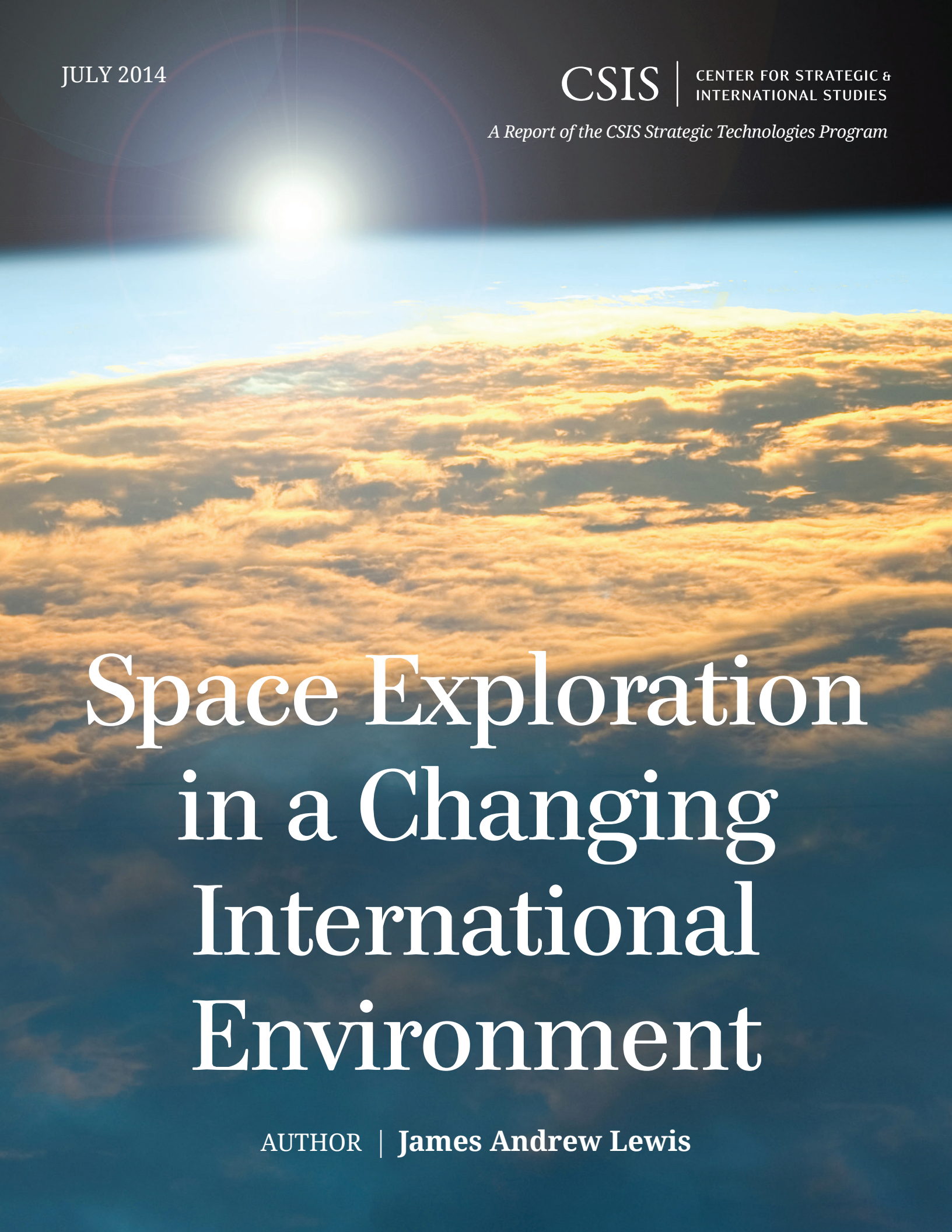

JULY 2014

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

A Report of the CSIS Strategic Technologies Program

Space Exploration in a Changing International Environment

AUTHOR | **James Andrew Lewis**

Space Exploration in a Changing International Environment

AUTHOR
James Andrew Lewis

A Report of the CSIS Strategic Technologies Program

July 2014

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

ROWMAN & LITTLEFIELD
Lanham • Boulder • New York • Toronto • Plymouth, UK

About CSIS

For over 50 years, the Center for Strategic and International Studies (CSIS) has worked to develop solutions to the world's greatest policy challenges. Today, CSIS scholars are providing strategic insights and bipartisan policy solutions to help decisionmakers chart a course toward a better world.

CSIS is a nonprofit organization headquartered in Washington, D.C. The Center's 220 full-time staff and large network of affiliated scholars conduct research and analysis and develop policy initiatives that look into the future and anticipate change.

Founded at the height of the Cold War by David M. Abshire and Admiral Arleigh Burke, CSIS was dedicated to finding ways to sustain American prominence and prosperity as a force for good in the world. Since 1962, CSIS has become one of the world's preeminent international institutions focused on defense and security; regional stability; and transnational challenges ranging from energy and climate to global health and economic integration.

Former U.S. senator Sam Nunn has chaired the CSIS Board of Trustees since 1999. Former deputy secretary of defense John J. Hamre became the Center's president and chief executive officer in 2000.

CSIS does not take specific policy positions; accordingly, all views expressed herein should be understood to be solely those of the author(s).

ISBN: 978-1-4422-4022-3 (pb); 978-1-4422-4023-0 (eBook)

Center for Strategic & International Studies
1616 Rhode Island Avenue, NW
Washington, DC 20036
202-887-0200 | www.csis.org

Rowman & Littlefield
4501 Forbes Boulevard
Lanham, MD 20706
301-459-3366 | www.rowman.com

Contents

Space Exploration in a Changing International Environment

James Andrew Lewis

Introduction

Nations use space activities to gain prestige and political advantage and to provide military and scientific benefits. There were two space powers in the 1950s. Now, many nations have a presence in space and many other nations plan to join them. Space is essential for business, research, and military operations.

Space exploration, however, remains an exclusive club. A handful of nations, chief among them the United States, engage in space exploration. The International Space Station (ISS) remains the only permanent manned presence in space, although its future value for exploration is limited. China plans to create its own permanent presence in space, as part of its active manned space program. India and Iran say they will develop manned space programs. Russia hopes to restore its manned exploration program and says it will build its own space station.

Nations are seeking the next step for space exploration because the current phase of space exploration is coming to an end. The decisions of the United States and its partners on the future of space exploration will determine the strategic situation in space. There are difficult issues to consider in moving ahead: the target of exploration beyond low earth orbit (LEO), the balance between manned and unmanned programs, the future of partnership and cooperation in space, and the ultimate fate of the ISS. How Western space powers answer these questions will decide both the pace and the future direction of exploration in space.

The space environment is remarkably stable, crowded but not really contested. Many nations operate satellites for communications and earth observation, and many others plan to acquire and operate such satellites. This is not competition. Rather, it is a desire by many countries to demonstrate independence, status, and technological capabilities. Nations want impendent space capabilities, particularly for geo-navigation, communications, and earth observation, but with few exceptions, they do not define this as a contest.

Those few exceptions are important, however. The United States and China are in a quiet competition for military advantage in space, avoiding direct confrontation but

planning for conflict. Russia is eager to restore its military space and space exploration capabilities to keep up with both the United States and China. India pays close attention to China's space activities and attempts to match them, and there is a nascent "space race" between it and China.

For other countries, however, "space race" is a term loaded with connotations that no longer make sense in the current strategic environment. The space race between the United States and the Soviet Union was part of a larger global contest between two different and competing political systems. The competition among nations today is different and less intense, a jockeying for prestige and influence rather than to win an ideological battle for the hearts of undecided nations. The Chinese have been careful to assert that they are not in a race, but we should not ignore the elements of competition and comparison that pervades their national thinking (and increasingly the thinking of the Russians) about space. In this competitive context, getting agreement among five leading space powers on a cooperative space effort to build and operate the ISS is an outstanding and unmatched achievement.

The international environment for space has changed significantly since the United States, Japan, Europe, and Russia agreed to build the ISS. Space exploration has become a mature governmental activity and has become in some ways "routinized." Most missions lack the drama of earlier space flight that captured public interest and political support. Routinization means that funding levels are unlikely to increase dramatically, but neither are they likely to be dramatically cut. The mature status of the space industry and technology suggests an emphasis in most countries on LEO operations. To go beyond the routine requires going beyond LEO.

For the major space powers, two major developments have reshaped the strategic environment. The most important of these developments is the growth of China's space capabilities and programs. China's emphasis in exploration is on human spaceflight, and its political leaders have great interest in spaceflight leading to a lunar landing. China has devised and consistently implemented an effective manned space program. China's neighbors and the United States watch China's assertive space program with concern.

