopher Yeaw, April 1, 2015.

established systems, a new generation of ICBMs is undergoing development in China, with a possible incorporation of survivability- or penetrability-enhancing attributes such as: multiple reentry vehicles (whether independently-targetable or not), reentry maneuverability, greater accuracy, greater range, and overland mobility by rail (as opposed to by road).[52] These developments are discussed in "Increasing the Penetrability of Adversary Missile Defenses," later in this section.

China also deploys nuclear-armed intermediate-range ballistic missiles (IRBMs) and medium-range ballistic missiles (MRBMs) for regional nuclear deterrence. These include the limited-mobility, liquid-fueled DF–3A IRBM, which is likely in the process of being phased out by the Second Artillery, as well as the road-mobile, solid-fueled DF–21 and DF–21A MRBMs.* [53] Official commentary during China's September 2015 military parade indicated that the newer DF–26 IRBM, also road-mobile and solid-fueled, is nuclear-capable.[54]

Submarine-Launched Ballistic Missiles

China is expected to deploy its first nuclear deterrence submarine patrols of the JIN-class (Type 094) nuclear-powered ballistic missile submarine (SSBN) by the end of 2015, marking its first credible at-sea second-strike nuclear capability.† [55] The JIN SSBN carries the nuclear JL–2 SLBM, which has a range of at least 7,400 kilometers (4,598 miles), or far enough to strike the continental United States depending on the location of the launch.[56] DOD has estimated the PLA Navy currently has three to four operational JIN SSBNs, and up to five additional JIN SSBNs will enter service by 2020.[57] In contrast with the opacity of its other nuclear capabilities, China openly touts the development of the JIN/JL–2. PLA Navy Commander Admiral Wu Shengli wrote in a CCP magazine, "This is a trump card that makes our motherland proud and our adversaries terrified. It is a strategic force symbolizing our great-power status and supporting national security." [58]

Some analysts have suggested China cannot rely upon the JIN SSBN as a survivable second-strike capability, given its noisy acoustic signature that lends itself to detection.[59] China may seek to improve on these deficiencies in its successor to the JIN SSBN and JL–2 SLBM, the Type 096 SSBN and JL–2 follow-on SLBM (official sources have confirmed the development of the submarine, but not the missile).[60]

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* For a description of ballistic missile ranges, as defined by the U.S. Department of Defense, see Table 1.

† The Commission's *2014 Annual Report to Congress* predicted China would deploy its first nuclear deterrence submarine patrols in 2014, citing DOD and intelligence community assessments. DOD has since revised this timeline to "sometime in 2015," which informs the Commission's current assessment. An unconfirmed report from independent Hong Kong-based news outlet *Ming Pao* asserted in September 2015 that the first of these patrols had taken place. At the time of the writing of this report, there had been no official confirmation that the patrol had taken place. Ming Pao, "First Armed Patrols of New Nuclear Submarine," September 30, 2015. Staff translation; and U.S. Department of Defense, *Annual Report to Congress: Military Power of the People's Republic of China 2015*, April 2015, 9.

Air-Launched Land-Attack Cruise Missiles

Although not explicitly confirmed in official sources, China may be developing a nuclear-capable air-launched cruise missile, the CJ–20, for use with a modernized version of China's longtime primary bomber, the H–6. This variant, the H–6K, has the ability to carry six land-attack cruise missiles (LACMs) and is equipped with powerful turbofan engines, giving it extended range—potentially out to the second island chain, including Guam.* [61] The CJ–20 is an air-launched version of the currently fielded CJ–10 (also known as the DH–10), a theater-range LACM that appears both conventional- and nuclear-capable.[62] A nuclear-capable CJ–20 would indicate China is developing new, air-delivered theater nuclear strike capabilities, in addition to its formidable ballistic missile theater nuclear forces and the strategic nuclear strike capability it has maintained since it became a nuclear state.

Conventional Strike: Doctrine and Capabilities

Conventional Missile Doctrine and Employment Concepts

The Second Artillery has since the mid-1990s added conventional strike capabilities to an arsenal that previously had comprised only nuclear ballistic missiles. The PLA has achieved "extraordinarily rapid" growth in its conventional missile capability, according to DOD. One decade ago, the Second Artillery only possessed the ability to target Taiwan, as well as a basic ability to strike targets within the first island chain. Today, China is fielding and developing a wide range of conventional ballistic and cruise missiles to hold targets at risk throughout the region—even as far as the second island chain.[63] No longer solely a nuclear force intended to be employed in the most dire of circumstances, the Second Artillery has taken on a mission of "dual deterrence, dual operations," in which it is responsible for nuclear deterrence and nuclear counterstrikes, as well as conventional deterrence and conventional precision strikes.[64]

Conventional Deterrence

According to Second Artillery doctrine, nuclear weapons serve as the ultimate deterrent; however, conventional missiles, as less destructive weapons, have fewer restraints on their use from an international public opinion perspective and are therefore more flexible instruments of deterrence and strike. The Second Artillery's concept of deterrence includes elements of what Western political scientists understand as "compellence," or the threat or use of force to persuade an adversary to comply with demands.[65] "Campaign deterrence" is defined in the chief Second Artillery doctrinal publication as employing military activities in which units display

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*The first island chain refers to a line of islands running through the Kurile Islands, Japan and the Ryukyu Islands, Taiwan, the Philippines, Borneo, and Natuna Besar. The second island chain is farther east, running through the Kurile Islands, Japan, the Bonin Islands, the Mariana Islands, and the Caroline Islands. PLA strategists and academics have long asserted the United States relies primarily on the first island chain and the second island chain to strategically "encircle" or "contain" China and prevent the PLA Navy from operating freely in the Western Pacific. Open Source Center, "PRC Article Surveys China's Naval Rivals, Challenges," January 6, 2012. ID: CPP20120109671003; Bernard D. Cole, *The Great Wall at Sea* (Second Edition), Naval Institute Press, 2010, 174–176.

the ability to demonstrate overwhelming force to accomplish strategic objectives and "force an enemy to accept our will or contain an enemy's hostile actions."[66] Examples of these military activities include using conventional missiles as a show of force to intimidate the adversary or executing "surgical strikes" against important assets to coerce the adversary to yield to Chinese demands.[67] In other words, whereas the United States uses "deterrence" to mean deterring aggression, China's use of "deterrence" includes the concept of deterring resistance to demands.

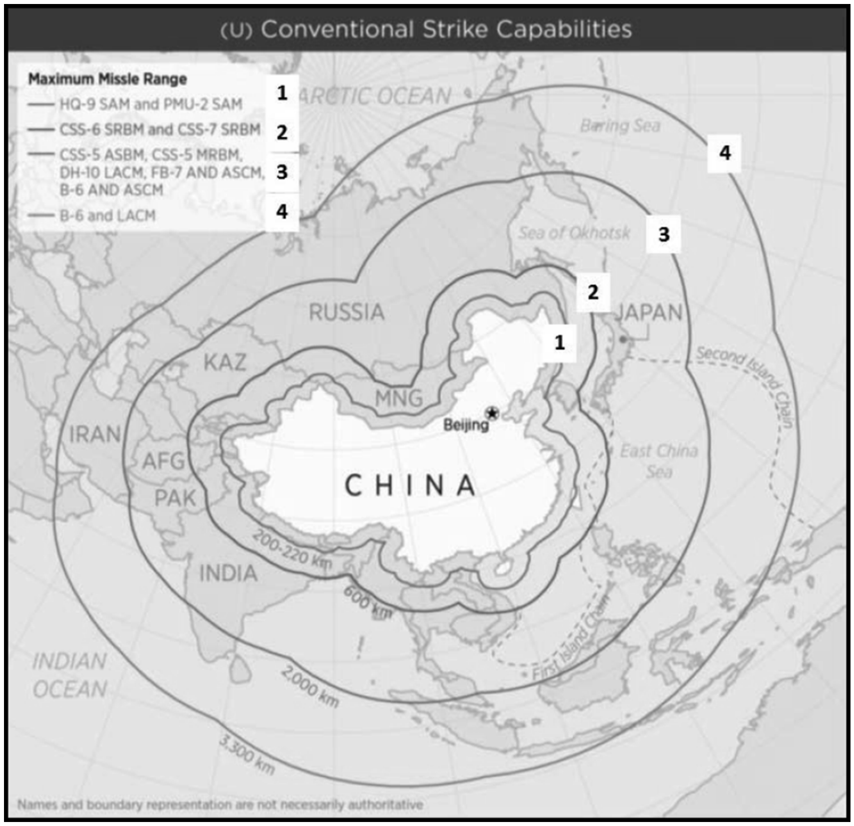
Conventional Strike

Mr. Medeiros, then senior political scientist at the RAND Corporation, writes of PLA conventional missile operations:

> *The PLA emphasizes using conventional missiles to strike first, strike hard, strike precisely, and strike rapidly. The aim of this approach is to "seize the initiative" and quickly gain "campaign control" in order to speed up the process of warfare leading to the adversary's quick capitulation.*[68]

If deterrence fails, the Second Artillery would likely weaken key enemy targets with network attack and electronic warfare before launching conventional missile strikes.[69] Potential targets for conventional missile strikes, which are outlined in authoritative publications, support this theme. These include C4ISR hubs, missile positions, military transportation and logistical hubs such as ports and airfields, key military facilities, critical infrastructure, and carrier strike groups. These targets are both critical and vulnerable, and would, if destroyed, severely impede the ability of adversary forces to function and communicate smoothly.[70] In a Taiwan scenario, for example, Chinese missile strikes on such targets could suppress Taiwan air defenses as a precursor to PLA Air Force operations over the Taiwan Strait.[71]

Figure 2: Select Conventional Strike Capabilities



Note: DOD uses a mix of both Chinese/Russian and NATO designators in the above graphic. CSS–6 and CSS–7 are the NATO designators for the DF–15 and DF–11, respectively. CSS–5 refers to the DF–21 ballistic missile. FB–7 is the NATO designator for the PLA's JH–7 fighter bomber, and B–6 is the designator for the PLA's H–6 bomber. See Table 3, "Ranges of China's Conventional Ballistic Missiles (Selected)," for a list of Chinese and NATO designators of ballistic missiles.

