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THE IMPLICATIONS OF CHINA'S MILITARY AND CIVIL SPACE PROGRAMS

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Mr. Chairman and Members of the Commission, thank you for inviting me to testify at today's hearing. I will confine my comments to the Commission's questions on the overall context of the People's Republic of China's (PRC's) emerging use of orbital systems to support military modernization efforts such as the country's emerging anti-access/area-denial (A2/AD) capabilities in the western Pacific, including the impact of the PRC's space program on the Chinese concept of Comprehensive National Power (CNP). Regarding the role that the PRC's space assets might play in U.S.-China conflict scenarios in the 2012-2020 timeframe, I will assess the likelihood of such conflicts occurring and argue that China's own growing military use of space may constrain their counterspace options in the long run to a greater extent than some of our war gaming has suggested.

How Has the Military Use of Space Changed since the 1960s?

The United States, starting with the first successful return of a film canister from a KH-1 Corona reconnaissance satellite in August 1960, began to exploit orbital space to monitor the evolution of the Union of Soviet Socialist Republic's (USSR's) strategic-nuclear forces. The USSR followed suit in April 1962 with the first successful return of film from the third Zenit-2 launch. Reconnaissance satellites, known euphemistically as National Technical Means (NTM), enabled the United States and the Soviet Union to monitor each other's military capabilities—especially intercontinental nuclear forces—throughout the Cold War. Although luck also played a part, NTM contributed to a stable relationship that, in the end, avoided a U.S.-Soviet nuclear exchange.

Throughout the Cold War, accessing the orbit using updated German rocket technology was costly, technically difficult and failure-prone. Excluding Corona launches without a camera, the initial KH-1 success was preceded by eight missions failures. Recall, also, the loss of two American space shuttles: *Challenger* during liftoff in 1986 and *Columbia* during reentry in 2003. As a result, the use of space for military missions such as strategic reconnaissance or attack warning was heavily dominated by the United States and the USSR well into the 1980s. Indeed, American and Russian quantitative dominance of near-Earth space persists even today in terms of on-orbit payloads. Counting civilian and military

satellites, in 2010 the United States and Russia had over 80 percent of the more than 3,100 payloads on orbit, while China's had only 3.3 percent (102 payloads). Moreover, although the number of nations and organizations with indigenous capabilities to build and launch satellites has only grown by two since the Cold War ended—Ukraine (capabilities inherited from the USSR after its collapse) and Iran—there are some thirty other nations whose satellites have been launched into orbit by other countries.[1] So, having a satellite, even if put into orbit by another country's launch provider, is rapidly becoming a commodity available in peacetime to most any nation with the necessary funding.

The prevailing American assumption during the Cold War was that military space systems would not survive the initiation of an all-out nuclear exchange with the Soviet Union. Orbital systems were, therefore, considered pre-conflict assets that both sides expected to lose if either country resorted to strategic-nuclear weapons. But, as I argued in a 2001 report published by CSBA, the role of space systems began to expand when Congress established the TENCAP (Tactical Exploitation of National Capabilities) program in 1977. Until then, operational commanders had generally had neither tasking authority nor real-time access to national reconnaissance systems. By the 1991 U.S. campaign to eject Iraqi forces from Kuwait (Operation Desert Storm), not only were General Norman Schwarzkopf's theater forces able to utilize overhead electro-optical and radar sensors, but a partial Global Positioning System (GPS) had been optimized to provide precision location and timing information during the 43-day conflict.[2]

Desert Storm heralded the beginning of the near-real-time integration of orbital systems into the kit of U.S. joint war fighters, a trend that has continued to the present day. Overhead systems not only provide the targeting information for American precision-guided munitions, but the GPS constellation enables weapons such as the Joint Direct Attack Munition to strike battlefield targets through even severe weather such as the sandstorm that, for three days starting on March 24, 2003, obscured the battlefield during Operation Iraqi Freedom. Space systems have been increasingly integrated into U.S. combat operations; they have provided much of the targeting information necessary for guided munitions to be effectively employed as well as the global connectivity on which U.S. battle networks depend.