The other significant change is the loss of U.S. manned spaceflight capabilities, leaving Western space powers dependent on Russia for access to the ISS. The United States, despite having the most advanced scientific and military space programs, has put its manned spaceflight program on hold. Human spaceflight is not a political priority for the United States, and its presence in space depends on a legacy program created by Ronald Reagan—the ISS. The United States compensates for the absence of a manned program with a commitment to send a manned flight to Mars in the indeterminate but distant future. This is not a space race with China, if only because the political interest for a "race" is lacking in the United States. Perhaps China's advances in civil space activities have not triggered any competitive impulses because China has so far merely repeated many of the U.S. successes in space from the 1970s.

In contrast to its human spaceflight program, U.S. unmanned and robotic exploration efforts have made consistent and impressive progress. Robotic exploration of Mars is the most visible of these activities. The unmanned programs of other nations are also impressive. The European Space Agency (ESA) has plans for the exploration of Mars and the moon, and its Rosetta spacecraft is maneuvering in close proximity to an asteroid. Japan's space agency, JAXA, has solar and planetary (Venus) unmanned missions in operation and is developing new exploratory missions for Mercury and asteroids. China and India have launched unmanned lunar exploration missions, and India (cooperating with the National Aeronautics and Space Administration, or NASA) recently launched a Mars observation satellite. These missions often entail a high level of cooperation and provide real scientific benefit for a relatively small share of space budgets. Their political and strategic value, however, is limited.

While U.S. investment in unmanned and military space activities remains high, American political leaders have lost interest in civil space activities because the political motives and drama that came from global competition with the Soviet Union are currently lacking. American political leaders do not believe they are in a space race, nor are they are interested in one. This may reflect a degree of hubris concerning American technological leadership. The assumption among political leaders may be that the United States is beyond challenge by China or other non-Western states. This indifference has implications for international partnership in space.

Another factor explaining the loss of interest lies in the long paralysis of the American manned spaceflight program. The shuttle did not provide its promised savings in launch costs and absorbed billions of dollars each year until the program's end. The ISS, though a valuable symbol of international cooperation and the centerpiece of American manned space activities, has so far shown only limited usefulness for research. Low earth orbit is not the "final frontier" and of little interest to the public, which has paid far more attention to robotic planetary exploration. To create a greater degree of public interest, spaceflight must go beyond LOE.

The reaction in the United States to the loss, the first time in more than 30 years, of the ability to put a human into space is telling. Reliance on the Russian space program did not generate any concern until the invasion of Crimea. Congress plans to increase NASA's budget by 0.48 percent in response.[1] The Obama administration's decision to reduce cooperation with Russia was made easier by the "stagnation in the U.S. space program." "There's a sense that we don't need the space relationships the way we once did," one senior administration official said, "because we don't have as much going on in space."[2]

1. Stewart Powell, "Amid Ukraine Tensions House Panel Increases Funding for NASA and Commercial Space program," *Houston Chronicle*, May 8, 2014, http://www.houstonchronicle.com/news/politics/article/Amid-Ukraine-tensions-House-panel-increases-5464481.php.

2. Kenneth Chang and Peter Baker, "NASA Breaks Most Contact with Russia," *New York Times*, April 2, 2014, http://www.nytimes.com/2014/04/03/world/europe/nasa-breaks-most-contact-with-russia.html?_r=0.

A reliance on Russia for access to space creates risk. The future of space cooperation with Russia is unclear, although the most likely outcome is that things will return to an uncomfortable status quo. Russia, like China, now has its own plans for space exploration, including a return to human spaceflight and construction of a Russian space station independent of the ISS. Whether these plans come to fruition or not, they suggest that the political understandings that underlay cooperation in the 1990s and 2000s no longer exist and that a new framework for cooperation must be developed (at least among Western partners).

U.S. plans for the human exploration of Mars are best seen as a placeholder for a serious human spaceflight effort. It is possible that improvements in propulsion technologies will make flights to Mars feasible and survivable, but these technologies are still in development. Robotic exploration provides the scientific benefits to be gained from exploring Mars at lower cost and much lower risk. While there is a vocal minority in favor of manned flights to Mars, serious political interest is lacking. A manned mission to Mars is not likely to occur for at least 10 years, if not longer.

Unlike other nations, the United States plans to increase its reliance on entrepreneurial and commercial space activities for LOE functions like supplying the space station and, eventually, providing for crew rotation. A White House statement explained that "NASA will partner with the aerospace industry in a fundamentally new way, making commercially provided services the primary mode of astronaut transportation to the International Space Station. A greatly strengthened U.S. commercial space industry competing for this critical part of NASA's mission will harness our nation's entrepreneurial energies."[3]

The emphasis on commercial and entrepreneurial space activities reflects the current American penchant to rely on the private sector to provide public services—this is true for both Republican and Democratic administrations—as it is considered more nimble, less risk averse, more innovative, and, perhaps most important, cheaper. Events in Crimea and the resultant tensions with Russia may provide a motive for accelerating both entrepreneurial and NASA manned flight programs. Subsidized entrepreneurial services would replace Russia's role in crew replacement and could perhaps lead to space tourism or some other commercial activity involving human spaceflight.

The Obama administration may hope to repeat for space exploration the success in the 1990s of shifting the Internet from a government and military responsibility to a commercial activity, but space and cyberspace are different, with space having a much higher cost of entry and greater risk. Concerned about the shift in policy, three former Apollo astronauts sent an open letter to the president saying that U.S. space policy "destines our nation to become one of second- or even third-rate stature."[4] The astronauts' complaint points to a

3. Charles Bolden and John Holdren, "Joint Statement on Launching a New Era in Space Exploration," WhiteHouse.gov, February 1, 2010, http://www.whitehouse.gov/files/documents/ostp/press_release_files/Joint%20Statement%202-2.pdf.

4. Jeffrey Kluger, "Has Obama's NASA Strategy Fizzled at Launch?," *Time*, April 16, 2010, http://content.time.com/time/health/article/0,8599,1982475,00.html.

fundamental problem for space exploration and international cooperation: whether partners can create a realistic plan to go beyond LEO and continue exploration after the ISS.

International Activity in Space

While the last decade has seen an expansion of the number of nations with space programs or operating satellites in space, there are a few distinct leaders in terms of capabilities and spending. Eight countries have active space launch programs capable of putting an object into orbit: China, France, India, Iran, Israel, Japan, Russia, and the United States. North Korea has a space launch program that is closely related to its efforts to develop ballistic missiles, and Turkey, Brazil, and South Korea are developing launch programs.[5]

Despite this action and investment, only the United States, Japan, China, and European Union have space exploration programs. The U.S. unmanned program is by far the best resourced and most advanced technologically. China's scientific programs are new, small, and largely focused on lunar exploration (China launched its first satellite "to conduct scientific experiments in space" in March 2014).[6] Japanese and European space exploration programs are technologically advanced and, after the United States, the most active. These three programs cooperate closely on many missions. Both India and Russia have plans for expanded exploration programs, including human spaceflight, that are at initial stages of development.

The number of countries with military programs is similarly limited. Although many countries have or plan to acquire earth observation satellites for security purposes, only three countries have full military space programs—the United States, China, and Russia—providing imagery, electronic intelligence, and communications services. The U.S. X-37 spacecraft, a smaller, robotic, and more advanced version of the space shuttle, has the ability to maneuver in orbit, remain in space for long periods, and return to earth, giving the United States the potential for very advanced military capabilities.[7] Europe has a bare-bones military presence in space (with strong reconnaissance capabilities). India's Defense Research and Development Organization has ambitious plans for military space, but these focus only on remote sensing and a planned constellation for navigation and timing similar to GPS or GLONASS.[8] Russia's military space capabilities fell into disrepair after 1990, and Russia has only recently begun to restore them. Iran is experimenting with some military space capabilities, but this is still at an early stage.

---

5. Doug Meisser, "U.S. Space Lead Continues to Decline Futron Space Competitiveness Index," *Parabolic Arc*, May 8, 2014, http://www.parabolicarc.com/2014/05/08/space-lead-continues-decline-futron-space-competitiveness-index/futron_2014_space_competitiveness_art/.

6. Xinhua, "China Launches Experimental Satellite," *China Daily Europe*, March 31, 2014, http://europe.chinadaily.com.cn/china/2014-03/31/content_17391838.htm.

7. Mike Wall, "US Air Force Mysterious X-37 B Space Plane Passes 500 Days in Orbit," Space.com, April 24, 2014, http://www.space.com/25611-x37b-military-space-plane-500-days.html.

8. D. S. Madhumathi, "August Launch for ISRO's First Defense Satellite," *The Hindu*, July 29, 2013, http://www.thehindu.com/news/national/august-launch-for-isros-first-defence-satellite/article4963869.ece.

Space is militarized but not weaponized. It is not a domain for combat operations. The use of space assets (together with information technologies) has transformed military operations and tactics. The United States leads in this transformation, but China is investing steadily in an effort to catch up. Future military missions will require an ability to integrate space assets and services into terrestrial operations. Space-based sensors and communications will provide surveillance, intelligence, and reconnaissance in real time over areas of interest for extended periods regardless of weather conditions. Precision navigation and timing satellites will reduce uncertainty in commanders' decisions and allow for greater precision in weapons use. However, space forces, as they are now, are not a source of fire and cannot destroy an opposing force or engage in combat.