Source: U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, April 2015, 87.

Conventional Missile Capabilities

China's initial development of its conventional missile forces focused heavily on the development of its SRBM force for Taiwan contingencies. In the past decade, China's development of longer-range missiles, pursuit of advanced missile technologies, and diversification of launch platforms have enabled it to hold at risk a wider range of targets farther from its shores. The improved stealth and warhead accuracy of China's expanded range of systems and launch platforms would serve to strengthen the element of surprise if these were used in a potential conflict.

Ballistic Missiles

The PLA's significant investment in modernizing and diversifying its conventional ballistic missile forces beyond short-range

Taiwan missions has continued to bear fruit. The defining features of most ballistic missiles are an initial propulsion phase followed by a ballistic trajectory through the atmosphere, reaching an apogee in space before traveling back into the atmosphere toward a target on Earth's surface.* DOD categorizes ballistic missiles by range as follows:

Table 1: Ballistic Missile Ranges Defined by U.S. Department of Defense

Ballistic Missile Type	Missile Range
Short-Range Ballistic Missile (SRBM)	<1,000 kilometers (621 miles)
Medium-Range Ballistic Missile (MRBM)	1,000–3,000 kilometers (621–1,864 miles)
Intermediate-Range Ballistic Missile (IRBM)	3,000–5,500 kilometers (1,864–3,418 miles)
Intercontinental Ballistic Missile (ICBM)	>5,500 kilometers (3,418 miles)

Source: U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, April 2015, 46; U.S. National Air and Missile Intelligence Center, *Ballistic and Cruise Missile Threat*, 2013, 9.

The following discussion explains China's SRBM, MRBM, and IRBM capabilities in further detail. It also describes China's well-known antiship ballistic missile (ASBM) capability (given their ranges, China's ASBMs are best categorized as MRBMs or IRBMs under the DOD's definitions). China's ICBM force, along with certain MRBM and IRBM systems, are nuclear-armed; for more information on these weapons, see the discussion earlier in this section on China's nuclear strike capabilities.

Short Range Ballistic Missiles. China's SRBM force consists mostly of multiple variants of the DF–11 and DF–15 missiles. One source details the remarkable growth of this force from 30 to 50 missiles in the mid-1990s to approximately 900 missiles in 2006. To achieve this, the inventory grew at a rate of 50 to 100 missiles per year.[72] In 2015, China maintains "at least 1,200" SRBMs, according to DOD.† [73]

The numerical growth rate of China's SRBM force has slowed in recent years as China focuses on qualitative improvements, replacing earlier generation missiles with newer variants that have improved ranges, accuracies, and payloads.[74] The primary value of these missiles for the PLA would be their utility in a Taiwan contingency; indeed, a majority of China's SRBMs are deployed along the Taiwan Strait.[75] However, the PLA could use the extended-range variants of the DF–15 beyond the Taiwan Strait. If deployed along China's eastern coastline, for example, these missiles could target U.S. and Japanese military facilities on Okinawa.[76] Similarly, DOD assesses that the DF–16, China's most recently fielded

* Short-range ballistic missiles generally stay within the Earth's atmosphere throughout the course of their flight.

† For further discussion on varying estimates of China's current SRBM deployments, see Chapter 3, Section 3, "Taiwan."

SRBM, threatens not only Taiwan, but also other regional targets.* [77]

Medium and Intermediate Range Ballistic Missiles. In ten years, China has gone from possessing only a limited ability to reach targets east of Taiwan to developing the ability to conduct precision strikes against land and naval targets within the first island chain. This is enabled by China's growing MRBM inventory and its progress toward developing an IRBM capability.[78]

China fielded its first conventional MRBM, the DF–21C, in 2008. Its maximum range of at least 1,750 kilometers (1,087 miles) allows China to strike a wide range of targets throughout the Western Pacific theater. According to Toshi Yoshihara, chair of Asia-Pacific Studies at the U.S. Naval War College, China's currently modest inventory of DF–21Cs would limit the flexibility of its MRBM employment in a conflict: "If the MRBM inventory remains relatively unchanged, then it can be inferred that the PLA intends to concentrate the missiles against a few bases at the outset of a campaign. If, however, the Second Artillery fields a sizable DF–21C missile force in the coming years, then the PLA may be preparing for a larger-scale undertaking involving more bases across Japan." † [79]

In addition, China's DF–16, known to be an SRBM, appears to have a medium-range variant as well. In testimony to the U.S. Senate Armed Services Committee in 2015, Lieutenant General Vincent Stewart, director of the U.S. Defense Intelligence Agency, stated, "medium-range ballistic missiles, including the DF–16 . . . will improve China's ability to strike regional targets." [80]

The PLA is also developing a new conventional, road-mobile IRBM with a range of up to 4,000 kilometers (2,485 miles) from the Chinese coast. This range covers targets in the second island chain, such as U.S. bases on Guam, and could even include Northern Australia and Alaska.[81] Although not confirmed by official U.S. government sources, some analysts attribute this program to a Chinese designator, DF–26, which is also capable of carrying nuclear warheads.[82] Official commentary during China's September 2015 military parade indicated that the DF–26, clearly road-mobile, has both nuclear and conventional capabilities, fitting these descriptions.[83]

China's advancements in theater-range conventional strike capabilities indicate the PLA's interest in an ability to secure military objectives beyond Taiwan. One of China's earliest efforts at developing a conventional strike capability was its fielding of the DF–25 MRBM in the 1980s. This missile had a reported mission of defending China's Spratly Island outposts in the South China Sea.[84] Unofficial sources have suggested this missile continues to be in

* China also continues to manufacture new SRBMs with even shorter ranges than those of the DF–11 and DF–15, including the (NATO-designated) CSS–9, CSS–14, CSS–X–16, and CSS–X–15. As discussed in the Commission's *2014 Annual Report to Congress*, these missiles are likely built to appeal to export markets, rather than for use by the PLA. U.S.-China Economic and Security Review Commission, *2014 Annual Report to Congress*, November 2014, 315–316; Richard Fisher (Senior Fellow, International Assessment and Strategy Center), interview with Commission staff, June 20, 2014; and U.S. National Air and Space Intelligence Center, *Ballistic and Cruise Missile Threat*, 2013, 13.

† Current numbers of missiles and launchers are not publicly available in official sources. However, naval analyst Jon Solomon in 2014 estimated China had a maximum of 40 DF–21C missiles. Jon Solomon, "The Chinese DF–21 Arsenal: Part 2," *Information Dissemination Blog*, November 11, 2014.

service and can also be armed with a nuclear warhead.[85] As China continues to seek to consolidate and secure its maritime claims in the East and South China seas, theater-range strike capabilities such as this missile would suggest an important Second Artillery role in a near seas maritime contingency beyond the Taiwan Strait.[86]

Antiship Ballistic Missiles. China fielded the world's first ASBM in 2010, a variant of the DF–21 family of MRBMs known as the DF–21D. Its range of at least 1,500 kilometers (932 miles) and maneuverable warhead give it the ability to strike moving adversary ships east of Taiwan from secure sites on the Chinese mainland. According to Mr. Erickson, China's DF–21D capability means that "in a crisis or combat situation, U.S. operators would have to draw a range ring for the DF–21D and then decide whether or not to risk sending [carrier strike groups] into that range ring."[87] Furthermore, because of the complex over-the-horizon targeting and maritime C4ISR required to successfully execute an ASBM strike, Professor Erickson argues the DF–21D is one element of a broader program to track and target ships at sea (see "China's C4ISR and Targeting Challenge," later in this section).[88]

In written testimony to the Commission, Dennis Gormley, senior lecturer at the University of Pittsburgh, raised additional technical questions regarding China's deployment of the DF–21D such as "whether or not China has truly mastered the terminal guidance and maneuvering capability needed to successfully attack a moving aircraft carrier. Particularly demanding is the development of sensors and warheads that can survive the rigors of atmosphere reentry, including high speeds and temperatures, without adversely affecting required seeker and warhead performance."[89] The ability of the Second Artillery to strike its intended target is significant because PLA doctrine appears to consider the possibility of using the DF–21D for precision strikes as well as warning shots.[90] In a tense wartime situation an error in DF–21D targeting, therefore, could mean the difference between deescalation and escalation.

Official commentary at China's September 2015 military parade stated that the DF–26 also has an antiship variant, indicating it has joined the DF–21D as an ASBM. The DF–26 represents an even longer-range option, with a credited range of 3,000–4,000 kilometers (1,800–2,500 miles).[91] According to Mr. Erickson, parading both missiles indicates that they have been "tested carefully and accepted into military service as operational hardware," but "the reconnaissance strike complex [for an antiship capability] that supports them, by contrast, remains a work in progress."[92] The additional range likely complicates the targeting challenge China already faces with the DF–21D.