From a U.S. perspective, therefore, the military use of space has changed fundamentally since the early 1960s. During most of the Cold War space systems were used mainly by the United States and USSR for strategic reconnaissance inside the other's sovereign territory prior to the outbreak of general nuclear war. Starting with Desert Storm, however, U.S. space systems have been used increasingly for near-real-time surveillance and targeting of enemy forces during ongoing conventional operations. An added wrinkle is that GPS, which first demonstrated its military value in 1991, subsequently evolved into a universal source of

1 Currently, in addition to the United States and Russia, France (a member of the European Space Agency with seventeen other nations), Japan, China, the United Kingdom, India, Israel, Ukraine and Iran all have orbited domestically built satellites.

2 Note, however, that the only GPS-aided precision munitions employed in 1991 were the 35 Conventional Air Launched Cruise Missiles (CALCMs) launched by B-52s on the first night of the war. The first use of inertially guided, GPS-aided Joint Direct Attack Munitions (JDAMs) was in 1999 during Operation Allied Force. Over 650 were delivered by B-2s.

precision location and timing data for individuals, financial institutions, commercial firms, numerous other organizations, and militaries around the globe. Though funded through the U.S. Air Force's budget, GPS is now a service that the U.S. government provides to everyone else on the planet free of charge.

Precision-Strike as a Revolution in Military Affairs

In the early 1990s, the Pentagon's Office of Net Assessment (ONA) under the direction of Andrew Marshall began exploring the prospect of an emerging revolution in military affairs (RMA) centered on what Soviet theorists termed reconnaissance-strike complexes (or RUKs from the Russian разведовательно-ударные комплексы). In the Soviet view, RUKs would integrate theater missiles (or other strike platforms) with precision-guided munitions or sub-munitions, advanced sensors, such as the Pave Mover SAR/MTI (synthetic-aperture radar/moving-target-indicator) radar, and automated command and control (C2). For Marshall, a central question was how the emergence of RUKs combined with new operational concepts and organizational arrangements might alter war's conduct. As early as 1984, Marshal N. V. Ogarkov had suggested that RUKs would eventually enable conventional strikes with precision weapons to approach the effectiveness of nuclear weapons against most targets. By the early 1990s, Marshall was suggesting that long-range precision strike might become the dominant operational approach, and that achieving information superiority might become a major focus of the operational art.[3]

Currently, the U.S. military is the only country to have demonstrated a global, end-to-end capability for precision strike in actual combat operations. With the collapse of the Soviet economy at the Cold War's end, the Russians, contrary to what Marshall and others expected in the 1990s, failed to field long-range precision-strike capabilities comparable to those of the United States. Instead, nearly two decades after ONA's first assessment of the "military-technical revolution" (or RMA), the country that appears to be making the greatest strides toward fielding regional RUKs is China.

So far, China's precision-strike capabilities are regional in the sense of being focused on limiting the U.S. power projection in the western Pacific, especially in the waters near Taiwan. One element of the PRC's emerging A2/AD capabilities is the development of a variant of the DongFeng (DF) 21 (CSS-5) medium-range ballistic missile capable of targeting U.S. naval surface combatants—notably aircraft carriers—at distances of up to 1,500 kilometers (810 nautical miles) from the Chinese mainland.[4] To provide accurate, real-time target information for the DF-21D anti-ship ballistic missile (ASBM), the Chinese have been considering the integration of data from a variety of space-based sensors, including electro-optical (EO), *synthetic-aperture radar (*SAR), electronic reconnaissance, and ocean surveillance satellites.[5] In 2010 China made three launches of its Yaogan series, which are believed to be military reconnaissance satellites. Most likely, Yaogan 10 carried a SAR sensor, Yaogan 11 an EO sensor, and Yaogan 9 was evidently a triplet of

3 Andrew W. Marshall, "Some Thoughts on Military Revolutions—Second Version," ONA memorandum for record, August 23, 1993, pp. 3-4.