The only likely military contest in space is between the United States and China. It is not, however, likely to involve space-based weapons (although given the covert nature of these programs, this cannot be ruled out). Both nations have terrestrial-based anti-satellite weapons, and Chinese doctrine calls for attacks on U.S. space assets. Both countries probably have planned to use cyber techniques against the other's space assets. As the People's Liberation Army (PLA) dependence on space services increases, U.S. planning for temporary, nonkinetic interference with Chinese military space assets will also increase. Even so, warfare in space is unlikely absent armed conflict between the United States and China.

Calling space a domain complicates any discussion of competition and cooperation. The term *domain* has several meanings, including the application of national sovereignty and as an area for military operations. The Department of Defense (DOD) uses the term *domain* (sometimes interchangeably with *environment*) as a way to organize planning and training efforts among the armed services.[9] DOD operates within the space domain, but it is impossible under existing international law and treaties to lay territorial claim to space. China has not extended territorial claims into space, but it clearly thinks of space as a crucial area of military operations and political action. Its military modernization and assertive foreign policy drives tensions in space.

While it would be helpful to reach international agreement on a "code of conduct" for space activities, we should not expect a code by itself to eliminate military risk. The primary problem is verification. China repeatedly denied that it had anti-satellite weapons (ASAT) programs before its 2007 test, so an agreement on rules without verification of compliance is only a first step of limited value. The development of confidence-building measures among space powers would also be useful, but China has been reluctant to discuss its military space intentions. Given the increasing level of maritime tensions and the lack of serious discussion of space security issues at a bilateral or multilateral level, continued military tensions form the backdrop for cooperation in space exploration.

9. The space domain is "exo-atmospheric," encompassing the earth's "ionosphere and magnetosphere, interplanetary space and the solar atmosphere." U.S. Department of Defense, *Department of Defense Dictionary of Military and Associated Terms* (Washington, DC: Department of Defense, March 2014), p. 243, http://www.dtic.mil/doctrine/new_pubs/jp1_02.pdf.

China's Space Activities

China's interest and investment in space goes back to the late 1950s, when its space launch and ballistic missile programs began as closely related efforts. Chinese planning for manned spaceflight began as early as the 1960s, and plans for a space station were announced by China in the late 1970s. China may have intended its 1970s Fǎnhuí Shì Wèixīng (FSW) recoverable satellite program to be the start of a manned program, and there was even some preliminary planning for a Chinese space shuttle. Planning for the current manned program began in the early 1990s. China has said that it will concentrate resources on "a limited number of projects" that are of "vital significance" to the nation. The goal of China's space efforts is a demonstration of technological prowess and national power.[10]

Manned spaceflight demonstrates to China's neighbors the seriousness of China's claim to regional leadership and makes the point that under the party's leadership, China has arrived as a world leader. The manned space capsule Shenzhou 6 carried seeds from Taiwan in a symbolic assertion of China's sovereignty over the island. China sees its space programs as a strategic activity to gain political and military advantage, but the primary purpose of China's manned space program is political. For China, it is especially important to show that it has reclaimed its place among the leading nations of the world. China's successes in space reinforce its claims to regional dominance by demonstrating that it is the most advanced among Asian nations, with technology and resources that others cannot match. The manned space program also serves an important domestic political purpose by enhancing the legitimacy of the Communist Party.

China's leaders need and use manned spaceflight in a way that other nations do not, to reinforce the political legitimacy of the party and show the Chinese people the progress the party is making in restoring China's global position. This ensures that China's space program has greater political support by national leaders than is the case in other countries. President Xi's attention to and support of the Chinese manned program is unlikely to diminish because it forms a useful counternarrative for the image of the party, which has been injured by widespread corruption and public policy failures in environment, urban planning, and transportation.

Space activities also support China's long-term economic goals and military strategies. China's intentions are to catch up with and surpass the West. The development of space capabilities that provide military benefit is a central part of this. The PLA is continuing to develop military doctrine that combines conventional capabilities with missiles and cyberattack, supported by military space services that include the use of satellites and antisatellite weapons, to defeat opponents in any possible air or naval battle. As the Chinese military continues to modernize at a rapid pace, China has increased its investment in reconnaissance, communications, and navigation satellites for military purposes. China's

10. James A. Lewis, "Surmounting the Peak: China's Space Program" (paper presented at the American Astronautical Society National Conference and 52nd Annual Meeting, League City, TX, November 2005).

military space activities seek to provide space services to its conventional forces that give it advantage in battle, deny space to potential opponents, and incorporate space into larger information operations.[11]

Chinese military strategists see the ability to use space as a central element of modern warfare. Space operations are an integral component of PLA military planning, both for China's own military purposes and to prevent adversaries from using space. China's defense industry prioritizes the development of missile and space systems, and China's space launch vehicle industry is expanding to support the manned space program's goal of a lunar landing. China is developing the heavy-lift Long March 5 rocket, which will more than double the weight of satellites China can put in both low earth orbit and geosynchronous orbit, with the first launch scheduled for this year.[12]

China has used foreign partnerships to speed its indigenous space effort by participating in and learning from the experience of other programs, but we should not underestimate the strength of its indigenous efforts. In 2013, China conducted 15 space launches, slightly less than the number of launches in 2012, putting China well on its way toward its announced goal of having 100 satellites in orbit by the end of 2015. These will include remote sensing, weather navigation, research, and communications satellites in addition to manned spacecraft. China also has active space denial programs (including kinetic, directed energy, and cyber attacks) to interfere with the space activities of its potential opponents during conflict.[13]

As part of its broad program of military modernization, China has deployed a satellite navigation system (called Beidou, or Compass) for its armed forces. Since the United States and its Pacific allies are among China's most likely opponents in any armed clash, the Chinese want to end dependence on GPS. China completed its Beidou navigation system with the launch of six satellites in 2012. China launched 11 "dual-use" remote sensing satellites the same year, part of a long-term effort to build a military satellite fleet. China's military space activities used to be "demonstrator" projects rather than sustainable capabilities (judging by on-orbit presence, which in the past was discontinuous), but this is no longer the case. Judging from the number and capabilities of Chinese satellites, Chinese military capabilities in navigation, communications, and anti-satellite warfare are adequate, while capabilities for reconnaissance and signals intelligence are moderate but improving.[14]

---

11. *Office of the Secretary of Defense, "Annual Report to Congress: Military and Security Developments Involving the People's Republic of China, 2013,"* http://www.defense.gov/pubs/2013_china_report_final.pdf; Zhao Lei, "Xi Calls for Joining Space and Air Roles," *China Daily,* April 15, 2014, http://www.chinadaily.com.cn/china/2014-04/15/content_17433504.htm.

12. People's Liberation Army, *The Diversified Employment of China's Armed Forces*, white paper, April 16, 2014, http://news.xinhuanet.com/english/china/2013-04/16/c_132312681_2.htm.

13. Ed Kyle, "2013 Space Launch Report," SpaceLaunchReport.com, December 30, 2013, http://www.spacelaunchreport.com/log2013.html.

14. James A. Lewis, "China as a Military Space Competitor," in *Perspectives on Space Security*, ed. John M. Logsdon and Audrey M. Schaffer (Washington, DC: Space Policy Institute, George Washington University, December 2005), http://www.gwu.edu/~spi/assets/docs/PERSPECTIVES_ON_SPACE_SECURITY.pdf.

The benefits to military capabilities from China's space program are cumulative as China increases the number and capabilities of its satellites, but the political benefits from the manned program are immediate and considered necessary by the party leadership. China will seek expanded cooperation with other space powers to accelerate improvements to its technological base, but its indigenous capabilities are maturing and have reached a level at least equal to the United States or Russia in the 1970s. China downplays any hint of a race in space, but in its domestic press, there is careful comparison of Chinese accomplishments to that of other nations.[15]

China is eager to use space cooperation as a diplomatic tool (at least with developing countries) and as a way to accelerate its own space program. China is interested in cooperation with other space powers, but its relations (at least with its neighbors) are tense. The possibility of armed conflict with China eliminates any opportunity for cooperation between China and the United States, Japan, or India in the near term. This suggests that any expansion of cooperation with China beyond current levels will be very limited. Cooperation with China makes sense only as part of some larger and reciprocal political initiative.

One question that comes up repeatedly is if the United States could cooperate with the Russians at the height of the Cold War, why can it not now cooperate with China. This analogy is historically inaccurate. The height of the Cold War was the 1950s and 1960s. Cooperation in space became possible only after the onset of détente with the Soviet Union in the early 1970s (and after the United States had "won" the race to the moon). There has been no détente with China, and some American analysts believe that bilateral relations are worsening. Cooperation with the United States depends on the larger political situation and could face strong resistance from the Department of Defense and from members of Congress. Concerns about technology transfers and espionage are obstacles to cooperation between the United States and China, and Congress has gone out of its way to block liberalization of U.S. space exports to China. India, Russia, and Japan are also unlikely to see expanded cooperation because of the state of their relationships with China.