Cruise Missiles

Unlike ballistic missiles, which require propulsion at launch before entering a ballistic trajectory, cruise missiles are propelled by jet engines and fly at generally level flight paths to their targets. They can be described, as in one recent report, as "pilotless airplanes" whose flights toward preplanned targets can be adjusted en route with data from a variety of guidance and navigation systems.[93] Because of their limited radar signature and low-altitude flight, cruise missiles are very stealthy weapons. Many cruise missiles are also designed to execute terminal evasive maneuvers to defeat missile defenses. For these reasons, cruise missiles can be very difficult to detect and defend against, particularly when part of a multi-axis attack of multiple cruise and ballistic missiles.[94]

Cruise missiles also provide the employing force with operational and planning flexibility. One aspect of their flexibility is that cruise missiles can be placed aboard a variety of ground-, sea-, and air-based platforms. Moreover, according to the testimony of Lee Fuell, then technical director for force modernization and employment at the U.S. Air Force's National Air and Space Intelligence Center, "These weapons are likely [intended] to reduce the burden on ballistic missile forces, as well as [to create] somewhat safer strike opportunities for Chinese aircrews, allowing them to engage from much longer distances and/or from advantageous locations of their own choosing."[95] These characteristics have led U.S. defense leadership to consider more closely the threat cruise missiles pose to the homeland. In May 2015, Vice Chairman of the Joint Chiefs of Staff Admiral James Winnefeld stated, "The element of surprise is nearly impossible with an ICBM attack, and we will always have time to react. We can't necessarily say the same thing for a cruise missile attack. ... [H]omeland cruise missile defense is shifting above regional ballistic missile defense in my mind, as far as importance goes."[96]

While ballistic missiles are mostly categorized by range, cruise missiles are categorized by intended mission and launch mode. The two key types of cruise missiles are land-attack cruise missiles (LACMs) and antiship cruise missiles (ASCMs).

Land-Attack Cruise Missiles. The Second Artillery fielded the CJ–10, China's first ground-launched LACM, in 2007–2008.[97] Because of their stealth, accuracy, and route variation ability, LACMs pose challenges to adversary air and missile defense systems in ways that ballistic missiles do not. In addition to their ability to undertake radar-evading flight at low altitudes, the newest LACMs include additional radar-evading features that make them even more difficult to detect. Moreover, salvos of multiple LACMs can be preprogrammed to approach a target from multiple directions or take circuitous routes toward the target—both methods of employment that have the effect of either overwhelming, evading, or confusing radar and air defenses.[98] With a reported range of at least 1,500 kilometers (932 miles), the CJ–10 has the ability to hold U.S. forces in Japan and South Korea at risk.[99]

In conjunction with developments in China's bomber fleet, China's development of the CJ–20, the air-launched version of the CJ–10, enhances the lethality of China's air-launched cruise missile arsenal. The H–6K variant of China's bomber force, as mentioned earlier in the discussion on China's nuclear capabilities, has the ability to carry six LACMs and a range potentially extending out to the second island chain, including Guam.[100] As described above, while not confirmed in official sources, there are some indications that the CJ–20 is nuclear-capable.*

China probably is developing a LACM for deployment aboard future PLA Navy ships and submarines, which would give the PLA Navy its first land-attack capability.[101] A sea-based LACM would diversify and potentially extend the range of China's strike options against U.S. facilities in the Indo-Pacific, particularly as the PLA Navy gains proficiency in long-range surface and subsurface patrols.[102]

Antiship Cruise Missiles. As an integral part of the rapid development and extended reach of China's PLA Navy in the past decade, China's ASCM capabilities have advanced significantly. Because there are doubts regarding whether U.S. Navy shipboard systems could reliably and adequately defend against intense salvos of China's advanced Russian-made and indigenous ASCMs, China's advancing ASCM technologies are reason for concern.[103] In a June speech, U.S. Deputy Secretary of Defense Robert Work raised the challenge of defending U.S. ships and bases against adversary missiles in a cost-effective manner:

> *We dominated the guided munitions warfare regime for the past 25 years. There's no question about it: we have. But now big state powers like China and Russia are rapidly catching up. So this is going to require a fundamental rethinking of the way the joint force operates. . . . [A] demonstrated capability to win the emerging guided munitions salvo competition . . . is job number one. This demonstrated ability to win this competition will underwrite our conventional deterrence in the 21st century. . . .*
>
> *We're on the wrong end of the cost equation in this competition right now. We have been for some time. [We have been] using multi-[million]-dollar missiles . . . to defend surface ships and fixed bases against relatively cheap ballistic and cruise missiles.*[104]

The variety of launch platforms for China's ASCMs, in addition to the range and targeting improvements China continues to make to its ASCM inventory, demonstrate China's prioritization of its antisurface warfare mission in its naval modernization efforts. Each of the PLA Navy's major surface combatants, for example, is equipped with ASCMs. As the PLA Navy has grown increasingly confident operating its surface combatants farther afield from the Mainland, it has also sought to ensure ASCM coverage closer to its shores through a rapidly growing fleet of ASCM-equipped corvettes and patrol vessels.[105] These vessels and most other PLA Navy surface combatants carry the subsonic YJ–83 family of ASCMs, a system that has been in service with the PLA Navy since the 1990s. Although missiles in the export versions of the YJ–83 have adver-

* Other air-launched LACMs include the YJ–63, reportedly deployed in 2004–2005, with a reported range of 200 kilometers (124 miles); and the KD–88. Although the advertised range of the KD–88 is at least 100 kilometers (62 miles), China may be developing a longer-range version of this LACM. U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, April 2015, 46; Dennis M. Gormley, Andrew S. Erickson, and Jingdong Yuan, *A Low-Visibility Force Multiplier: Assessing China's Cruise Missile Ambitions*, National Defense University Press, 2014, 35.

tised ranges of 65–100 nautical miles (74 miles–115 miles), the domestic versions of this system likely have much longer ranges.[106] A more recent addition to China's inventory of ship-launched ASCMs is the 150 nautical mile (173 mile) range YJ–62, a missile China began publicizing in the mid-2000s.[107] China also uses ASCMs for coastal defense, and has utilized a shore-based version of the YJ–62 for this mission.[108]

In addition to their potential use in surface-to-surface engagements, some ASCMs can be submarine-launched. According to the U.S. Navy's Office of Naval Intelligence, the PLA Navy has been increasingly equipping its submarines with modern ASCMs in the past decade: "Given the rapid pace of acquisition, well over half of China's nuclear and conventional attack submarines are now ASCM-equipped, and by 2020, the vast majority of China's submarine force will be armed with advanced, long-range ASCMs."[109] The YJ–18 is a domestically developed and produced ASCM with confirmed submarine- and surface-launched variants. According to DOD, the YJ–18 would extend the ASCM range of China's SONG, YUAN, and SHANG submarines to a maximum of 290 nautical miles (334 miles), which would significantly increase China's antiaccess/area denial* capabilities. Previous Chinese submarine-launched ASCM ranges were 120 nautical miles (138 miles) for the Russian SS–N–27 launched from some of China's KILO submarines, and 20 nautical miles (23 miles) for the YJ–82 launched from SONG, YUAN, and SHANG submarines.[110] The YJ–18's longer range will significantly expand the area U.S. forces must monitor for Chinese submarine activity. The YJ–18 is almost certainly capable of supersonic speeds during the terminal phase of its flight, a feature that reduces the time shipborne defenses have to react to an incoming threat (relative to subsonic missiles).[111] Furthermore, missiles capable of achieving supersonic speeds are more challenging to defeat with hard kill countermeasures. China has fitted a surface-launched variant of the YJ–18 on its LUYANG III DDGs, and likely will deploy the YJ–18 on its Type 095 nuclear attack submarine and Type 055 DDG, which are still under development.[112] In addition, China probably will deploy a ground-launched variant of the YJ–18 to replace the YJ–62 ASCM in shore-based missile units.

Finally, ASCMs are the centerpiece of China's maritime strike missions. PLA Navy Aviation fighter-bombers and bombers carry a 107 nautical mile (124 mile) range version of the YJ–83 family ASCM. PLA Navy helicopters have been observed carrying ASCMs as well, though it is unclear how widespread this practice is.[113] Air-launched ASCMs appear to be an area of development for the PLA Navy, as demonstrated by China's continued upgrades to its H–6 bomber. One improvement is an increase in the number of ASCMs it can carry from two to four; another is the modification

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*According to the U.S. Department of Defense, "antiaccess" actions are intended to slow the deployment of an adversary's forces into a theater or cause them to operate at distances farther from the conflict than they would prefer. "Area denial" actions affect maneuvers within a theater, and are intended to impede an adversary's operations within areas where friendly forces cannot or will not prevent access. China, however, uses the term "counterintervention," reflecting its perception that such operations are reactive. U.S. Department of Defense, *Military and Security Developments Involving the People's Republic of China 2013*, 2013, i, 32, 33; U.S. Department of Defense, *Air-Sea Battle: Service Collaboration to Address Anti-Access & Area Denial Challenges*, May 2013, 2.

of some H–6 bombers to serve as tankers, increasing the range of these aircraft. Most notably, China has developed the YJ–12 long-range, supersonic ASCM capable of being launched from the H–6.[114] The YJ–12's long range (unofficial sources have estimated its range to be 215 nautical miles (248 miles)) and ability to conduct evasive approach and maneuvers toward its target pose immense challenges for shipboard defenses, limiting the time a ship has to engage the incoming missile.[115] As Robert Haddick, an expert on Asia Pacific security, stated in testimony to the Commission in 2015:

> *The YJ–12 is the most dangerous antiship missile China has produced thus far, posing an even greater risk to the U.S. Navy's surface forces in the Western Pacific than the much-discussed DF–21D antiship ballistic missile. The arrival of the YJ–12 is just one more indication of how the U.S. Navy is falling further behind in the missile competition against China, exposing flaws in operating concepts that U.S. and allied commanders have relied on for years.*[116]

Taken together, the variety of platforms the PLA Navy has equipped with ASCMs provides China with a multilayered area denial capability in its near seas and beyond. Professor Gormley, along with co-authors Mr. Erickson and Jingdong Yuan, states in a study on Chinese cruise missiles: "ASCMs are increasingly poised to challenge U.S. surface vessels, especially in situations where the quantity of missiles fired can overwhelm Aegis air defense systems through saturation and multi-axis tactics. More advanced future Chinese aircraft carriers might be used to bring ASCM- and LACM-capable aircraft within range of U.S. targets."[117] The U.S. Navy is currently exploring advanced ship defense technologies, such as electromagnetic railguns and directed energy weapons, that could mitigate U.S. surface vulnerability to long-range, supersonic missile strikes.[118]

China's Missile Research and Development

The research and development (R&D) structure behind China's missile programs, which has grown in both scale and capacity to deliver innovative outputs in recent years, merits a brief description on its own. Key players in this structure include:

- Top-level leadership in the Central Military Commission* and State Council,† which develop strategic requirements for aerospace technologies and determine whether each project will enter the crucial engineering R&D phase.[119] On an ad hoc basis, the Central Special Committee—reporting to the

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* China's Central Military Commission is the country's top military decision-making body. Congressional-Executive Commission on China, *China's State Organizational Structure*.