4 Andrew S. Erickson and David D. Yang, "On the Verge of a Game-Changer," *Proceedings*, May 2009.

5 Ian Easton and Mark A. Stokes, "China's Electronic Intelligence (ELINT) Satellite Developments: Implication for U.S. Air and Naval Operations," Project 2049 Institute, February 2011, p. 7.

satellites designed for ocean reconnaissance.[6] Robert Willard, commander of U.S. Pacific Command, indicated in December 2010 that China's 2nd Artillery Corps had reached "initial operational capability" with the DF-21D ASBM system, although he added that the Chinese had not yet tested the entire system against a moving ship at sea.[7] Nonetheless, China's development of ASBM and its supporting sensors reflect a strong aspiration—now approaching realization—to be able to hold at risk U.S. carrier battle groups should they try to operate in and around Taiwan as occurred during the crisis of 1995-1996. Indeed, in the near term the People's Liberation Army (PLA) seems intent on establishing a virtual keep-out zone for U.S. power-projection forces extending from the Chinese mainland out to the first island chain running from southern Japan, through Okinawa and Taiwan, to the Philippines and Malaysia.

The Two Sides of Growing Dependence on Information from Space in "Hi-Tech Local Wars"

In the aftermath of the 1991 Persian Gulf War and subsequent "limited wars under high-tech conditions" (*jubu zhanzheng zai gaojishu tiaojian xia*), Chinese military theorists concluded that the PLA's longstanding reliance on mass mobilization for all-out war was no longer applicable. As the United States demonstrated in 1991—and, again, in 2003—industrial-age military forces based on the massive application of mechanized firepower stood little chance against the high-tech, information-led forces of the United States.[8] The PLA, therefore, had no choice but to start down a path of strategic modernization that recognized "informationalization" (*xinxi hua*) as a key element of future wars. Informationalization, moreover, involved more than just embracing information technology. Information needed to pervade everything from planning and logistics to operations in all five conflict domains (land, sea, air, space and cyberspace), with "informational warfare" becoming the basic form of local war under high-tech conditions.[9]

Chinese appreciation of the vital role information will play in future hi-tech local wars has two main ramifications. The first is that, from a modernization perspective, the PLA has no choice but to invest in the capability to get information for its forces from space. It is not unreasonable to suspect that, without some in-flight target updates, a DF-21D reentry vehicle, even with terminal guidance, might be hard-pressed to hit a U.S. aircraft carrier operating hundreds of miles off the Chinese coast. After all, during a notional five-minute DF-21D time of flight, a U.S. carrier moving at 25 knots could change its position by some two nautical miles, and radio-frequency aerosol obscurants could defeat the warhead's radar terminal guidance. China's emerging ASBM capability, therefore, is likely to require

6 Yaogan details can be found on Gunter Kreb's Space Page at http://space.skyrocket.de/

7 Andrew Erickson and Gabe Collins, "China Deploys World's First Long-Range, Land-Based 'Carrier Killer': DF021D Anti-Ship Ballistic Missile (ASBM) Reaches "Initial Operational Capability" (IOC)," China SignPost," December 26, 2010, Issue 14, p. 1, accessed May 4, 2001, at http://www.chinasignpost.com/2010/12/china-deploys-world's-first-long-range-land-based-'carrier-killer'-df-21d-anti-ship-ballistic-missile-asbm-reaches-"initial-operational-capability"-ioc/, accessed May 6, 2011.

8 Peng Guanqian Yao Youzhi (chief editor), *Science of Strategy* (Beijing: Military Science Press, 2001), pp. 359-361.

9 Peng, *Science of Strategy*, pp. 369-370.

in-flight target updates, and Chinese writings indicate that these updates will come from satellites.