India's Space Activities

Like China, India uses its space program to make a global statement about itself as a major power. India's space program is also driven in part by competition with China, and if there is a space race in Asia, it is between India and China (China is winning). Indian space activities (or announced activities) track closely with and often follow China's plans and announcements. The Indian Space Research Organization (ISRO) has ambitious plans and good technical capabilities but is hampered by a lack of resources. ISRO's budget has increased to $1.3 billion.[16] Although it is very difficult to estimate China's actual spending on space, the budget for its national space agency is roughly the same (noting that additional

15. Xinhua, "Commentary: China Confident in Space Exploration," *People's Daily*, June 13, 2013, http://english.people.com.cn/202936/8283914.html.

16. Department of Space for the Government of India, *Outcome Budget for the Department of Space Government of India 2013–2014*, ISRO.org, http://www.isro.org/pdf/Outcome%20budget2013-14.pdf.

funding is available from military sources and from research investment programs like Project 863). India's programs are famously frugal; the current Mars project, for example, is reported to have cost only $73 million. The lunar mission, Chandrayaan-1, cost about $90 million. ISRO's ability to perform complex missions at low cost is enviable, but this can lead to limitation on payload and instrumentation.

India has launched satellites to explore both the moon (in 2008) and Mars (in late 2013). Plans for a second lunar probe, with a lunar lander built by Russia, were delayed by problems with the Russian manufacturer, and delivery has been rescheduled for 2017. In the interim, ISRO would like to build its own Lander if it can secure funding from the Indian government. India also has planned for a manned spaceflight program, with the first launch tentatively intended for the 2020s, if funding becomes available.

Indian motives are similar to China's except in one key aspect. Like China, ISRO's programs demonstrate national pride and independence, improve India's technological base and military capabilities, and assert regional status. Unlike China, however, the domestic political role of the program is much smaller, and India's democracy allows domestic critics to question the expenditure of funds for space when there is so much need on the ground. These criticisms, however, have little weight given the degree of competition with China.

India has cooperative programs for space with all the major space powers, including the United States. NASA is providing space navigation and tracking services for India's Mars mission. India held talks this year with Russia on expanded space cooperation. Previous cooperative efforts with Russia focused on the use of GLONASS and Russian contribution of a Lander for a follow-on lunar mission. Space cooperation with Japan dates back to the 1960s, and cooperation with the ESA began in the 1980s; the first lunar mission carried ESA instruments in its payload. India may not want its "flagship" space initiatives to be subsumed in a larger international project, but other joint projects will be attractive to it. India's desire to demonstrate its independent capabilities may limit opportunities for cooperation, but these face even greater limitations due to resource constraints.

Europe in Space: Capabilities and Ambitions

Europe will take a status quo approach to space, with a continued emphasis on unmanned space exploration missions for scientific purposes. Both ESA and the Europe Commission's (EC) Directorate for Enterprise and Industry develop European space policy. The EC's space policy, developed in coordination with ESA, has economic and political goals. Like other EC policy documents on innovation and technology, it calls for an approach that will allow the European Union to "take the global lead" in "selected strategic policy areas" and provide Europe the basis for or leadership in international discussions of space.

European strategic goals for space revolve around navigation, remote sensing, and scientific activities. Navigation, under the Galileo program, has commercial and security

goals. Remote sensing has both environmental and security goals. Europe sees space as a strategic activity that is essential to ensure European global leadership (in addition to commercial and scientific benefits). Europe pursues cooperation in space as a goal in itself, part of building the larger European enterprise and extending Europe's international influence.

ESA has a number of political and social goals—to show European independence in space, create another pan-European institution, sustain a space industrial base, and inspire European youth to enter scientific or engineering careers.[17] The emphasis on terrestrial, commercial, and social applications suggests not so much a "soft power" approach to strategy but the absence of a strategy that links space activities to specific political or security goals. European public opinion may explain some of this lack of interest. A survey of public opinion in 27 European countries conducted by the commission found, unsurprisingly, that more Europeans were more concerned with employment and health care as priorities than with space. Europeans saw space activities as important for their contribution to energy and environmental monitoring and for the potential to contribute to medical research.

Military and civil space programs in Europe are bifurcated between national and European institutions, but there are high levels of cooperation among these national programs. Military activities in space are conducted at the member-state (e.g., national) level, given the limitations placed on EU defense efforts by EU member states. The most advanced programs are in France, Germany, and the United Kingdom, with an emphasis on reconnaissance and communications, but Spain and Italy also have military programs. The UK Space Agency and its French counterpart, the Centre National d'Etudes Spatiales, will collaborate in earth observation and telecommunications satellites as well as other space activities. France cooperates with Germany, Spain, and Italy, and its desire to find ways to share the burden of independent space capabilities is the driver for much of the bilateral cooperation in Europe on security space programs.

European attitudes on cooperation with China are shaped by Europe's desire for access to the China market and the remote likelihood of military conflict. For the first time in 500 years, no European state has a presence in Asia. The PLA poses no threat to Europe. This had made some European nations indifferent to Asian security issues, while other have reassessed the relative important of trade and security in guiding their relations with China and have given greater emphasis to economic aspects.

The Galileo navigation satellite program shows some of the tensions in European policies toward China. Foreign participation provides some funding for the program, and the program has a number of foreign partners, including China.[18] However, China's

17. For example, see http://www.esa.int/Our_Activities/Operations/A_light-speed_voyage_to_the_distant_future.

18. European Union, "Galileo: Loyola de Palacio Welcomes the Green Light for an EU-China Agreement," press release, October 27, 2003, http://www.eurunion.org/news/press/2003/2003065.htm; BBC, "China Joins EU Satellite Network," http://news.bbc.co.uk/2/hi/business/3121682.stm; European Commission, Directorate

participation was particularly troubling for the United States. China was able to glean useful technology and programmatic skills from its partnership with Galileo, and European component manufacturers supply some key elements of Beidou, including precise atomic clocks otherwise unavailable to China and essential for navigation satellites. Senior Chinese military officers have said Beidou is more important to China than manned space flight or the Chinese lunar probes now under way, according to reports in the state-run media. While China would have been able to deploy Beidou without European assistance, it would have taken longer and been less precise.[19]

ESA also says it has no intention of limiting cooperation with Russia in space as a result of the occupation of Crimea. Russian occupation of Crimea is the most important challenge to European security in more than two decades, so this is a strange disconnect from larger strategic issues that confront Europe. This decision has several implications for understanding the attitudes of European political leaders to space activities (and to Russia) and suggests that at some level, European leaders do not see space activities as central to their strategic interests.

Russia's Uncertain Return to Space

Russia's space program has been in decline for years, but President Putin has announced plans to restore it to its former glory. President Putin has pledged a renewed space effort, and if he decides to make space a focus for reasons of national prestige, we could see a rapid return to a very strong Russian space program.

In line with Putin's efforts to reinvigorate Russia, the Russian space agency Roscomos has announced a new exploratory effort. Russia at first said it would invest $1 billion annually in manned spaceflight and consider extending the operational life of the ISS. Russia's deputy prime minister promised, in response to U.S. sanctions over Russia's annexation of Crimea, to consider a joint space program with China after Russia ends its participation in the ISS in 2020. As a first step, Russia has established a working group for cooperative space projects with China.[20]

Russia's latest draft space strategy, if leaked copies are accurate, calls for Russia to colonize the moon by 2030, with the project itself beginning in 2014. The three-stage program would first conduct tests at the lunar polar regions, have cosmonauts land on the moon, and, in the final stage, construct a lunar base. Russia says that the base on the moon

---

General for Energy and Transportation, "Galileo: European Satellite Navigation System: Public Regulated Services," http://europa.eu.int/comm/dgs/energy_transport/galileo/programme/service_prs_en.htm.

19. David Lague, "Special Report: In Satellite Tech Race, China Hitched a Ride from Europe," Reuters, December 22, 2013, http://news.yahoo.com/special-report-satellite-tech-race-china-hitched-ride-195616719.html.