† China's State Council, headed by Premier Li Keqiang, presides over China's ministries, commissions, and direct offices. It is responsible for executing laws, supervising the government bureaucracy, and carrying out the administrative functions of the Chinese government. Congressional-Executive Commission on China, *China's State Organizational Structure*.

China's Missile Research and Development—*Continued*

Politburo Standing Committee, Central Military Commission, and State Council and historically led by China's top political leaders—evaluates and provides recommendations on certain strategic dual-use high-technology programs, potentially including military programs such as ballistic missiles as well.* [120]

- The PLA General Staff Department and PLA Second Artillery, which develop operational and technical requirements for China's missile programs. After approval by the Central Military Commission and State Council, the Second Artillery likely develops short- to long-term (e.g., 5- to 15 or more-year) acquisition programs for missile systems.[121]
- The PLA General Armaments Department, which oversees the procurement process and approves contracts for these programs' four R&D stages: preliminary research, concept development and program validation, engineering R&D, and design finalization.[122]
- Research institutes within the General Armaments Department, the Second Artillery, the defense industry, or civilian universities, which can all compete for preliminary research contracts.[123] The Second Artillery handles concept development, and one of the academies within China's two defense industry conglomerates—the China Aerospace Science and Industry Corporation and China Aerospace Science and Technology Corporation—conducts engineering R&D, with a Second Artillery unit embedded inside. Both the academy and the embedded unit are involved in testing, which is required before a program can proceed to design finalization.† [124]

A joint Central Military Commission and State Council standing office ultimately approves the finalized design.[125] Overall, the heavy involvement of senior Chinese leaders throughout the process indicates the pervasiveness of central leadership guidance and approval authority while the proliferation of actors involved demonstrates China's commitment to pushing for increased civil-military integration.

China's missile R&D efforts have likely benefited from consistent funding increases concurrent with its growth in overall military spending. China likely allocates at least 10 percent and potentially up to 15 percent of its overall defense budget to R&D, comparable to that of the United States, which has allocated

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*For more information regarding the Central Special Committee, see Chapter 2, Section 2, "China's Space and Counterspace Programs."

†As with all defense conglomerates, the State Administration of Science, Technology, and Industry for National Defense, part of the State Council's Ministry of Industry and Information Technology, exercises administrative oversight over these companies. Mark Stokes, "China's Evolving Space and Missile Industry: Seeking Innovation in Long-Range Precision Strike," in Tai Ming Cheung, *Forging China's Military Might: A New Framework for Assessing Innovation*, Johns Hopkins University Press, 2014, 246.

China's Missile Research and Development—*Continued*

roughly 10–11 percent in recent years.* [126] Further, in step with other Chinese defense conglomerates, the two corporations each now encompass numerous publicly-listed firms, enabling them to raise funds from multiple sources, including state funding, capital markets, and corporate activities.[127] Yet persistent structural challenges may limit the impact of these large cash inflows: China's defense companies produce far lower revenues per worker than U.S. counterparts, and the civilian sector's track record shows marketization to be of limited benefit to the improvement of firms' efficiency.[128]

In contrast to China's first ballistic and cruise missile systems, which relied on foreign technologies and expertise, today's PLA missile development is focused on conservative, incremental upgrades to existing missile variants.[129] This indicates that China's missiles are at a low-to-medium level of innovation—one that emphasizes incremental improvements to indigenous systems originally based on foreign technology.[130] However, as Mr. Stokes states, China's defense aerospace industry may now be poised to deliver surprising breakthroughs in "disruptive technology" in some cases.[131] The DF–21D ASBM, if demonstrated to perform as promised, would be the initial example of this newfound innovative capacity.[132]

Increasing the Penetrability of Adversary Missile Defenses

China has steadily developed its offensive missile forces over the past two decades to pursue the capabilities necessary to fully execute its conventional and nuclear missions, but recognizes that adversary missile defenses pose a major challenge to the success of these operations. As a result, China is considering quantitative and qualitative measures to improve penetrability of adversary missile defenses.

Chinese Views on U.S. Missile Defense and Prompt Global Strike

Official U.S. statements emphasize that its ballistic missile defense capabilities are intended to defend the U.S. homeland from states such as North Korea and Iran and do not threaten the efficacy of China's strategic nuclear deterrent.[133] Nevertheless, China views these systems as a shield that could render its relatively limited nuclear arsenal impotent.[134] As Christopher Twomey, asso-

* Using new methodology created by the University of California Institute on Global Conflict and Cooperation to measure Chinese defense R&D spending, these totals are revised upward from the Commission's *2014 Annual Report to Congress*. As a ratio of China's official defense budget, the institute assesses that China's defense R&D allocation in 2013, the latest year for which numbers are available, was 18.4 percent. However, as many items not in China's official defense budget contributed to this R&D spending measurement, a more accurate share relative to China's actual defense spending is likely 10–15 percent. Tai Ming Cheung (Director, University of California Institute on Global Conflict and Cooperation), interview with Commission staff, June 12, 2015; Tai Ming Cheung, "How Much Does China Spend on Defense-Related Research and Development" (2015 Workshop on Chinese Defense Science, Technology, and Innovation in a Period of Major Change, Washington, DC, February 9, 2015).

ciate professor at the U.S. Naval Postgraduate School, testified to the Commission, "There is a sense in Beijing that U.S. missile defense undermines a relatively stabilizing phenomenon of mutual vulnerability between the U.S. and China. . . . Other Chinese [analysts] attack missile defense as a way to escape mutual vulnerability on the grounds that it is an attempt to achieve 'absolute security' for the United States. By implication, this means absolute insecurity for others, China included." [135]

The 2013 *Science of Military Strategy* indicates China views the U.S. conventional prompt global strike program, envisioned to provide the United States the ability to conduct a precision strike anywhere on Earth within one hour, as a threat to China's nuclear retaliatory capability as well.[136]

In addition to its views on the strategically destabilizing effects of U.S. homeland missile defense, China has objected to the enhancement of U.S. theater missile defense in Asia.[137] It has particularly criticized the U.S. sale of the Patriot anti-missile system to Taiwan in the 1990s, as well as subsequent upgrades to the system.[138] More recently, China has objected to the potential U.S. deployment of the Terminal High-Altitude Area Defense system to South Korea, despite U.S. assurances that it would be a purely defensive system aimed at North Korea.[139] In a March 2015 press conference, a Chinese Ministry of National Defense spokesperson stated: "We think [the deployment of a] missile defense system by some countries in the Asia Pacific region is neither conducive to strategic stability and mutual trust, nor to regional peace and stability. And we hope relevant countries can be prudent in taking actions." [140] The nature of China's objections to theater missile defense suggest that its broader opposition to missile defense systems in general may be pretextual; theater missile defenses do not protect the homeland of another country from retaliatory attack and therefore do not reduce the value of China's nuclear arsenal, the stated reason for China's general opposition to missile defense. Theater missile defense does, however, reduce the value of China's missile inventory in support of its regional ambitions, a more likely reason for its objections.

Advancements in Warhead Delivery Systems and Penetrability

China's views on U.S. missile defense strongly influence its development of technologies intended to counter, overwhelm, or defeat missile defenses. China continues to research and develop both passive and active countermeasures in an effort to ensure penetrability against adversary missile defenses. Passive countermeasures include deploying chaff and decoys to confuse missile defenses and jamming missile defense radars and sensors to render them inoperable. Active countermeasures include more advanced technologies such as kinetic "hit-to-kill" intercept and directed energy intercept technologies, as well as early warning radar.[141] These active countermeasure technologies, still under development by China, have much in common with those being developed under China's counterspace program. For more information, see Chapter 2, Section 2, "China's Space and Counterspace Programs."