These observations about the dependence of the DF-21D ASBM on space-based sensors raise an important point about U.S. perceptions of PLA approaches to space systems in the event of a conflict with the United States. A frequent move by the China team in U.S. war games has been to mount attacks early on to deny the use of satellites to both sides on the premise that U.S. forces have more to lose than China's. If, however, the 2nd Artillery Corps needs information from overhead sensors to carry out its own missions in time of war, the strategy may not make as much sense as war games have tended to suggest. Selectively dazzling or blinding U.S. EO satellites as they come into view over Chinese territory with ground-based lasers is one thing. Rendering LEO unusable for all nations either by generating debris from multiple kinetic attacks on U.S. reconnaissance satellites,[10] or by detonating a nuclear weapon above the mesosphere to charge up the Earth's van Allen radiation belts, is another. Both are essentially "Samson" options.

The other ramification of the vital role that satellites have increasingly played in U.S. military operations is that the Chinese cannot help but appreciate just how dependent American precision warfare is on the use of space. Precision munitions are only useful if they can be supplied with precision targeting information such as the GPS coordinates of an aim point. To get that information to shooters in time to deal with time-sensitive targets, the United States has invested heavily in developing global battle networks as well as intelligence, surveillance and reconnaissance (ISR) systems such as EO and radar satellites as well as unmanned air vehicles (UAVs) like the RQ-4 Global Hawk and MQ-1 Predator. An advantage of UAVs over LEO satellites is that they can dwell over a target area and provide staring surveillance rather than periodic looks. The UAVs, however, are critically dependent on communications satellites (COMSATs). Currently, a single Predator orbit requires data rates of up to 6.4 million bits/second (Mbps); and the electro-optical, infrared and synthetic aperture radar feeds from a single Global Hawk can potentially consume as much as 274 Mbps. These bandwidth requirements have been met by military and commercial COMSATs in geostationary orbits. In addition, the UAVs themselves depend on GPS for precise geo-location of whatever their sensors are "seeing." Thus, the targeting and battle-management networks integral to current U.S. strike operations contain vulnerabilities to attacks ranging from jamming C2 links to the covert insertion of false data into U.S. networks. During the major combat phase of Operation Iraqi Freedom (OIF) in March-April 2003, the Combined Air Operations Center (CAOC) in Saudi Arabia used 31 military and 27 commercial COMSAT terminals with a capacity of nearly 210 Mbps.[11] Overall, the total information flow in and out of theater during OIF's major combat phase is estimated to have peaked around three billion bits per second while some 84 percent of all military

10 Forden has estimated that kinetic anti-satellite attacks on nine U.S. LEO satellites could produce nearly 19,000 new pieces of debris over four inches in diameter, which could lead to a run-away chain of collisions that could render low-earth orbit unusable for thousands of years (Noah Shachtman and Geoffrey Forden, "How China Loses the Coming Space War (Pt. 3)," Wired, January 2008, online at http://blog.wired.com/defense/2008/01/inside-the-ch-2.html, accessed May 7, 2011).

11 J. R. Wilson, "Satellite Communications Key to Victory in Iraq," Military & Aerospace Electronics, August 2003, online at http://mae.pennnet.com/articles/article_display.cfm?Section=ARCHI&C=News&ARTICLE_ID=183379&KEYWORDS=SATCOM&p=32, accessed May 7, 2011.

communications in and out of the theater went through commercial COMSATs.[12] As for the dependence of precision strike operations on space, nearly 44 percent of the guided munitions expended in the OIF air campaign used inertial/GPS-aided guidance to home in on their aim points.