20. "Russia, China Agree to Create Working Group for Space Cooperation Projects," Itar-Tass.com, May 17, 2013, http://en.itar-tass.com/russia/731997; Staff Reporter, "Russia May Launch Joint Space Program with China: RIA Novosti," *Want China Times*, May 29, 2014, http://www.wantchinatimes.com/news-subclass-cnt.aspx?id=20140529000067&cid=1101; Charlotte Mathieu, "Assessing Russia's Space Cooperation with China and India," *ESPI Reports*, Issue 12, June 2008, http://www.isn.ethz.ch/Digital-Library/Publications/Detail/?id=124767&lng=en.

by 2030 will serve as a starting point for manned flights to Mars. The cost of the project is estimated to be roughly $5 billion, affordable for Russia but possibly an underestimate. Russia hopes to attract private investors to the project.[21]

How much progress Russia can make in restoring its space capabilities remains to be seen. The Russian economy is dependent on oil exports, and changes in oil prices will affect its ability to direct resources to space. In the past, even when Moscow allocated resources to space, corruption was a problem that led to program delays or failures.[22] Russia has also had problems with its Proton Launch vehicle, with six failures (out of 35 launches) since 2010, leading President Putin to restructure Roscosmos. Putin has promised that Roscosmos will receive roughly 2 trillion rubles between 2013 and 2020 (or about $8 billion a year).[23]

These promises and the announcement of greater cooperation with China reflect Russian unhappiness with the U.S. reaction to Crimea. The new focus of the Russian space program is prestige and national pride. Russia will prefer to cooperate only with those nations like India with whom it has (or can assert) a client relationship.[24] In the past, Russia was unwilling to develop serious cooperative efforts with China because of concerns over technology transfer and an implicit competition between the two nations.[25] It is unclear whether the new initiatives designed to respond to a common opponent will fare batter. The issue would then be whether it makes sense to continue the cooperation created in happier times, when Russia was not so confrontational in its relations with Europe and the United States.

The Future of Space Exploration and the Role of the ISS

Since 1958, NASA's budget has averaged a little more than $15 billion (this does not count military space expenditures by the United States).[26] The Apollo years saw this figure almost

---

21. Mark Brown, "Russians Plan Moonbase, Mars Network by 2030," *Wired*, March 14, 2012, http://www.wired.com/2012/03/russia-moonbase-mars/; "Russia Will Begin Moon Colonization in 2030—Draft Space," RT.com, May 9, 2014, http://rt.com/news/157800-russia-moon-colonization-plan/.

22. Sergei Guriev, "Corruption Has Laid Waste to the Russian Economy," *Financial Times*, April 2, 2014, http://www.ft.com/cms/s/0/939659ae-b67d-11e3-b230-00144feabdc0.html#axzz338iJa7Em.

23. Peter de Selding, "Russia Boosting Space Budget to Surpass China, Equal Europe," *Space News*, June 5, 2013, http://www.spacenews.com/article/civil-space/35638russia-boosting-space-budget-to-surpass-china-equal-europe.

24. Corey Flintoff, "For Russia's Troubled Space Program Mishaps Mount," NPR.org, March 12, 2012, http://www.npr.org/2012/03/12/148247197/for-russias-troubled-space-program-mishaps-mount; Jessica Golloher, "Russian Space Program Woes Continue," DW.de, February 27, 2012, http://www.dw.de/russian-space-program-woes-continue/a-15770720/.

25. "Vladimir Putin Pivots Eastward: Should America Be Worried?" *The Economist*, May 24, 2014, http://www.economist.com/news/leaders/21602695-vladimir-putin-pivots-eastward-should-america-be-worried-best-frenemies?zid=307&ah=5e80419d1bc9821ebe173f4f0f060a07.

26. Office of Management and Budget, "Historical Tables," http://www.whitehouse.gov/omb/budget/Historicals/; NASA, "Budget Information," http://www.nasa.gov/audience/formedia/features/MP_Budget_Previous.html; Simon Rogers, "Nasa Budgets: US Spending on Space Travel since 1958," *The Guardian*, February 1, 2010,

double; the amount fell by a third in the 1970s but has remained steady (in constant 2012 dollars) since the mid-1980s. NASA's problem is not lack of money but a lack of strategic direction from America's political leadership. Lacking the strategic motives present in the Cold War contest with the Soviet Union, there is much less political interest in space exploration.

The idea of colonizing another planet has considerable appeal. There are several problems, however. First, with current propulsion technologies, a flight to Mars could take months, and it is likely that the crew would not arrive in a condition to mount exploratory or colonization efforts. The long flight has implications for any follow-on support missions. Second, the Mars environment is unwelcoming and would require greater support than the lunar landings of the 1960s and 1970s, adding weight, cost, and risk to the mission. The overall cost of even a small mission to Mars is considerable. Cost and technology combine to put any realistic Mars mission decades into the future.

Lunar exploration is attractive for a number of reasons. Lunar exploration (both manned and unmanned) is feasible now with current technology, and it is probable that there will be a human return to the moon within a decade by some country, most likely by China. U.S. space partners can participate in lunar exploration given the lower cost and technology threshold for investigation when compared with Mars. Lunar exploration could become a new focal point for cooperation in space. A coordinated program of robotic exploration by space partners could lay the foundation for a return and human presence.

The nearness of the moon (compared with Mars) makes support for an exploratory mission more feasible and reduces risk to the crew, both for the journey and if rescue is necessary. Overall, the cost of lunar exploration is a fraction of a serious Mars effort. The cost of a return to the moon is much less than a flight to Mars, and if earlier estimates are correct, building a permanent presence would be less than the cost of building the ISS and would have comparable operating costs.[27] The availability of material for construction on the lunar surface (including possibly water) would also make the creation of a permanent presence less expensive. Lunar exploration also provides tangible political benefits, given its visibility from earth and the possibility for immediate action (as opposed to a Mars flight decades in the future) and could serve as a launch pad for future exploratory missions, including to Mars.

Mars and the moon each have advantages and disadvantages as targets for manned space exploration. Responding to criticism of his administration's plans for space exploration, President Obama dismissed a return to the moon, saying "we've been there

---

http://www.theguardian.com/news/datablog/2010/feb/01/nasa-budgets-us-spending-space-travel; "NASA's Share of Total Federal Government Expenditures since 1958," richardb.us, May 30, 2014, http://www.richardb.us/nasa.html#graph; "NASA Budget History," penny4nasa.org, May 30, 2014, http://www.penny4nasa.org/wp-content/uploads/2012/07/NASABudgetGraph.png.

27. Vincent Sabathier, Johannes Weppler, and Ashley Bander, "Costs of an International Lunar Base," *CSIS Commentary*, September 24, 2009, http://csis.org/publication/costs-international-lunar-base.

before."[28] This rejection of a lunar program may undervalue the strategic implications of China being the only nation with a presence on the moon and overlooks the practical consideration that the moon is much easier to reach with both manned and unmanned missions on its surface with current technology.

The focus on manned flight to Mars rather than the moon brings into question the ability of the United States to create effective exploration strategies. A return to the moon is technologically feasible; flight to Mars is not. However, NASA's deputy associate administrator for the Human Exploration and Operations Mission said in February 2014 that "as NASA pursues an ambitious plan for humans to explore an asteroid and Mars, U.S. industry will create opportunities for NASA to advance new technologies on the moon. NASA will support, but not fund, lunar exploration." Given private sector reluctance to invest in high-risk operations that do not guarantee a financial return, the United States may be ceding lunar exploration to China's manned program.[29]

The unpredictable factor is whether U.S. attitudes will change as China's space accomplishments increase at the same time that tensions with China are also increasing. A Chinese colony on the moon, although years distant, could provoke unease among American leaders that could lead to increased attention to space (it is unlikely to provoke significant unease among European leaders). Technological breakthroughs that make it easier to attain orbit would also change U.S. activities in space, and these might come from entrepreneurial space companies or the military space activities as much as NASA. Absent a change in the political perception of China's space program or in the technology used to gain orbit, U.S. interest in space exploration will involve near-term efforts to replace the reliance on Russia for space station crew rotation and a low-level, long-term effort to develop the ability to stage the manned exploration of Mars.

Absent some other goal, international space cooperation depends on the ISS. The space station remains the single most visible mechanism for cooperation among Western space powers and the only mechanism for cooperation in manned space flight, but its expense and support difficulties suggest that space partners need a new goal to revitalize cooperation. Even if the return on investment for ISS research is low, there are still political commitments and rationales for ISS spending.

Research on the ISS faces both high fixed costs and high marginal costs compared with other research platforms. The primary research purpose of the space station is to identify and solve the problems of long-duration space flight. NASA sees the ISS as an "invaluable technology test bed for a range of potential solutions to the challenges of human space exploration" and estimates that "Station-based research will be necessary to mitigate 21

28. Barack Obama, "Remarks by the President on Space Exploration in the 21st Century" (speech given at John F. Kennedy Space Center, Merrit Island Florida, April 15, 2010), http://www.whitehouse.gov/the-press-office/remarks-president-space-exploration-21st-century.

