

ARE WE LOSING THE SPACE RACE TO CHINA?

HEARING BEFORE THE SUBCOMMITTEE ON SPACE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY HOUSE OF REPRESENTATIVES ONE HUNDRED FOURTEENTH CONGRESS

SECOND SESSION

September 27, 2016

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ARE WE LOSING THE SPACE RACE TO CHINA?

TUESDAY, SEPTEMBER 27, 2016

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON SPACE
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:06 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Brian Babin [Chairman of the Subcommittee] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

EDDIE BERNICE JOHNSON, Texas
RANKING MEMBER

Congress of the United States
House of Representatives

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

2321 RAYBURN HOUSE OFFICE BUILDING

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(202) 225-6371

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Are We Losing the Space Race to China?

Tuesday, September 27, 2016
10:00 p.m.
2318 Rayburn House Office Building

Witnesses

Hon. Dennis C. Shea, Chairman, U.S.-China Economic and Security Review Commission

Mr. Mark Stokes, Executive Director, Project 2049 Institute

Mr. Dean Cheng, Senior Research Fellow, Asian Studies Center, Heritage Foundation

Dr. James Lewis, Senior Vice President and Director, Strategic Technologies Program, Center for Strategic & International Studies

**U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY**

Charter

TO: Members, Committee on Science, Space, and Technology
FROM: Majority Staff, Committee on Science, Space, and Technology
DATE: September 27th, 2016
SUBJECT: Subcommittee on Space Hearing: “Are We Losing the Space Race to China?”

On Tuesday, September 27th, 2016 at 10:00 a.m. in Room 2318 of the Rayburn House Office Building, the Committee on Science, Space, and Technology, Subcommittee on Space will hold a hearing titled, “Are We Losing the Space Race to China?”

Hearing Purpose

The hearing will examine the achievements, capabilities, and future direction of China’s space program, as well as the impact to U.S. leadership in space.

Witnesses

- **Hon. Dennis C. Shea**, Chairman, U.S.-China Economic and Security Review Commission
- **Mr. Mark Stokes**, Executive Director, Project 2049 Institute
- **Mr. Dean Cheng**, Senior Research Fellow, Asian Studies Center, Heritage Foundation
- **Dr. James Lewis**, Senior Vice President and Director, Strategic Technologies Program, Center for Strategic & International Studies

Staff Contact

For questions related to the hearing, please contact Mr. Tom Hammond, Staff Director, Space Subcommittee, Mr. G. Ryan Faith, Professional Staff Member, Space Subcommittee, or Mr. Brian Corcoran, Policy Assistant, Space Subcommittee, at 202-225-6371.

Chairman BABIN. The Subcommittee on Space will come to order. Without objection, the Chair is authorized to declare recesses of the Subcommittee at any time, and welcome to today's hearing titled "Are We Losing the Space Race to China?"

I now recognize myself for five minutes for an opening statement.

After the Columbia accident, President George W. Bush sought to revitalize our nation's space program by challenging NASA to return to the Moon and then chart a course to Mars. Steady advances were made towards those goals with strong Congressional support for the Constellation program.

NASA made solid progress towards the development of the Ares I and Ares V vehicles. The Commercial Cargo program was initiated and the International Space Station neared completion.

All of that success came to a screeching halt when President Obama was sworn in. His fiscal year 2010 budget request slashed well over a billion dollars from the exploration budget.

He then tasked a blue ribbon commission to evaluate NASA's current plans. The panel found that the original plan was not executable, something that should have come as no surprise given the Obama Administration's budget cut. President Obama cancelled Constellation in its next budget request, redirected even more money to Earth Science to support its radical political agenda, and then guaranteed dependence on Russia for access to space for an extended period of time, which is still ongoing.

So what does this have to do with China? Well, this vacuum of leadership has led not only to extended dependence on Russia for access to space, but also facilitated the ascendance of China as a leading spacefaring nation. China has capitalized on this Administration's weakness by offering partnerships with other nations on missions, like a return to the Moon, which the United States chose to walk away from.

Rather than charting a bold course that inspires the international community to engage with us, the Obama Administration has alienated historic allies and potential partners alike. Only because of Congress is NASA building deep space exploration capabilities.