Sheer numbers of missiles fired in salvos, in combination with the deployment of other airborne threats, can overwhelm adversary missile defenses and act as an aid to warhead penetration as well.[142] As Jeffrey Haworth, director of intelligence and security in the missile defense component of U.S. Strategic Command, stated at a 2015 conference on U.S. Army air and missile defense, "Regardless of whether we are talking about unmanned aerial systems, whether we're talking about aircraft, whether we're talking about missile systems ... there is more of everything. ... There is more of everything at every range; there is more of everything at every capability; there is more of everything at every category of threat."[143] In short, as Professor Yoshihara testified, "quantity matters." Moreover, "targets that survived previous raids must be struck again. In wartime, missiles could fall prey to malfunction, outright misses, interception by enemy ballistic missile defense systems, and other low-tech methods by defenders to defeat the incoming missiles. Possessing adequate inventory to account for attrition is thus particularly crucial for ballistic missiles that can only be used once."[144]

Multiple Independently-Targetable Reentry Vehicles

In 2015, DOD confirmed that China's DF–5 ICBMs have a multiple independently-targetable reentry vehicle (MIRV) capability.[145] Rather than containing a single warhead per missile, a MIRV-equipped missile allows for a payload of several miniaturized warheads, each of which can be targeted independently. The DF–5's characteristics—liquid-fueled and silo-based, with a long lead-time required for fueling—make it less survivable and more susceptible to adversary attack than its road-mobile counterpart, the DF–31 ICBM. Nevertheless, these elements, combined with the DF–5's relatively large size, also provide the missile with greater "throw weight," or weight it is capable of launching to its target (currently between 3,000 and 3,200 kilograms (6,614 and 7,055 pounds)). China appears to have taken advantage of these characteristics of the DF–5—a missile that can definitively reach the continental United States—to deploy MIRVs in its strategic missile force, increasing its ability to penetrate adversary missile defenses and enhancing the credibility of its nuclear forces as a deterrent.[146]

Other systems in development may also be MIRV-equipped. The DF–41, an ICBM currently in development with a reported range of 12,000 kilometers (7,456 miles), could also be capable of carrying MIRVs.[147] Additionally, in February, Admiral Cecil D. Haney, commander of U.S. Strategic Command, testified to the House Subcommittee on Strategic Forces that China is "[modernizing] its strategic forces by ... developing a follow-on mobile system capable of carrying multiple warheads."[148] One U.S. media report interpreted this statement to refer to the DF–31B system reportedly in development.[149] U.S. and Chinese government sources have not confirmed the program, but unofficial sources have suggested the DF–31B could include multiple reentry vehicles.[150] Finally, some analysts have speculated that the JL–2 follow-on SLBM in development may be MIRV-capable as well.[151]

Maneuverable Reentry Vehicles

China's progress in developing maneuverable warheads suggests it is also pursuing maneuverable reentry vehicle (MaRV) technology. Because MaRV-equipped warheads are capable of performing preplanned flight maneuvers during reentry, they are more difficult to intercept and better able to penetrate adversary missile defenses.[152] One example of China's progress in this area is its development of the DF–21D ASBM, which features a maneuverable warhead.[153] The ability of DF–21D sensors and warheads to survive atmospheric reentry remains uncertain, calling into question its MaRV capability in the absence of successful tests against a moving target at sea.[154] Nevertheless, the missile's deployment suggests the PLA finds some utility in this technology for its missile forces. Some Western analysts and media reports identify reentry maneuverability as a possible attribute of the ongoing DF–41 and DF–26 and reported DF–31B missile programs as well.[155]

Hypersonic Weapons

Three countries—the United States, China, and Russia—currently have programs underway to develop hypersonic weapons, which can sustain flight in the Mach 5 to Mach 10 speed range (roughly 3,840 to 7,680 miles per hour) and theoretically strike any target on earth in under one hour.* The very high speeds of these weapons, combined with their maneuverability and ability to travel at lower, radar-evading altitudes, would make them far less vulnerable than existing missiles to current missile defenses.[156]

Due to limited public information, high-confidence assessments of China's hypersonic weapons program are not possible; however, it appears China's hypersonic weapons program is in its developmental stages and is progressing rapidly.[157] China's research into hypersonic weapons has likely focused on two types of propulsion: (1) a boost-glide weapon, which like a ballistic missile is launched from a large rocket on a relatively flat trajectory that either never leaves the atmosphere or reenters it quickly, before being released and gliding unpowered to its target; or (2) a "supersonic combustion ramjet" or scramjet engine, efficient at hypersonic speeds, which could also be activated after release from a rocket or even launched by aircraft.[158] According to one unconfirmed media source, China reportedly conducted a fifth glide vehicle test in August 2015, potentially its second in 2015 following three tests in 2014.[159] Mr. Stokes estimates China may be able to field a hypersonic glide vehicle by 2020 and a scramjet-propelled cruise vehicle with global range before 2025.[160]

Scramjets would theoretically be slower than boost-glide vehicles, operate at shorter ranges, and present a significant engineering challenge, but would also be cheaper, more maneuverable, and, because of their non-ballistic flight profiles, potentially less prone to

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*While some ballistic missiles travel in this speed range already, they do not sustain this speed for the duration that these new weapons would. In general, a "hypersonic weapon" is viewed as one able to fly at hypersonic speeds for "significant distances" and a period of time measured in minutes, meaning it reaches its target—anywhere on Earth—in under one hour. Harry Kazianis, "The Real Military Game-Changer: Hypersonic Weapons 101," *Lowy Institute for International Policy Interpreter Blog*, March 14, 2014; Robert Farley, "A Mach 5 Arms Race? Welcome to Hypersonic Weapons 101," *National Interest*, December 31, 2014.

miscalculations arising from a conventional missile launch that could be interpreted as a nuclear strike.[161]

Boost-glide vehicles are part of the same family of technologies as the terminally guided reentry vehicles on China's existing ballistic missiles. Therefore, given the relatively short ranges of China's known glider tests—such as a test in 2014 with an apparent range of 1,750 kilometers (1,087 miles), roughly the same range as the DF–21D ASBM—Dr. Acton assessed that "it is possible, though by no means certain, that the glider is essentially a 'souped-up' version of an existing type of terminally guided re-entry vehicle" at present.[162] China likely faces significant engineering challenges in developing gliders with longer ranges of a few thousand kilometers or more; another challenge will be to ensure the reception of navigation data given the high speeds of the gliders.[163] While a 500–2,000 kilometer (311–1,243 mile) total range for the glider in 2020 would be "ambitious but not unreasonable," the existing glider model likely could not simply be placed on an ICBM to achieve intercontinental range.[164]

Whether China arms its hypersonic weapons with a nuclear or conventional payload will hint at how China intends to incorporate hypersonic weapons into PLA planning and operations.

- A nuclear payload could indicate the program is based on China's efforts to assure retaliatory strike capabilities against adversary missile defenses. The National Air and Space Intelligence Center assesses the glide vehicle is associated with China's nuclear program, and 2015 saw no developments that would alter this assessment.[165]

- A conventional payload, in conjunction with an intercontinental range, could indicate a growing role for very long-range conventional weapons in PLA doctrine, according to Dr. Acton.[166] Hypersonic weapons are more effective at penetrating area missile defenses, such as those protecting the U.S. homeland, than are regional point defenses,* suggesting that shorter-range hypersonic weapons would likely not alter the regional balance of power in the Western Pacific.[167]

- Alternatively, China may intend its hypersonic program for both nuclear and conventional purposes, or may simply be following the United States in pushing the technological frontier and is not yet certain which it will pursue.[168]

* James Acton explained the distinction between area and regional defenses in testimony to the Commission as follows: "In broad terms, defenses can be divided into area defenses, which are capable of protecting large swathes of territory, and point defenses, which are capable of protecting particular targets or small clusters of targets. The Ground-Based Mid-Course Defense system deployed in Alaska and California to protect the United States against a North Korean ICBM by intercepting warheads as they pass through outer space is an example of an area defense. Patriot missiles, which are designed to intercept short-range missiles in their terminal phase, are examples of point defenses." U.S.-China Economic and Security Review Commission, *Hearing on China's Offensive Missile Forces*, written testimony of James Acton, April 1, 2015.

China's Developing Missile Defense Capabilities

China ramped up its ballistic missile defense development efforts following the United States' withdrawal from the Anti-Ballistic Missile Treaty in 2002, culminating in several ballistic missile defense technology tests.* [169] China's efforts in this area are not entirely new. China began a ballistic missile defense research program soon after developing nuclear weapons in 1964,[170] and maintained this research even after the United States and Soviet Union signed the treaty in 1972, despite China's consistent rhetoric condemning ballistic missile defense systems during this time.[171] Even after Deng Xiaoping reportedly canceled the program in 1983 due to technical feasibility concerns, Chinese writings indicate this research continued.[172] During the past decade, Beijing's rhetoric aside, Chinese research has increasingly included efforts to develop China's own ballistic missile defense systems in addition to existing efforts to develop countermeasures to adversaries' systems.[173]

Based on its intensifying research in this area, China is rapidly developing more robust missile defense capabilities to supplement its existing array of long-range surface-to-air missiles, which provide only a limited capability against ballistic missiles.[174] China has continued working to develop a kinetic energy intercept capability for intercepts of ballistic missiles and other aerospace vehicles at exo-atmospheric altitudes. For intercepts within the upper atmosphere, China is developing a ground-based midcourse interceptor, conducting two successful tests in 2010 and 2013.† China faces several remaining technical challenges in deploying an effective ballistic missile defense system: developing the capacity to resist electronic attack, developing the ability to respond to multiple warheads, and fielding a space-based early warning system.[175]

Reflecting on the United States' experience with developing the Ground-based Midcourse Defense System, Frank Rose, Assistant Secretary of State for Arms Control, Verification and Compliance, stated that the State Department expects a comparable system in development in China to "provide at most a limited defense of the Chinese homeland, which would not counter the U.S. strategic deterrent and therefore would not undermine strategic stability." [176]

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*The United States announced its withdrawal from the Anti-Ballistic Missile Treaty on December 13, 2001, based on President Bush's assessment that the Treaty hindered the United States' ability to develop ways to defend against future terrorist or rogue-state missile attacks. In the Bush Administration's view the emergence of these new threats, in light of a more cooperative strategic relationship with Russia, necessitated the deployment of territorial defense systems specifically prohibited under the Treaty. George W. Bush, "Remarks by the President on National Missile Defense, ABM Withdrawal" (Rose Garden, Washington, DC, December 13, 2001); Office of the White House Press Secretary, "Announcement of Withdrawal from the ABM Treaty," December 13, 2001.