29. David Milward, "U.S. Ready to Return to the Moon," *Telegraph*, February 3, 2014, http://www.telegraph.co.uk/news/worldnews/northamerica/usa/10614953/US-ready-to-return-to-moon.html.

of the 32 most significant human health risks identified as barriers to long-duration exploration missions."[30]

NASA spends an average of 35 hours per week on scientific investigations. In 2008, NASA performed 62 investigations. Since then, the annual number of investigations has been over 100, but more than half of these have focused on problems for long-duration manned flight. NASA's research agenda for the ISS was predicated on the continued operation of the shuttle, with its ability to deliver heavy cargo loads. Its demise means that there currently are delays and limits on the ability to conduct research on the ISS.[31]

A former ISS director at NASA believes that the next step is low earth activities by private-sector actors, saying, "I hope that we are able in the next decade to turn over the low Earth orbit environment for development by the private sector." NASA administrator Bolden says that NASA should encourage private industry, "not nations," to invest in and build "the second-, third- [and] fourth-generation space station."[32] Bolden has said that the ISS is not an ideal environment for some types of experiments and expects commercially owned space stations to provide space research facilities. But NASA's inspector general wrote in July 2013 that it is difficult to attract private funding for research and that this poses "significant challenges to NASA's efforts of maximizing the Station's research potential." Private research entities want "a substantial infusion of government funds" and will choose cheaper terrestrial research options.[33]

The ISS is the greatest symbol of cooperation in space. Science adviser John Holdren said this year that that the ISS remains "the pinnacle of international cooperation in space to date—until at least 2020."[34] The implications for the space station are that NASA will continue to operate it for the rest of its operational life and perhaps longer, if this does not entail a considerable increase in expense. The political and experiential benefits of the space station are great even if the research benefits are limited, given current spending levels. NASA and the United States will expect the ISS partners to similarly maintain their current levels of support and activity, at least until we are much closer to the planned retirement date.

The dilemma is that the essential commitment to the ISS puts at risk the development of new exploratory programs by locking in resources. There would be strategic benefit to revitalizing space exploration and going beyond LEO. Balancing the requirement to maintain the ISS with the need for new exploration activities will be a difficult challenge for

30. John Holdren, "Prepared Remarks" (presented at the International Space Exploration Forum Session I: National Policies and Public Support for Space Exploration, Washington, DC, January 9, 2014), http://www.whitehouse.gov/sites/default/files/microsites/ostp/isef__jph_isef_remarks-_1_8_14_as_prepared.pdf.

31. NASA Office of the Inspector General, "NASAs Efforts to Maximize Research on the International Space Station," July 8, 2013, http://oig.nasa.gov/audits/reports/FY13/IG-13-019.pdf.

32. Amy Svitak, "Budget Pressures Prompt ISS Partners to Justify Costs," *Aviation Week*, May 21, 2012, http://aviationweek.com/awin/budget-pressures-prompt-iss-partners-justify-costs.

33. NASA Office of the Inspector General, "NASAs Efforts to Maximize Research on the International Space Station."

34. Holdren, "Prepared Remarks."

nations both individually and in multinational cooperation. In civil space, progress will require a redefinition of the goals of exploration in a way that captures both the public imagination and political support.

Reenergizing multinational cooperation in space exploration requires identifying and agreeing on an achievable near-term goal for activities beyond LOE. The alternative would be to move entirely to unmanned exploration, but the political effects of such a decision, given China's forceful plans, are uncertain and risky. The example of the space shuttle, where no consistent or sustained effort was made to replace it, shows that we cannot wait to begin such planning or we will end up with no viable replacement for the ISS and no serious effort at manned exploration. The only options for manned exploration are placing a new space station further out in space or returning to the moon and, perhaps, establishing a permanent presence. Both are expensive undertakings but do not pose the insurmountable technological challenges of human flight to Mars. If the United States continues to insist that a flight to Mars is the only option for manned exploration, which will likely remain its policy until at least 2017, planning for cooperation will need to focus on the transition to an attainable option for a manned presence in space, including either replacing or extending the service life of the ISS.

Expanded space cooperation among Western partners can focus in two areas to generate public interest and political support: earth science and unmanned planetary or deep space exploration. These are the topics that have both scientific value and public interest, which can generate political support for space programs. Collaboration among the United States, Japan, and Europe has been important in robotic exploratory efforts and could be expanded in developing new exploratory programs. This will require national space agencies and their political overseers to develop positions on a number of fundamental issues that face space exploration. It is also worth reexamining the decision to move the focus of exploration away from the moon. Its proximity makes it an attractive target for unmanned research and exploration.

The Strategic Challenge in International Space Exploration

Space programs serve a strategic national purpose by demonstrating resolve, capability, and power, but in Western nations they have lost much of their luster and their strategic purpose in the last few decades. Space programs can be reconnected to strategy only if political leaders choose to do so. A new framework for cooperation in space exploration requires assessing the degree of interest and support from political leadership. There are two probable outcomes: Political leaders could decide that space exploration is of serious strategic concern and put more emphasis, attention, and resources into new and existing projects. Without action, the most likely outcome is a slowly degrading status quo, with political leaders maintaining a custodial relationship to space, where program levels are kept relatively stable but no new initiatives are undertaken.

Regaining strategic advantage from space exploration depends on whether partners can identify and agree on a viable goal for exploration beyond the space station. These are questions of higher and lower priorities for programs and resources. For the long term, as the space station approaches the end of its operational life, as Chinese space activities increase, and as political support erodes for space exploration as it is currently conducted, national agencies and their partners will need to define a new approach to space exploration. The following actions would help address challenges and opportunities in space:

Develop a transition plan for the ISS and activities beyond LEO. There is currently no replacement for the ISS as a vehicle for a manned presence in space and for international cooperation. Space exploration plans should assume continued operation of the space station until the end of the decade, if not longer. But a placeholder based on maintaining the ISS will not regenerate enthusiasm or provide balance for China's energetic space program. The ISS currently serves as a test bed for long-duration space flight. A new phase of planning should also make it a springboard for exploration beyond LOE. We do not want to repeat the shuttle experience of knowing that a system is reaching the end of its operational life without building its replacement.

Reconsider lunar exploration. Attitudes toward the moon among some in the space community often seem to reflect a "been there, done that" approach, that it is not worth replicating the successes of the 1970s. This may undervalue the strategic implications of China being the only nation with a presence on the moon and overlooks the practical consideration that the moon is much easier to reach with current technology. While the ultimate goal of lunar exploration should be a human return, the effort can begin with robotic vehicles, leading to a permanent presence. No other space activity will have the same strategic effect. Greater attention to the moon opens the possibly of manned lunar missions, which do not face the technical difficulties of flight to Mars.

Make Mars the ultimate, not the next, goal. Each generation of space exploration has had a focal point—attaining orbit, reaching the moon, building the ISS. It is time for a new goal, but it must be like the others—something within reach. A new strategy would link the ISS, a lunar return, and Mars exploration into a single, multiyear strategy. This three-phase strategy might be more attractive to the United States, whose space policy commits it to a return to Mars. A multiyear strategy would reduce the political problems created by the long interval between the end of the shuttle and the ability to send a mission to Mars. Both the ISS and lunar exploration can make important contributions to resolving the major problems a flight to Mars would engender.

Mobile robots on Mars provide immense amounts of scientific data, and the rovers Spirit and Opportunity operated for years after their missions were expected to end. A new, larger vehicle, Curiosity, is expanding research activities. There is an opportunity in the next few years as the orbits of Mars and earth reach perigee to use new propulsion systems (if available) to accelerate Mars exploration, but given costs and difficulties, Mars should not be the only next step for space exploration. Successful research into new modes

of propulsion could help to revitalize space exploration whether they are undertaken as part of a larger Mars effort or independently.

Emphasize robotic exploration in the near term. The strategic challenge for space exploration is getting beyond LEO in the next few years by the end of the ISS. Human spaceflight has the greatest political effect, but it will take time to reenergize it. No Western nation has the ability to put humans into space at the moment. While the need to develop an independent capacity to crew the space station will likely lead to a restoration of LEO capabilities, this answers neither the political nor the strategic challenges Western nations face in space. Robotic exploration (which has provided much greater scientific benefit than manned programs and, in the case of some missions, has generated considerable public attention) provides a gap filler that allows for visible space activities that provide political benefits and can build the knowledge base needed for later human exploration.

Strengthen cooperative space programs. Recalculating the balance between national efforts and cooperative programs is essential for progress in spaceflight but depends on whether partners can identify and agree on a viable goal for exploration beyond the space station. Space agencies need to consider how current cooperative efforts in exploration can support a more ambitious agenda for space exploration beyond the ISS. This highlights the value of the space station as a mechanism for building international cooperation for new exploratory and research endeavors. The space station remains the single best mechanism for cooperation and the only mechanism for cooperation in manned space flight, but its expense and support difficulties for research suggest that space partners need a new goal to revitalize cooperation.