There is extensive evidence that the PLA understands these U.S. dependencies and is making every effort to find ways to be able to exploit them in any future conflict with the United States. The Chinese are investing in everything from jamming to counter-network attack (the offensive form of cyber warfare), anti-satellite (ASAT) systems, and directed-energy weapons. Retired Vice Admiral Mike McConnell argued in February 2010 that the United States is already engaged in a cyber-war with various competitors, adding that the United States was losing this "war," particularly against China.[13] As for traditional "kinetic" approaches to undermining U.S. access to space, in January 2007 China demonstrated a direct-ascent ASAT capability by destroying one of its own aging LEO weather satellites with a kinetic-kill vehicle launched by a mobile missile at the Xichang space facility in Sichuan province.[14] Suffice it to say that even if the PLA would hesitate to disarm its own precision-strike capabilities by taking out both sides space systems in a future conflict, the Chinese will certainly do what they can to degrade and interfere with unimpeded U.S. access to space.

The Chinese Space Program and Comprehensive National Power

Table 1: Hu Angang and Men Honghua's CNP Calculations, 2004[15]

	1980	1985	1990	1995	1998
United States	22.485	22.011	22.138	21.903	22.785
China	4.736	5.306	5.646	7.163	7.782

So far, I have focused almost exclusively on the military use of space. Since the 1980s, however, Chinese scholars have developed the concept of Comprehensive National Power (CNP) to quantify the relative power relationships between nations and even to predict the outcome of future local wars under high-tech conditions. While different versions of CNP can be found in Chinese writings, the gist is that CNP involves more than economic and military strength. Political power and influence, science and technology, natural resources as reflected in a country's population and territory, and social development (literacy,

12 Forden, "How China Loses the Coming Space War (Pt. 2)," *Wired*, at http://blog.wired.com/defense/2008/01/inside-the-ch-1.html.

13 Mike McConnell, "Mike McConnell on How to Win the Cyber-war We're Losing," *The Washington Post*, February 28, 20010, pp. B1, B4.

14 Ashley J. Tellis, "Punching the US Military's 'Soft Ribs': China's Antisatellite Weapon Test in Strategic Perspective," Carnegie Endowment for International Peace, Policy Brief 51, May 2007, p. 4. Destruction of the *Feng Yun* 1-C weather satellite created a debris field of more than thirty-five thousand shards larger than one centimeter (Ashley J. Tellis, "China's Military Space Strategy," *Survival*, September 2007, pp. 41).

15 Hu Angang and Men Honghua, "The Rising of Modern China: Comprehensive National Power and Grand Strategy," paper at the "Rising China and East Asian Economy" conference, Seoul, March 19-20 2004, pp. 22-23. These are the most recent CNP figures for China and the United States I have seen.

education levels, etc.) also contribute to CNP. The obvious point to be made is that the PRC's space program contributes to the country's CNP over and above its contributions to China's military power. China is among the three countries—the other two being the United States and Russia—that have put humans in space on their own. China's current efforts to explore the moon, as well as its longer-term aspirations to land humans there again (starting in 2030) and begin construction of a lunar base, contribute to the PRC's science and technology as well as the country's international prestige. While it is anyone's guess what impact the establishment of a Chinese lunar base might have on power relationships on Earth, the contributions of China's space program to the country's CNP is not limited to the military sphere. As General Ding Henggao has quoted Deng Xiaoping as saying, if China had not had nuclear weapons and launched satellites in the 1960s, "then China would not be called an important, influential country and would not enjoy the international status that it does today."[16]

Table 1 shows CNP estimates for the PRC and the United States from 1980 to 1998 by the Chinese scholars Hu Angang and Men Honghua from the Center for Chinese Studies at Tsinghua University in Beijing. The figure depicts the PRC as a rising power, but still, at the beginning of the twenty-first century, one substantially inferior to the United States. China's economy has, of course, continued to grow much faster than the United States' since the turn of the century. Hu and Men's 2004 paper also contains gross domestic product (GDP) projections that show China's economy being greater than that of the United States by 2020.[17] These projections are consistent with the International Monetary Fund's recent announcement that China's GDP will surpass America's in real terms in 2016. Nevertheless, just as CNP is composed of more than military power, it also reflects more than GDP. Consequently, surpassing the United States in GDP does not mean surpassing the United States in Comprehensive National Power.