Unfortunately, the administration refuses to let NASA show any detailed plans for a Journey to Mars beyond a PowerPoint chart. China, on the other hand, has demonstrated a willingness to answer calls for collaboration with open arms. This has clearly strengthened their soft power and international standing.

China's near-term plans for space exploration continue their nation's philosophy of steady and measured progress, but their long-term goals are very ambitious. They have already placed astronauts in orbit five times, launched a space station, and placed a rover on the Moon. They have announced plans for a larger space station, a first-of-a-kind mission to the far side of the Moon, and potentially a manned mission to the Moon in the 2030s.

The Administration's abdication of leadership in space exploration has significant consequences. If we do not lead, someone else will. Leadership in space means security, technological prowess, and innovation. Our future prosperity depends on our leadership in space. If we do not lead, we will not set the terms and condition for those who follow.

When the United States explores and embarks on adventures of discovery, we take with us our ideologies and our principles. I, for one, want to ensure that space becomes a domain of freedom and liberty, not autocracy and oppression. If we do not lead, we will weaken our partnerships. I want countries to embark with us into the cosmos, rather than team with China as a last resort.

The Obama Administration has already told the Europeans that they are not interested in their Moon Village proposal. They've tried to walk away from their commitments to the Germans on SOFIA and actually abandoned ExoMars. International partners have memories. They also have options.

China is building a resume of accomplishments that positions them as a viable alternative. Given their recent provocative actions in the South China Sea, and the longstanding oppression of their own people, we should all be wary of perpetuating conditions that push other nations to partner with China.

Furthermore, we should ensure that any U.S. cooperation with China in space is mutually beneficial, appreciates the risk of technology exploitation, and fits into a larger strategic perspective that recognizes Chinese provocation.

Aside from recent tensions in the South China Sea, China also threatens our nation's cyber security. Couple that with their irresponsible antisatellite tests, one is hard-pressed to find a reason to reward their behavior with increased cooperation. We may not be in a space race with China. We may not even be competing with China in space, but the strategic choices we make clearly impact China's space capabilities, something that we should all pay attention to given that China's civil space activities are inseparable from their military.

I look forward to our witnesses' testimony today, and I thank them for appearing.

[The prepared statement of Chairman Babin follows:]



COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
September 27, 2016

Media Contact: Kristina Baum
(202) 225-6371

Statement of Space Subcommittee Chairman Brian Babin (R-Texas)
Are We Losing the Space Race to China?

Chairman Babin: After the *Columbia* accident, President George W. Bush sought to revitalize our nation's space program by challenging NASA to return to the Moon and then chart a course for Mars. Steady advances were made towards those goals with strong Congressional support for the Constellation Program. NASA made solid progress towards the development of the Ares 1 and Ares 5 vehicles. The Commercial Cargo program was initiated and the International Space Station neared completion.

All of that success came to a screeching halt when President Obama was sworn in. His FY2010 budget request slashed well over a billion dollars from the exploration budget. He then tasked a blue ribbon commission to evaluate NASA's current plans. The panel found that the original plan was not executable, something that should have come as no surprise given the Obama administration's budget cut. President Obama cancelled Constellation in its next budget request, redirected even more money to Earth Science to support its radical political agenda, and guaranteed dependence on Russia for access to space for an extended period of time.

So what does this have to do with China? Well, this vacuum of leadership has led not only to extended dependence on Russia for access to space, but also facilitated the ascendance of China as a leading spacefaring nation. China has capitalized on this administration's weakness by offering partnerships with other nations on missions, like a return to the Moon, which the U.S. chose to walk away from. Rather than charting a bold course that inspires the international community to engage with us, the Obama administration has alienated historic allies and potential partners alike. Only because of Congress is NASA building deep space exploration capabilities. Unfortunately, the administration refuses to let NASA show any detailed plans for a "Journey to Mars" beyond a PowerPoint chart. China, on the other hand, has demonstrated a willingness to answer calls for collaboration with open arms. This has clearly strengthened their soft power and international standing.

China's near-term plans for space exploration continue their nation's philosophy of steady and measured progress, but their long-term goals are ambitious. They have already placed astronauts in orbit five times, launched a space station, and placed a rover on the Moon. They have announced plans for a larger space station, a first-of-a-kind mission to the far side of the Moon, and potentially a manned mission to the Moon in the 2030s.