†China's government publicly described another test conducted on July 23, 2014, as a "land-based missile interception test," but the United States government assesses with "high confidence" that this was instead an anti-satellite missile test. Frank A. Rose, "Ballistic Missile Defense and Strategic Stability in East Asia" (Federation of American Scientists workshop, Washington, DC, February 20, 2015).

China's C4ISR and Targeting Challenge

ISR: Understanding the Battlespace and Obtaining Targeting Data for Precision Strike

To realize the full potential of its long-range precision strike capabilities, China requires detailed awareness of a potential battlespace as well as the ability to obtain targeting data at increasingly far distances from the Chinese mainland. As Mr. Fuell of the National Air and Space Intelligence Center stated, "One key dependency inherent to missile warfare is targeting: effective and timely target selection is an absolutely critical part of the kill chain. We have little insight into this key phase, but it is quite possible that, as with overall joint integration, it may represent an overall structural weakness, and training at the unit level may not help address it." [177]

The PLA's primary strategic preoccupation, Taiwan, consists mostly of stationary targets located across the Taiwan Strait. However, as China has sought to project power further from its shores and developed missiles to engage targets at longer ranges, maritime C4ISR—understanding the activity taking place in waters and airspace off China's coast and integrating this data into actionable information for distribution to operational forces—has become an increasingly critical component of PLA operations. The U.S. Office of Naval Intelligence states that even building a detailed air and maritime picture of China's 875,000-square-nautical-mile "near seas" is a daunting task; the addition of the Philippine Sea, a key interdiction area in a Taiwan or South China Sea conflict, adds 1.5 million square nautical miles to the vast area China would need to monitor.[178] Moreover, a wide range of military, law enforcement, and commercial shipping, fishing, and oil and natural gas vessels operate in these waters, further complicating target discrimination in a potential conflict.

It remains unclear whether China can obtain targeting data and pass it to missile launch units in a timely manner, particularly for targets beyond the first island chain, according to DOD.[179] However, China is engaged in an effort to improve its overall C4ISR capability.[180] At present, China builds a maritime C4ISR picture from a variety of sources:

Tactical reporting. China's ability to track activities along its coast originates from the PLA Navy's initial operational emphasis on coastal defense.[181] As the PLA Navy has operated farther from Chinese shores, China's maritime law enforcement agencies have taken up greater littoral-area responsibilities, mostly supplanting the role of the navy in this area. Both naval and law enforcement assets at sea directly report information to contribute to China's maritime C4ISR. However, this data is limited to the operating areas and sensor ranges of these ships and aircraft.[182]

Ground-based radars. In addition to ground-based coastal radars to monitor coastal areas, China is relying on more advanced ground-based sensors to enable over-the-horizon surveillance, a necessity for the successful targeting of long-range missiles. China operates ground-based surface-wave and sky-wave radars, which can track targets at distances much farther than conventional radars can—perhaps 1,600 nautical miles (1,841 miles) or more.[183]

Airborne ISR. A variety of airborne platforms contribute to China's ability to discern air and maritime activity in its near seas and beyond. A growing fleet of fixed-wing maritime patrol, airborne early warning, and surveillance aircraft currently serve as the core of China's airborne ISR capability, but other airborne assets are also poised to play a key role. Ongoing naval shipbuilding efforts indicate prioritization of surface combatants capable of embarking helicopters, a feature that will augment China's over-the-horizon targeting capability.[184] Additionally, the PLA Navy is incorporating unmanned aerial vehicles into its fleet for maritime ISR missions. Unmanned aerial vehicles have a long loiter time and can provide persistent surveillance beyond the ability of manned assets. Unmanned aerial vehicle sensors could support conventional SRBM missions, and possibly MRBM, ASBM, and battle damage assessment missions as well.[185] Furthermore, some developmental unmanned aerial vehicles, such as the Yilong, Sky Saber, and Lijian platforms, will likely have the ability to integrate strike weapons, although no testing or employment of such systems has yet been revealed.[186]

Space-based ISR. A maturing space-based ISR infrastructure will provide higher resolution for the PLA's tracking of air and naval activity out to the second island chain, as well as improve its ability to guide missiles to moving targets at sea. For more information on China's ISR satellites, see Chapter 2, Section 2, "China's Space and Counterspace Programs." There are also indications the Second Artillery is interested in using the near space region—the area between the atmosphere and space at 20–100 kilometers (12–62 miles) in altitude—for surveillance, communications relay, electronic warfare, and precision strike through the use of near space vehicles.[187]

Data Fusion and Command and Control

Both data fusion and command and control are critical for the timely passing of up- and down-echelon information—such as targeting data, battle damage assessments, and launch orders—that inform missile operations.

In addition to collecting accurate targeting data, the PLA has the additional challenge of fusing the data and disseminating it to Second Artillery missile launch units. Although an ideal scenario would fuse data from all of China's ISR sensors into a single display and disseminate it to all PLA units, this scenario requires far more coordination and standardization across multiple units than exists at this time.[188]

Command and control ensures that required information is passed in a timely manner to the appropriate units, in order to lay the groundwork for operational efforts such as missile launches. As the PLA continues to strive toward joint operations, the difficulty of managing targeting information across multiple PLA services and branches will grow significantly. Additionally, the relatively recent involvement of PLA services other than the Second Artillery in missile employment will increase the complexity of the command

and control of such missile launches. Nuclear weapons in particular have a tightly centralized release authority running from China's Central Military Commission, of which Xi Jinping is the chairman, directly to the Second Artillery. The pending deployment of submarine-launched and possible air-launched nuclear-armed missiles introduces the PLA Navy and the PLA Air Force into nuclear chains of command, potentially lengthening and complicating the decision-making and launch process in a nuclear scenario.[189]

The limited public information about Beijing's nuclear command and control could make it more likely that an adversary's actions in a crisis could, in Beijing's view, cross the nuclear threshold, even if this was not the adversary's intent. China so highly values its nuclear command and control that the destruction or degradation of this function has been raised by outside analysts as a possible trigger for its use of nuclear weapons.[190] In an interview with Commission staff, Professor Twomey stated, "It assumes a lot to expect the Chinese interpret an attack on their command and control systems in an intense crisis as solely a conventional attack. A significant loss of such capabilities might appear to Beijing to presage an escalation across the strategic threshold [into the nuclear realm], whatever U.S. intentions in that regard might have been."[191]

Second Artillery Training Developments

In conjunction with technical developments to China's offensive missile forces, the Second Artillery has focused on improving training to employ its relatively new capabilities to the fullest extent. In line with PLA reforms under Xi Jinping that have emphasized training under "realistic combat scenarios," the Second Artillery in the past three years has sought to ensure its training conditions mirror those it would face in combat. As emphasized in official PLA media, the Second Artillery has sought to shift training away from scripted, predictable exercises by including features such as: unique geographic environments and extreme weather conditions, year-round training, long-range mobility operations, precision-strike practice using live fire, deviation from prepared plans, "complex electromagnetic environments," and greater usage of maneuvers and camouflage to increase survivability.[192]

Additionally, based on the PLA's broader effort to master integrated joint operations, the Second Artillery has expanded training in support of or in conjunction with the PLA Army, Navy, and Air Force.[193] Second Artillery units were involved in each of China's three large-scale military-wide exercises held in 2014: Stride, Joint Action, and Firepower. DOD described these exercises, which involved multiple evolutions across all of China's seven military regions, as a "significant milestone in the PLA's long-term goal of developing into a modern, professional, and capable military force."[194] A July 2015 PLA Navy exercise also shed light on the role of the Second Artillery in a joint environment. Held in the South China Sea, the exercise reportedly involved over 100 naval vessels and several Second Artillery launch battalions, in addition to several PLA aircraft and information warfare forces. Official Chinese press indicated the Second Artillery likely coordinated with the PLA Navy to suppress key targets on land as well as ship targets at sea. Media reports also highlighted the PLA Navy's success in antiship missile interception during the exercise.[195] Finally, of note, press on the exercise indicates training was conducted in "transporting and deploying whole units of onshore missile forces," suggesting the significance of logistics to the Second Artillery's operations.[196] As the Second Artillery has taken part in more multiservice exercises, it has also emphasized cross-region mobility and logistics, necessary skills for the coordinated and timely movement of multiple PLA elements across China.[197]

Finally, the Second Artillery appears to be emphasizing the frequency of its training exercises, according to PLA media sources.[198] As the PLA seeks to shift from a training cycle based on traditional annual conscription schedules to a more continuous training cycle emphasizing year-round readiness, the Second Artillery and other services will follow suit. The increasing professionalization of PLA personnel and a growing corps of non-commissioned officers will also contribute to the ability of the Second Artillery to maintain year-round readiness.[199]

Implications for the United States

The increasing numbers, diversity, survivability, lethality, and penetrability of China's offensive missile forces deeply and negatively affect U.S. security interests, particularly those related to its military force structure and planning, regional alliance commitments, treaty obligations, and approach to deescalating potential crises in the U.S.-China relationship. China's growing offensive missile capabilities are clearly intended to support its nuclear threat posture and aggressive assertions of sovereignty in the East and South China seas, which the Commission documents in other sections of this Report. Unless the United States understands China's evolving missile doctrine and growing capabilities and responds vigorously, it runs a growing risk of being unable to deter deliberate aggression and reduce the risk of miscalculations that could lead to an escalating armed conflict.