The Role of Space in Possible U.S.-China Conflicts in 2012 and 2020

The most common scenarios for a conflict between the United States and the PRC are built around a Chinese attempt to take Taiwan by military force. The first point to be made about the likelihood of such an attempt is that China has been fairly successful in pursuing the economic entanglement of Taiwan. In 2003 I participated in discussions of net assessment with senior Taiwanese national security officials held in Taipei. What struck me during that trip was the growing migration of Taiwan's advanced technologies and businesses to mainland China, lured by such incentives as lower labor costs. Since then, the indications are that the gradual economic entanglement of Taiwan has continued, and that it is leading—in the long run—to Taiwan's eventual economic "capture" by the PRC. If this assessment is correct, then the chances of the PRC initiating a military takeover of Taiwan in 2012 or even 2020 appear to be quite low. Why use military force if economic entanglement leading to economic capture is succeeding? Note, too, that this approach

16 Michael Pillsbury (ed.), *Chinese Views of Future Warfare* (Washington, DC: National Defense University Press, 1997), p. xxix.

17 Angang and Men, "The Rising of Modern China," p. 5.

embodies Sun Tzu's dictum that the acme of strategy is to subdue the enemy without fighting.

The second point to be made about prospective U.S.-PRC conflicts in 2012 or 2020 draws on the ongoing efforts of China scholars to understand how PRC leaders and strategists envision the future security environment. Michael Pillsbury, Jacqueline Newmyer and others argue that China's leaders view international relations since the Cold War through the prisim of the strategy and statecraft that emerged from China's Warring States Period (from around 400 BCE to China's unification under the Qin Dynasty in 221 BCE). According to Newmyer, the Warring States period "was a militarized age when roughly seven small kingdoms vied for ascendancy over the territory now considered China's Han core."[18] After some two centuries of struggle, the state of Qin emerged victorious, unified China, and launched the dynastic era that lasted into the twentieth century. Newmyer believes that in light of the Warring States literature, China's grand strategy today seeks "to prevent the encirclement of China while encircling prospective enemies, with the aim of creating a disposition of power so favorable to the PRC that it will not actually have to use force to secure its interests."[19] However, because China is a rising power whose conventional military power remains substantially inferior to that of the United States, it is imperative for China to avoid a direct military conflict with the global hegemon for the time being. As Hu and Men concluded in 2004, militarily, China is still not strong enough "to cope with the military challenges by the forces advocating for Taiwan independence."[20] This reading of Chinese grand strategy provides, in my view, further grounds for questioning the likelihood of a U.S.-PRC conflict over Taiwan in 2012 or 2020.

What role might China's space capabilities play should such a conflict occur nonetheless? Answers to this question vary widely. In 2001, the commission on U.S. national security in space warned that unless steps were taken to reduce the vulnerability of America's space systems, the country would face the real possibility of a "Space Pearl Harbor."[21] After the PRC's successful ASAT test in January 2007, Geoffrey Forden from the Massachusetts Institute of Technology concluded that even with months of planning and prepositioning, the best China could do against U.S. space capabilities would be to attack nine LEO satellites. He argued that the short-term consequences of such an attack would be limited, and that, due to the redundancy of U.S. space systems, even under the worst-case scenario China's all-out ASAT attack would "only reduce" America's use of precision-guided weapons and satellite communications into and out of the theater.[22]

My inclination is to think that Forden's assessment better reflects actual PRC ASAT capabilities between now and 2020 than did the 2001 space commission's warning of a

18 Jacqueline Newmyer, "Oil, Arms, and Influence: The Indirect Strategy Behind Chinese Military Modernization," *Orbis*, Spring 2009, p. 207.