The administration's abdication of leadership in space exploration has significant consequences.

If we do not lead, someone else will. Leadership in space means security, technological prowess, and innovation. Our future prosperity depends on our leadership in space.

If we do not lead, we will not set the terms and condition for those who follow. When the U.S. explores and embarks on adventures of discovery, we take with us our ideologies and principles. I, for one, want to ensure that space becomes a domain of freedom and liberty, not autocracy and oppression.

If we do not lead, we will weaken our partnerships. I want countries to embark with us into the cosmos, rather than team with China as a last resort. The Obama administration has already told the Europeans that that they are not interested in their Moon Village proposal. They've tried to walk away from their commitments to the Germans on SOFIA and actually abandoned ExoMars. International partners have memories. They also have options. China is building a resume of accomplishments that positions them as a viable alternative.

Given their recent provocative actions in the South China Sea, and the long-standing oppression of their own people, we should all be wary of perpetuating conditions that push other nations to partner with China. Furthermore, we should ensure that any U.S. cooperation with China in space is mutually beneficial, appreciates the risk of technology exploitation, and fits into a larger strategic perspective that recognizes Chinese provocation.

Aside from recent tensions in the South China Sea, China also threatens our nation's cyber security. Couple that with their irresponsible antisatellite tests, and one is hard-pressed to find a reason to reward their behavior with increased cooperation.

We may not be in a space race with China. We may not even be competing with China in space, but the strategic choices we make clearly impact China's space capabilities – something that we should all pay attention to given that China's civil space activities are inseparable from their military.

I look forward to our witnesses' testimony, and thank them for appearing.

###

Chairman BABIN. I now recognize the Ranking Member, the gentlewoman from Maryland, for an opening statement.

Ms. EDWARDS. Good morning, and welcome to our distinguished witnesses today. I want to thank Chairman Babin for calling this hearing.

You know, on October 4, 1957, 59 years ago next week, the Soviet Union stunned the world when it launched Sputnik I into outer space. That launch, marking the first time a manmade satellite was placed into Earth orbit, caught Americans by surprise and indeed sparked fears that the Soviet Union might also be capable of sending missiles with nuclear weapons from Russia to the United States.

Not long after, Congress passed legislation establishing the National Aeronautics and Space Administration (NASA). The agency's budding space program became important in America's efforts to demonstrate U.S. preeminence and technological prowess over the Soviet Union.

To that end, President John F. Kennedy stood before Congress on May 25, 1961 proposing that "this nation should commit itself to achieving the goal before this decade is out of landing a man on the Moon and returning him safely to the Earth."

Following a series of interim achievements that demonstrated NASA's ability to dock and perform extravehicular activities in space, the space race ended with the successful July 20, 1969, Apollo 11 landing of the first humans on the Moon. How different would today's world be if NASA had not responded to President Kennedy's challenge?

And now, almost 50 years since that historic event, some are asking if we are again in a space race, but this time with China. Two weeks ago, China successfully placed in orbit its Tiangong-2 experimental orbiting space lab, and that accomplishment comes on the heels of China's landing a robotic rover on the Moon, with plans announced to do the same on Mars.

So should we be concerned that China may be closing the gap in spaceflight capabilities? Well, today's panel is well qualified to address this question. In particular, I look forward to hearing about China's pace of progress in exploring space and how our track record fares in comparison.

I'd also like to know if the recent success of China's space program is due to its ability to stay on course. In addition, I'd like to get the witnesses' views on what they believe the goals and objectives of the Chinese space program are and what impacts other domestic priorities have on the conduct of their space activities. So I look forward to hearing the panel's views on whether the U.S. should seek greater cooperation with other space-faring nations, including China, and what challenges we face if we choose to do so.

And just in closing, and in reference to the Chairman's statement, you know, I think that there's a lot of blame that can be passed along Pennsylvania Avenue from one end to the next for the uncertainty, for the contrary priorities and confusing priorities across Republican and Democratic Presidents and Members of Congress, and in my very short eight years on this Subcommittee and on this Committee, I've witnessed that conflict in priorities, and I think that as Democrats and Republicans here in the House and

the Senate that we would do our nation well and our nation's space program well for the future to make sure that we set down priorities that put us all on the same page when it comes to our priorities for space exploration, engage our international partners, and commit the resources across Presidents, Republicans and Democrats that it's going to take to get the job done.