U.S. Military Force Structure and Planning

China's offensive missile force can threaten increasingly large portions of the Western Pacific—where the U.S. military has operated uncontested since the end of the Cold War—requiring significant alterations to U.S. military planning assumptions. China is rapidly introducing to its ballistic and cruise missile inventories weapons capable of hitting targets out to the first and second island chains, covering Guam as well the territory of U.S. allies. Some of these weapons are able to target a widening diversity of platforms, including aircraft carriers. These developments strengthen China's ability to carry out its antiaccess/area denial strategy in the event of a conflict and complicate Washington's efforts to promote and advance U.S. goals and objectives in Asia.

The United States faces both financial and strategic costs in defending against these new capabilities. Because it is so expensive and technically challenging to defend against relatively low-priced and high-impact missiles, a spending competition between additional Chinese offensive missiles and U.S. defensive systems would not be favorable for the United States.[200] To address this problem, the United States is currently working to develop innovative and lower-cost-per-shot methods to defend against the missiles of potential adversaries, including China.[201] Some U.S. defense analysts have also called for the United States to reconsider its current force structure's emphasis on short-range aircraft, and instead emphasize the procurement of long-range stealth bombers that would allow the United States to operate beyond the reach of advanced Chinese missiles.[202] Additionally, due to China's heavy and growing reliance on C4ISR for the targeting and guidance of its missiles, solutions to disrupt networks that would support Chinese missile and aerospace forces could be a realistic disabling option for the United States in a conflict. Rear Admiral Jesse Wilson (U.S. Navy), director of the Joint Integrated Air and Missile Defense Organization, stated in 2015, "We need to look left of launch . . . if I can disrupt other [parts] of the adversary's kill chain, I don't have to fire an SM–3, I don't have to fire a Patriot, I don't have to fire a [Terminal High-Altitude Area Defense missile]," and, because of the finite and limited number of U.S. interceptors, "I don't have the numbers to do it anyway." [203] The United States, however, is similarly reliant on its sensors and communications networks for its military operations, particularly those far from home—a potential drawback to this approach. As Mr. Haddick testified, "In a potential conflict in East Asia, such an exchange of blows against both sides' ISR and command networks could favor the Chinese 'home team' which could have an easier task of restoring these functions than would U.S. expeditionary forces." [204]

U.S. defense strategy, policy, planning, and budgeting must take these stark realities into account. Specifically, U.S. planners must evaluate the adequacy of U.S. national and theater missile defense policies and capabilities, as well as U.S. offensive strike policies and capabilities, to deter and deny the threat that emanates from China's evolving missile competencies.

Alliance Management

The PLA's growing inventory of theater-range missiles—both conventional and nuclear—affect the strategic calculations of U.S. allies in the region as they consider how to adjust their military strategies to account for a rising China. According to Professor Yoshihara, "For some time to come, the missile will be China's best answer to U.S. forward presence, power projection, and security commitments to treaty allies and friends." [205] China's increasing ability to use its missile arsenal to threaten U.S. partners and allies supports its regional ambitions, improves its coercive ability, weakens the value of deterrence efforts targeted against it, and widens the range of possibilities that might draw the United States into a conflict. The nascent theater nuclear missile capability China appears to be developing could introduce uncertainty to U.S. extended deterrence in Asia, as U.S. allies falling under the U.S. nuclear umbrella likely will look to the United States for reassurance regarding the seriousness of its treaty commitments.* [206]

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* For more information on the impact of China's growing influence and military modernization on U.S. alliances and security partnerships in Asia, see Chapter 3, Section 1, "China and Asia's Evolving Security Architecture," of the Commission's *2014 Annual Report to Congress*.

U.S. Treaty Obligations

China's missile force modernization has contributed to a U.S. policy debate regarding U.S. obligations as a signatory to the Intermediate Range Nuclear Forces (INF) Treaty.* The U.S. State Department confirmed in 2014 and 2015 that Russia had violated its treaty obligations by testing a prohibited missile.[207] Meanwhile China, uninhibited by treaty obligations, has engaged in a relatively low-cost build-up of land-based theater-range missiles, giving it the ability to target a large portion of the Pacific theater. These developments have raised questions about the modern-day relevance of the INF Treaty for the United States.

Although most analysts seem to agree that completely abrogating the INF Treaty would be an overreach,[208] given its continuing benefits for the United States,† some have argued that modifications should be made. Evan Braden Montgomery, senior fellow at the Center for Strategic and Budgetary Assessments, has suggested altering the treaty so that ground-based theater-range missiles might be permitted only in Asia. In testimony to the Commission, Dr. Montgomery offered three benefits of this "Asia option": (1) it could enable the U.S. deployment of ground-based missiles in the Western Pacific, enhancing deterrence and improving crisis stability as China's military becomes more powerful; (2) it could provide both the United States and Russia bargaining leverage against China, which currently has no incentive to accept any limits on its offensive missile forces; and (3) it could drive a wedge between China and Russia, since Russian missile developments under such an "Asia option" would very likely be aimed at China.[209] Other analysts, skeptical that the United States would benefit from the opportunity to re-introduce ground-based theater-range missiles and concerned that such a development would destabilize rather than stabilize the strategic balance for the United States and its allies, advocate for the maintenance of the status quo of the INF Treaty.[210] As China continues to expand its intermediate-range missile capabilities, and Russia determines whether to proceed in devel-

* Signed by the United States and Soviet Union in 1987, the INF Treaty required "destruction of both parties' ground-launched ballistic and cruise missiles with ranges between 500 and 5,500 kilometers (310 and 3,418 miles), along with their launchers and associated support structures and support equipment," altogether eliminating 846 U.S. and 1846 Soviet missiles. Although titled a "Nuclear Forces" Treaty, INF's prohibition of conventional systems is more relevant to the current discussion—China's buildup of conventional intermediate-range ballistic and cruise missiles has been a driving force behind this debate in recent years. Amy F. Woolf, "Russian Compliance with the Intermediate Range Forces (INF) Treaty," *Congressional Research Service*, June 2, 2015, 8; U.S. Department of State, *Treaty Between The United States Of America and The Union Of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter-Range Missiles (INF Treaty)*, December 8, 1987.

† The treaty is regarded as both a keystone of U.S.-Russia security relations and an arms control success, having eliminated an entire class of weapons between the United States and Russia; this limited each nation's nuclear missile arsenal to its strategic deterrent of ICBMs and removed the need to compete in deploying INF-accountable systems. Moreover, the treaty is essential to NATO's deterrence posture, preventing Russia, at least in legal terms, from deploying inexpensive short- and medium-range ballistic and cruise missiles on its European border for purposes of political coercion, as China has done on the Taiwan Strait. Evan Braden Montgomery, "China's Missile Forces Are Growing: Is It Time to Modify the INF Treaty?" *National Interest*, July 2, 2014; Steven Pifer, "Don't Scrap the INF Treaty," *National Interest*, June 9, 2014; Elbridge Colby, "The Real Trouble with Russia: Moscow Might Have Violated the Intermediate-Range Nuclear Forces Treaty—Here's How to Respond," *Foreign Affairs*, April 7, 2014; and Michael R. Gordon, "U.S. Says Russia Tested Missile, Despite Treaty," *New York Times*, January 29, 2014.

oping weapons in violation of the treaty, this issue will likely continue to grow in importance.

Nuclear Strategy and Crisis Management

China's development of long-range precision strike capabilities, coupled with its assertion of sovereignty in its near seas, has resulted in a strategic environment susceptible to crisis instability. According to Avery Goldstein, professor and director for the Center for the Study of Contemporary China at the University of Pennsylvania:

> *In a crisis, China or the United States might believe it valued what was at stake more than the other and would therefore be willing to tolerate a higher level of risk. But because using conventional forces would only be the first step in an unpredictable process subject to misperception, missteps, and miscalculation, there is no guarantee that brinksmanship would end before it led to unanticipated nuclear catastrophe. . . . China, moreover, apparently believes that nuclear deterrence opens the door to the safe use of conventional force. Since both countries would fear a potential nuclear exchange, the Chinese seem to think that neither they nor the Americans would allow a military conflict to escalate too far.*[211]

Since the end of the Cold War, the United States has not been faced with an adversary capable of seriously contesting U.S. dominance of a battlespace, and has had little imperative to consider how nuclear escalation could factor into a potential conflict.[212] As multiple witnesses testified at the Commission's April hearing, the United States should consider carefully how to constrain and bring an end to hostilities in a limited conflict under the specter of nuclear escalation.[213] As China continues to modernize its conventional and nuclear missile forces, these questions will only become more pressing.

Table 2: Ranges of China's Nuclear Ballistic Missiles (Selected) *

Chinese Designator and Missile Type	NATO Designator	Deployment Mode	Approximate Maximum Range in kilometers (miles)
DF–3A IRBM	CSS–2	Transportable	3,000 (1,864)
DF–4 ICBM	CSS–3	Transportable	5,500 (3,418)

* The JL–1 SLBM was omitted from this chart because the Xia-class SSBN, the only Chinese submarine on which the JL–1 has been deployed, is likely currently incapable of conducting operational missions. DOD noted in 2010 that the Xia's operational status was in question, and in 2015 omitted any mention of the Xia in discussing China's SSBNs in its "Annual Report to Congress on Military and Security Developments Involving the People's Republic of China." U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, April 2015, 9; U.S. Office of Naval Intelligence, *The PLA Navy: New Capabilities and Missions for the 21st Century*, April 2015, 16; Kyle Mizokami, "Asia's Submarine Race," *US Naval Institute News*, November 13, 2013; U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2010*, April 2010, 34; Bud C. Cole, *The Great Wall at Sea*, Naval Institute Press, 2010, 108; and Richard Halloran, "Is There a Plan Behind China's Subs?" *Taipei Times*, May 2, 2007.