End the dependence on Russia. An assessment of Russia's space program is necessary to judge the future of cooperation in space. Russia says it will invest $1 billion annually in manned spaceflight and will consider extending the operational life of the ISS. The strategic issue is whether it makes sense to continue the cooperation created in happier times, when Russia was not so confrontational in its relations with Europe and the United States. Russia's deputy prime minister recently demonstrated the awkwardness of reliance on Russia, when he suggested that if the United States was going to object to Russian activities in Crimea, it should use trampolines to get crew to the station.[35] Even if Russia was still cooperative, a review of the Soyuz capsule's performance suggests a steady decline in Russian capabilities that Putin's renewed space effort may or may not reverse. Absent political change, Russia will not be a reliable partner.[36]

Build confidence and restraint with China. China cannot be isolated, but neither should it be rewarded until its behavior changes. Ultimately, the best outcome for China (and for Russia) would be a situation where some cooperation was possible despite political

35. Alan Boyle, "Trampoline to Space? Russian Official Tells NASA to Take a Flying Leap," NBC News, April 29, 2014, http://www.nbcnews.com/storyline/ukraine-crisis/trampoline-space-russian-official-tells-nasa-take-flying-leap-n92616.

36. Flintoff, "For Russia's Troubled Space Program Mishaps Mount"; Golloher, "Russian Space Program Woes Continue."

differences, but this may be years in the future. The development of confidence-building measures among space powers would be useful as a means to manage uncertainty about space activities, but China has been reluctant to discuss its military space intentions. Changing this will be useful, and while cooperation will be difficult, greater transparency among space programs should not face the same obstacles.

The strategic challenge for space exploration lies in expanding activities beyond LEO before the end of the operational life of the ISS. The demise of the space shuttle shows the risks of a static approach to space exploration. The opportunity exists to build on a strong base of robotic exploration by many nations, but these efforts should be seen only as foundational, as a starting point for new space exploration strategies. Unlike earlier space exploration programs, these are scientific initiatives that do not have the political and strategic rationales of their predecessors that served as a focal point for exploration and, with the ISS, for international cooperation.

Meeting the challenge for space exploration will require new strategies, new budget priorities, and new decisions on how Western space powers will cooperate. Cooperation in space is, ultimately, a political decision. This is not always apparent. But cooperation is also a learned behavior and depends on experience and institutions. This highlights the importance of maintaining the space station as the anchor for continued international cooperation as nations move forward, but what will cooperation look like after the ISS? Will nations go their own independent ways, or will they find new projects that can take the place of the ISS as the focal point for a cooperative approach to space exploration?

Space activities provide nations with scientific, commercial, and military advantage. Space activities are a tangible reflection of a nation's resources, capabilities, and pride. In a new and more difficult international environment, gaining the full strategic value of space exploration will require a redefinition of the goals of exploration in a way that capture both the public imagination and political support. The decision is whether space exploration will, for Western countries, become a purely scientific activity rather than one that provides both research and strategic benefits.

Select Bibliography

Achenbach, Joel. "The Skies. The Limit." *Washington Post*, September 14, 2013, http://www.washingtonpost.com/sf/national/2013/09/14/the-skies-the-limits/.

Baker, Peter, and Kenneth Chang. "NASA Breaks Most Contact with Russia." *New York Times*, April 2, 2014, http://www.nytimes.com/2014/04/03/world/europe/nasa-breaks-most-contact-with-russia.html?_r=0.

BBC. "China Joins EU Satellite Network." BBC.co.uk, September 19, 2003, http://news.bbc.co.uk/2/hi/business/3121682.stm.

Behrens, Carl. "The International Space Station and the Space Shuttle." Congressional Research Service, March 18, 2009, http://www.fas.org/sgp/crs/space/RL33568.pdf.

Behrens, Carl. "Space Launch Vehicles: Government Activities, Commercial Competition, and Satellite Exports." Congressional Research Service, March 20, 2006, http://www.fas.org/sgp/crs/space/IB93062.pdf.

Bianco, William. "The International Space Station's Scientific Payoff Is Real. And increasing." *Washington Post*, October 25, 2013, http://www.washingtonpost.com/blogs/monkey-cage/wp/2013/10/25/the-international-space-stations-scientific-payoff-is-real-and-increasing/.

Bolden, Charles. "Statement of the Honorable Charles F. Bolden, Jr. Administrator National Aeronautics and Space Administration before the Subcommittee on Commerce, Justice, Science, and Related Agencies, Committee on Appropriations, U.S. House of Representatives." NASA.gov, March 20, 2013, http://www.nasa.gov/pdf/736847main_3_20_13_Bolden_testimony.pdf.

Bolden, Charles. "Statement of the Honorable Charles F. Bolden, Jr. Administrator of the National Aeronautics and Space Administration before the Subcommittee on Space, Committee on Science, Space and Technology, U.S. House of Representatives." House Committee on Science, Space, and Technology, March 27, 2014, http://science.house.gov/sites/republicans.science.house.gov/files/documents/HHRG-113-SY16-WState-CBolden-20140327.pdf.

Bolden, Charles, and John Holdren. "Joint Statement on Launching a New Era in Space Exploration." whitehouse.gov, February 1, 2010, http://www.whitehouse.gov/files/documents/ostp/press_release_files/Joint%20Statement%202-2.pdf.

Boyle, Alan. “Trampoline to Space? Russian Official Tells NASA to Take a Flying Leap.” NBC News, April 29, 2014, http://www.nbcnews.com/storyline/ukraine-crisis/trampoline-space-russian-official-tells-nasa-take-flying-leap-n92616.

Cheng, Dean. “Five Myths about China’s Space Program.” Heritage Foundation WebMemo #3379 on Space Policy, September 29, 2011, http://www.heritage.org/research/reports/2011/09/five-myths-about-chinas-space-program.

Cheng, Dean. “Responding to China’s Manned Space Challenge.” Heritage Foundation Issue Brief #3468 on Space Policy, June 26, 2012, http://www.heritage.org/research/reports/2012/06/space-program-responding-to-china-s-manned-space-challenge.

Cheng, Dean. “U.S. China Space Cooperation More Costs Than Benefits.” Heritage Foundation WebMemo #2670 on Space Policy, October 30, 2009, http://www.heritage.org/Research/Reports/2009/10/US-China-Space-Cooperation-More-Costs-Than-Benefits.

Committee on the Scientific Context for Space Exploration, Space Studies Board, Division of Engineering and Physical Science, National Research Council of National Academies. *Science in NASA’s Vision for Space Exploration*. Washington, DC: National Academies Press, 2005.

European Commission, Directorate General for Energy and Transportation. “Galileo: European Satellite Navigation System: Public Regulated Services,” http://europa.eu.int/comm/dgs/energy_transport/galileo/programme/service_prs_en.htm.

European Space Agency. “How Much Does It Cost?” Last modified May 14, 2013, http://www.esa.int/Our_Activities/Human_Spaceflight/International_Space_Station/How_much_does_it_cost.

European Space Agency. “A Light Speed Voyage to the Distant Future.” Last Modified May 15, 2014. http://www.esa.int/Our_Activities/Operations/A_light-speed_voyage_to_the_distant_future.

European Union. “Galileo: Loyola de Palacio Welcomes the Green Light for an EU-China Agreement.” Press release, October 27, 2003, http://www.eurunion.org/news/press/2003/2003065.htm.

Flintoff, Corey. “For Russia’s Troubled Space Program, Mishaps Mount.” NPR.org, March 12, 2012, http://www.npr.org/2012/03/12/148247197/for-russias-troubled-space-program-mishaps-mount.

Futron. “Space Competitiveness Index: 2014.” http://www.futron.com/SCI_2014.xml.

Gehman, Harold, et al. *Columbia Accident Investigation Board*. Washington, DC: National Aeronautics and Space Administration and Government Printing Office, 2003. http://spaceflight.nasa.gov/shuttle/archives/sts-107/investigation/CAIB_medres_full.pdf.

Golloher, Jessica. “Russian Space Program Woes Continue.” DW.de, February 27, 2012, http://www.dw.de/russian-space-program-woes-continue/a-15770720.

Government Accountability Office. “International Space Station: Approaches for Ensuring Utilization through 2020 Are Reasonable but Should Be Revisited as NASA Gains More Knowledge of On-Orbit Performance.” GAO.gov, December 15, 2011, http://www.gao.gov/products/GAO-12-162.

Government Accountability Office. “International Space Station: Significant Challenges May Limit Onboard Research.” GAO.gov, November 25, 2009, http://www.gao.gov/products/GAO-10-9.

Government Accountability Office. “NASA: Actions Needed to Improve Transparency and Assess Long-Term Affordability of Human Exploration Programs.” Gao.gov, May 8, 2014, http://www.gao.gov/products/GAO-14-385.

Government Accountability Office. “NASA: International Space Station and Shuttle Support Cost Limits.” GAO.gov, August 31, 2001, http://www.gao.gov/products/GAO-01-1000R.

Government Accountability Office. “NASA: Significant Challenges Remain for Access, Use, and Sustainment of the International Space Station.” GAO.gov, March 28, 2012, http://www.gao.gov/products/GAO-12-587T.