19 Newmyer, "Oil, Arms, and Influence," p. 207.

20 Angang and Men, "The Rising of Modern China," p. 30.

21 "Report of the Commission to Asses United States National Security Space Management and Organization," January 11, 2001, pp. 8-9.

22 Forden, "How China Loses the Coming Space War (Pt. 3)," Wired, at http://blog.wired.com/defense/2008/01/inside-the-ch-2.html. Forden assumed that a DF-21 was used to launch the Chinese kinetic-kill vehicle in January 2007. He also speculated that the kill vehicle used an optical sensor to intercept and destroy the Feng Yun 1-C weather satellite.

looming Space Pearl Harbor. Ashley Tellis, whose assessment of China's military space strategy in the autumn 2007 issue of *Survival* sparked a strident debate over China's counterspace capabilities and strategic goals in early 2008,[23] mentions several other options—directed-energy weapons, electronic attacks including jamming, and terrestrial attacks against the ground segments of U.S. space systems—that provide alternatives to direct-ascent, kinetic attacks against U.S. satellites. To these alternatives I would add cyber attacks aimed at disrupting U.S. computer networks. There are other ways, then, to try to turn U.S. dependence on space into vulnerabilities in addition to kinetic attacks on satellites, and some ways are certainly easier than others.

Because of the Chinese space program, an adequate net assessment of U.S. and Chinese space capabilities in hypothetical western Pacific conflicts circa 2012 or 2020 would require not only classified data but detailed analysis that, frankly, I have not done. Since a 2005 summer study on military advantage, the Office of Net Assessment has been trying to produce an assessment of military competition in space. Complications such as the growing overlap between space and cyberspace have prevented ONA from making much progress. The United States clearly has vulnerabilities stemming from its dependence on space for everything from ISR and C2 to precision strike and Blue Force tracking; but understanding how well the PLA could exploit those capabilities depends on many things, including the effectiveness of PRC counterspace and A2/AD capabilities, the redundancy of the relevant U.S. assets both in orbit and within the atmosphere, and the adaptability and combat experience of U.S. war fighters. Again, setting aside the Samson options, my inclination is to suggest that evolving Chinese efforts to exploit U.S. "informational" vulnerabilities in space would be unlikely to produce a decisive advantage over the United States in conflicts in the western Pacific through the end of this decade.

Might the balance shift more in China's favor beyond 2020? It is very hard to say. A further complication, though, is that the weaponization of space is underway. Here I am not thinking primarily about the U.S. Air Force's X-37B orbital test vehicle, the second of which was launched in March 2011 as USA-226. Rather, I am thinking mainly about the efforts of commercial space companies such as ViviSat and MDA (MacDonald, Dettwiler and Associates) to develop satellites that will be able to extend the mission lives of existing satellites. ViviSat's mission-extension vehicle, for example, will be able to dock with a geostationary communications satellite and assume all attitude and station-keeping control. MDA's servicer will be able to refuel satellites and Intelsat has signed up as its anchor customer. However, space vehicles with these capabilities could also be used to neutralize satellites, thereby opening the door to the de facto weaponization of space.

23 See Ashley J. Tellis, "China's Military Space Strategy, *Survival*, Autumn 2007, pp. 41-72; and "China's Military Space Strategy: An Exchange," *Survival*, February March 2008, pp. 157-196. Perhaps the most controversial issue in the 2008 exchange among Michael Krepon, Eric Hagt, Shen Dungli, Bao Shiiu, Michael Pillsbury and Tellis was over whether China aspires to replace the United States as the world hegemon. This debate preceded Christopher Ford's 2010 *The Mind of Empire*, which argued that Chinese intellectual tradition, going back to the Warring States period, "lacks a meaningful concept of coequal, legitimate sovereignties pursuant to which states may coexist over the long term in nonhierachical relationships" (p. 273). One should, however, pay attention to the caveats Ford attaches to this thesis (ibid., pp. 274-282).

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