Table 2: Ranges of China's Nuclear Ballistic Missiles (Selected)—*Continued*

Chinese Designator and Missile Type	NATO Designator	Deployment Mode	Approximate Maximum Range in kilometers (miles)
DF–5A ICBM	CSS–4 Mod 2	Silo	13,000 (8,078)
DF–5B ICBM	CSS–4 Mod 3	Silo	13,000 (8,078)
DF–21 MRBM	CSS–5 Mod 1	Road Mobile	1,750 (1,087)
DF–21A MRBM	CSS–5 Mod 2	Road Mobile	1,750 (1,087)
DF–26 IRBM	Unknown	Road Mobile	3,000–4,000 (1,800–2,500)
DF–31 ICBM	CSS–10 Mod 1	Road Mobile	7,000–7,200 (4,349–4,474)
DF–31A ICBM	CSS–10 Mod 2	Road Mobile	11,000–12,000 (6,834–7,455)
JL–2 SLBM	CSS–NX–14	SSBN	7,000–7,400 (4,349–4,597)

Note: China likely is in the process of phasing out the DF–3A IRBM.
Source: Commission judgments and estimates based on analysis by nongovernmental experts on China's military, consecutive versions of the annual DOD *Report to Congress on Military and Security Developments Involving the People's Republic of China*, the 2013 National Air and Space Intelligence Center report on cruise and ballistic missiles, the 2015 U.S. Office of Naval Intelligence report on the PLA Navy, and U.S. and Asian media reporting.

Table 3: Ranges of China's Conventional Ballistic Missiles (Selected)

Chinese Designator and Missile Type	NATO Designator	Deployment Mode	Approximate Maximum Range in kilometers (miles)
DF–11 SRBM	CSS–7 Mod 1	Road Mobile	300 (186)
DF–11A SRBM	CSS–7 Mod 2	Road Mobile	600 (373)
DF–15 SRBM	CSS–6 Mod 1	Road Mobile	600 (373)
DF–15A SRBM	CSS–6 Mod 2	Road Mobile	850 (528)
DF–15B SRBM	CSS–6 Mod 3	Road Mobile	725 (450)
DF–16 SRBM	CSS–11 Mod 1	Road Mobile	1,000 (621)
DF–16 MRBM	Unknown	Road Mobile	1,200 (746)
DF–21C MRBM	CSS–5 Mod 3	Road Mobile	1,750 (1,087)
DF–21D ASBM	CSS–5 Mod 5	Road Mobile	1,500 (932)
DF–26 IRBM/ASBM	Unknown	Road Mobile	3,000–4,000 (1,800–2,500)

Source: Commission judgments and estimates based on analysis by nongovernmental experts on China's military, consecutive versions of the annual DOD *Report to Congress on Military and Security Developments Involving the People's Republic of China*, the 2013 National Air and Space Intelligence Center report on cruise and ballistic missiles, the 2015 U.S. Office of Naval Intelligence report on the PLA Navy, and U.S. and Asian media reporting.

Table 4: Ranges of China's Cruise Missiles (Selected)

Chinese Designator and Missile Type	NATO or Export Designators	Launch Platform	Approximate Maximum Range in kilometers or nautical miles (nm) (miles)
KD–88 LACM	Unknown	Air	100 kilometers (62)
YJ–63 LACM	C603	Air	200 kilometers (124)
CJ–10/DH–10 LACM	Unknown	Road-mobile	1,500–2,000 kilometers (932–1,242)
CJ–20 LACM	Unknown	Air	1,500 kilometers (932)
YJ–83 ASCM Family	CSS–N–8, C802, C802A	Ship, ground, and air	100 nm (115)
YJ–62 ASCM Family	C602	Ship and ground	150 nm (172)
YJ–8 ASCM Family	CSS–N–4, C801	Ship, submarine, and air	22 nm (26)
YJ–8A ASCM Family	C801A	Ship and air	65 nm
[None; Russian Export to China]	SS–N–27B ASCM	Submarine	120 nm (138)
[None; Russian Export to China]	SS–N–22 ASCM	Ship	65–130 nm (75–150), depending on variant
YJ–12 ASCM	Unknown	Air	215 nm (250)
YJ–18 ASCM	CH–SS–NX–13	Submarine, ship	290 nm (334)

Source: Commission judgments and estimates based on analysis by nongovernmental experts on China's military, consecutive versions of the annual DOD *Report to Congress on Military and Security Developments Involving the People's Republic of China*, the 2013 National Air and Space Intelligence Center report on cruise and ballistic missiles, the 2015 U.S. Office of Naval Intelligence report on the PLA Navy, and U.S. and Asian media reporting.

Conclusions

- The chief roles of China's nuclear arsenal are to deter an adversary from undertaking a nuclear first strike and to reduce the pressure on China to yield to an adversary's demands, or desist from aggression, under threat of nuclear attack. China's belief that its nuclear arsenal would deter an adversary from taking a conventional fight into the nuclear realm could encourage it to be more adventurous in its risk-taking during a crisis because it may not sufficiently fear the prospect of nuclear escalation.

- China is secretive about the details of its official nuclear policy, leading to uncertainty regarding key principles of its nuclear weapons doctrine. Key elements of China's nuclear policy, such as its "no-first-use" pledge and presumptive de-alerting policy, may be under reconsideration but are unlikely to change officially.

- China appears to be pursuing a theater nuclear capability in addition to the strategic nuclear capability it has maintained since it became a nuclear state in the 1960s. In a conflict, China's maturing theater nuclear capability could provide it with the means to flexibly employ nuclear weapons to deescalate or otherwise shape the direction of conflict.

- China is pursuing a credible second-strike capability with an emphasis on survivability against an adversary's first strike. By diversifying its nuclear strike capabilities away from solely land-based systems in silos, China seeks to ensure its ability to absorb a nuclear strike and retaliate in kind. Examples of this diversification include road-mobile intercontinental ballistic missiles, submarine-launched ballistic missiles, and potentially air-launched land-attack cruise missiles.

- China's initial development of its conventional missile forces focused heavily on expanding its short-range ballistic missile force for Taiwan contingencies. In the past decade, China's development of longer-range missiles, pursuit of advanced missile technologies, and diversification of its launch platforms have enabled it to hold at risk a wider range of targets farther from its shores.

- China is developing cruise missiles that are increasingly difficult for the U.S. military to detect and defend against. The PLA has fielded its first ground-launched land-attack cruise missile, and also appears to be developing air-, ship-, and submarine-launched cruise missiles with land-attack and antiship missions. China is in the midst of improving the qualitative aspects of its cruise missile technologies; in the meantime, the quantitative strength of its cruise missiles poses a formidable challenge to existing U.S. Navy defenses.

- China recognizes that adversary missile defenses—particularly the U.S. ballistic missile defense architecture—pose a major challenge to the success of its missile operations. As a result, China is developing measures to improve its forces' ability to penetrate opposing missile defenses, such as multiple independently-targetable reentry vehicles, maneuverable reentry vehicles, and hypersonic weapons.

- To realize the full potential of its long-range precision strike capabilities, China requires detailed awareness of a potential battlespace as well as the ability to obtain targeting data at increasingly far distances from the Chinese mainland. Effective and timely target selection and information coordination is an area the PLA continues to seek to improve.

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RECOMMENDATIONS

China's Space and Counterspace Programs

The Commission recommends:

- Congress continue to support the U.S. Department of Defense's efforts to reduce the vulnerability of U.S. space assets through cost-effective solutions, such as the development of smaller and more distributed satellites, hardened satellite communications, and non-space intelligence, surveillance, and reconnaissance assets such as unmanned aerial vehicles.
- Congress direct the U.S. Department of Defense, U.S. Air Force, and relevant agencies within the U.S. Intelligence Community to jointly prepare a classified report that performs a net assessment of U.S. and Chinese counterspace capabilities. The report should include a strategic plan for deterring, with active and passive systems, strikes against U.S. assets in light of other countries' rapid advancements in kinetic and non-kinetic counterspace technology.
- Congress direct appropriate jurisdictional entities to undertake a review of (1) the classification of satellites and related articles on the U.S. Munitions List under the International Trafficking in Arms Regulations and (2) the prohibitions on exports of Commerce Control List satellites and related technologies to China under the Export Administration Regulations, in order to determine which systems and technologies China is likely to be able to obtain on the open market regardless of U.S. restrictions and which are critical technologies that merit continued U.S. protection.
- Congress allocate additional funds to the Director of National Intelligence Open Source Center for the translation and analysis of Chinese-language technical and military writings, in order to deepen U.S. understanding of China's defense strategy, particularly related to space.

China's Offensive Missile Forces

The Commission recommends:

- Congress direct the U.S. Department of Defense to provide an unclassified estimate of the People's Liberation Army Second Artillery Force's inventory of missiles and launchers, by type, in future iterations of its *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China*, as included previously but suspended following the 2010 edition.

- Congress direct the U.S. Department of Defense to prepare a report on the potential benefits and costs of incorporating ground-launched short-, medium-, and intermediate-range conventional cruise and ballistic missile systems into the United States' defensive force structure in the Asia Pacific, in order to explore how such systems might help the U.S. military sustain a cost-effective deterrence posture.
- Congress continue to support initiatives to harden U.S. bases in the Asia Pacific, including the Pacific Airpower Resiliency Initiative, in order to increase the costliness and uncertainty of conventional ballistic and cruise missile strikes against these facilities, and thereby dis-incentivize a first strike and increase regional stability.
- Congress continue to support "next-generation" missile defense initiatives such as directed energy and rail gun technologies, and require the U.S. Department of Defense to report to committees of jurisdiction on the status of current component sourcing plans for the development and production of directed energy weapons.