Government Accountability Office. “Space: International Space Station (ISS)—Ongoing Assessments for Life Extension Appear to be Supported.” GAO.gov, April 11, 2011, http://www.gao.gov/products/GAO-11-519R.

Government Accountability Office. “Space Station: Impact of Grounding the Shuttle Fleet.” GAO.gov, September 12, 2003, http://www.gao.gov/products/GAO-03-1107.

The Hindu. “China Ready for Space Cooperation with India.” *The Hindu*, December 2, 2013, http://www.thehindu.com/news/international/world/china-ready-for-space-cooperation-with-india/article5413815.ece.

Holdren, John. “Prepared Remarks.” Presented at the International Space Exploration Forum Session I: National Policies and Public Support for Space Exploration, Washington, DC, January 9, 2014, http://www.whitehouse.gov/sites/default/files/microsites/ostp/isef__jph_isef_remarks-_1_8_14_as_prepared.pdf.

Johnson-Freese, Joan. “Human Space Flight—The Space Shuttle and Beyond.” Senate Committee on Commerce, Science, and Transportation, May 18, 2005, http://www.spaceref.com/news/viewsr.html?pid=16644.

Johnson-Freese, Joan. “U.S. Opens Space Door to China.” *Discovery*, February 11, 2013, http://news.discovery.com/space/nasa-space-china.htm.

Kluger, Jeffrey. “Has Obama’s NASA Strategy Fizzled at Launch?” *Time*, April 16, 2010, http://content.time.com/time/health/article/0,8599,1982475,00.html.

Lague, David. “Special Report: In Satellite Tech Race, China Hitched a Ride from Europe.” Reuters, December 22, 2013, http://news.yahoo.com/special-report-satellite-tech-race-china-hitched-ride-195616719.html.

Lewis, James A. “China as a Military Space Competitor.” In *Perspectives on Space Security*, edited by John M. Logsdon and Audrey M. Schaffer. Washington, DC: Space Policy Institute, George Washington University, December 2005, http://www.gwu.edu/~spi/assets/docs/PERSPECTIVES_ON_SPACE_SECURITY.pdf.

Lewis, James A. “Surmounting the Peak: China’s Space Program.” Paper presented at 52nd Annual American Astronaut Society National Conference and Meeting, League City, TX, November 15–16, 2005.

Logan, Jeffrey. “China’s Space Program: Options for U.S.-China Cooperation.” Congressional Research Service, September 29, 2008, http://www.fas.org/sgp/crs/row/RS22777.pdf.

Messier, Doug. “U.S. Space Lead Continues to Decline Futron Space Competitiveness Index.” Parabolic Arc, May 8, 2014, http://www.parabolicarc.com/2014/05/08/space-lead-continues-decline-futron-space-competitiveness-index/futron_2014_space_competitiveness_art/.

Milward, David. “U.S. Ready to Return to the Moon.” *Telegraph*, February 3, 2014, http://www.telegraph.co.uk/news/worldnews/northamerica/usa/10614953/US-ready-to-return-to-moon.html.

Morgan, Daniel. “The Future of NASA: Space Policy Issues Facing Congress.” Congressional Research Service, January 27, 2011, http://www.fas.org/sgp/crs/space/R41016.pdf.

Morgan, Daniel. “NASA Appropriations and Authorizations: A Fact Sheet.” Congressional Research Service, April 30, 2014, http://www.fas.org/sgp/crs/space/R43419.pdf.

National Aeronautics and Space Administration. “International Space Station.” http://www.nasa.gov/mission_pages/station/research/index.html#.U3oVp_ldVyx.

Nation Aeronautics and Space Administration, Office of the Inspector General. “NASA’s Efforts to Maximize Research on the International Space Station.” July 8, 2013, http://oig.nasa.gov/audits/reports/FY13/IG-13-019.pdf.

National Research Council. *America’s Future in Space: Aligning the Civil Space Program with National Needs.* Washington, DC: National Academies Press, 2009.

Obama, Barack. “Remarks by the President on Space Exploration in the 21st Century.” Speech given at John F. Kennedy Space Center, Merrit Island, FL, April 15, 2010, http://www.whitehouse.gov/the-press-office/remarks-president-space-exploration-21st-century.

Office of the Secretary of Defense. “Annual Report to Congress: Military and Security Developments Involving the People’s Republic of China 2013.” defense.gov, http://www.defense.gov/pubs/2013_china_report_final.pdf.

Pace, Scott. “Integrating National Interests in Space.” Paper presented at the 63rd International Astronautical Congress, Naples, Italy, October 1–5, 2012, http://www.gwu.edu/~spi/assets/docs/IAC-12.E3.2.7%20Pace%20Final.pdf.

Pace, Scott, and Giuseppe Reibaldi. *Future of Human Spaceflight: The Need for International Cooperation.* Paris, France: International Academy of Astronautics, 2009. http://www.gwu.edu/~spi/assets/docs/IAA_HSSG_final_Study_2010.pdf.

People's Liberation Army. *The Diversified Employment of China's Armed Forces*. White paper, April 16, 2014, http://news.xinhuanet.com/english/china/2013-04/16/c_132312681_2.htm.

Powell, Stewart. "Amid Ukraine Tensions House Panel Increases Funding for NASA and Commercial Space Program." *Houston Chronicle*, May 8, 2014, http://www.houstonchronicle.com/news/politics/article/Amid-Ukraine-tensions-House-panel-increases-5464481.php.

RT. "Russia Will Begin Moon Colonization in 2030—Draft Space Program." RT.com, May 9, 2014, http://rt.com/news/157800-russia-moon-colonization-plan/.

Sabathier, Vincent, Johannes Weppler, and Ashley Bander. "Costs of an International Lunar Base." *CSIS Commentary*, September 24, 2009, http://csis.org/publication/costs-international-lunar-base.

Sankaran, Jaganath. "Space Cooperation: A Vital New Front for India-U.S. Relations." *Space News*, April 7, 2014, http://www.spacenews.com/article/opinion/40127space-cooperation-a-vital-new-front-for-india-us-relations.

Siceloff, Steven. "Commercial Crew's Public-Private Funding Paying Off." NASA.gov, August 9, 2013, http://www.nasa.gov/content/commercial-crews-public-private-funding-paying-off/#.U3oO-vldVyw.

Stine, Deborah. "U.S. Civilian Space Policy Priorities: Reflections 50 Years after Sputnik." Congressional Research Service, February 2, 2009, http://www.fas.org/sgp/crs/space/RL34263.pdf.

Strickland, Eliza. "China: The Next Space Superpower." *IEEE Spectrum*, December 31, 2013, http://spectrum.ieee.org/aerospace/space-flight/china-the-next-space-superpower.

Svitak, Amy. "Budget Pressures Prompt ISS Partners to Justify Costs." *Aviation Week*, May 21, 2012, http://aviationweek.com/awin/budget-pressures-prompt-iss-partners-justify-costs.

Theobald, Bill. "Private Companies Claim Better, Cheaper Options for New NASA Rocket." Space.com, June 19, 2009, http://www.space.com/6868-private-companies-claim-cheaper-options-nasa-rocket.html.

U.S. Department of Defense. *Department of Defense Dictionary of Military and Associated Terms*. Washington, DC: Department of Defense, March 2014. http://www.dtic.mil/doctrine/new_pubs/jp1_02.pdf.

Xinhua. "Commentary: China Confident in Space Exploration." *Xinhua,* June 13, 2013, http://english.peopledaily.com.cn/202936/8283914.html.

Zhao, Lei. "Xi Calls for Joining Air and Space Roles." *People's Daily*, April 15, 2014, http://english.people.com.cn/90785/8597891.html.

About the Author

James Andrew Lewis is a senior fellow and director of the Strategic Technologies Program at CSIS, where he writes on technology, security, and the international economy. Before joining CSIS, he worked at the Departments of State and Commerce as a Foreign Service officer and as a member of the Senior Executive Service. His government experience includes work on a range of politico-military and intelligence issues. He was the rapporteur for both the 2010 and 2013 UN Group of Government Experts on Information Security. Lewis has authored numerous publications since coming to CSIS, publishing a series of reports and essays exploring the relationship between technology and national power. He is an internationally recognized expert on technology and strategy whose work includes the report *Securing Cyberspace for the 44th Presidency* (CSIS, 2008). Lewis led a long-running Track II dialogue on cybersecurity with China. His remarks appear frequently in the media, and he has testified numerous times before Congress. His current research examines international security and governance in cyberspace and the effect of the Internet on politics. Lewis received his PhD from the University of Chicago.

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

1616 Rhode Island Avenue NW | Washington, DC 20036
t. 202.887.0200 | f. 202.775.3199 | www.csis.org

ROWMAN & LITTLEFIELD

Lanham • Boulder • New York • Toronto • Plymouth, UK

4501 Forbes Boulevard, Lanham, MD 20706
t. 800.462.6420 | f. 301.429.5749 | www.rowman.com

Cover photo: Milosz Aniol/Shutterstock.com.