And so I look forward to hearing from our panel today about those and other priorities, and with that, I yield the balance of my time.

[The prepared statement of Ms. Edwards follows:]

OPENING STATEMENT
Ranking Member Donna F. Edwards (D-MD)
of the Subcommittee on Space

House Committee on Science, Space, and Technology
Subcommittee on Space
"Are we Losing the Space Race to China?"
September 27, 2016

Good morning, and welcome to our distinguished panel of witnesses. I want to thank Chairman Babin for calling this hearing.

On October 4, 1957, 59 years ago next week, the Soviet Union stunned the World when it launched Sputnik I into outer space. That launch, marking the first time a man-made satellite was placed into Earth orbit, caught Americans by surprise and sparked fears that the Soviet Union might also be capable of sending missiles with nuclear weapons from Russia to the United States. Not long after, Congress passed legislation establishing the National Aeronautics and Space Administration (NASA).

The agency's budding space program became important in America's efforts to demonstrate U.S. preeminence and technological prowess over the Soviet Union. To that end, President John F. Kennedy stood before Congress on May 25, 1961 proposing that *"this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth"*.

Following a series of interim achievements that demonstrated NASA's ability to dock and perform Extravehicular Activities in space, the space race ended with the successful July 20, 1969 Apollo 11 landing of the first humans on the Moon.

How different would today's world be if NASA had not responded to President Kennedy's challenge?

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So, should we be concerned that China may be closing the gap in spaceflight capabilities?

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So, I look forward to hearing the panel's views on whether the U.S. should seek greater cooperation with other space-faring nations, including China, and what challenges we face if we choose to do so.

Well, Mr. Chairman, we have a lot to discuss this morning, and I look forward to our witness' testimony.

Thank you, and I yield back the balance of my time.

Chairman BABIN. Thank you, Ms. Edwards.

And I now recognize the Chairman of our full Committee, Chairman Smith.

Chairman SMITH. Thank you, Mr. Chairman, and thanks to our witnesses for being here today as well.

Just this month, China launched its second experimental space station. While it's just a single module and is smaller than the International Space Station, it signifies continued Chinese progress and persistence.

The Soviets flew their first large, modular space station, Mir, 3-1/2 decades after the first cosmonaut went to space. China plans to have their own slightly smaller equivalent to the Mir space station in operation by the mid-2020s. This is roughly two decades after China launched its first astronaut into orbit.

Meanwhile, the Obama Administration's cuts to exploration and disruption of exploration planning has eliminated our opportunities to return to the Moon, and the Administration has no real plan for landing people on Mars. China continues to make progress. We cannot resign ourselves to the remembrance of past achievements. It is time for the United States to reassert its leadership.

For over 50 years, the United States has been committed to the peaceful use and exploration of outer space. Our philosophical principles of freedom, the rule of law, and transparency are evident in the actions we take. The United States shares scientific data and findings, promotes international cooperation, and maintains international peace and security in outer space. The world has benefited from U.S. space leadership.

The success of China's space program will be different. China does not hold the same values of our society. Unlike the United States, China does not have distinct military and civilian space programs. The Chinese military is functionally in charge of all space activities, with the Chinese National Space Agency responsible for international affairs and intergovernmental agreements. China already has demonstrated a strong disregard for interests of other countries in outer space through its antisatellite tests. Here on Earth, illegal incursions into the South China Sea represent a blatant disregard for the international rule of law. Will their disregard of international law continue to extend into outer space?

When China launched its first person into space in 2003, it caught the world's attention. Over the years, our focus has waned and now China's accomplishments in space have become commonplace. We cannot ignore Chinese achievements and become complacent.

Just yesterday, the New York Times featured a large article on the largest single dish radio telescope, which is being built in China. China is making steady progress in all fields of exploration, including astronomy.

If the United States fails to reassert its leadership, China's rise may undermine U.S. plans to transfer low-Earth orbit habitation and human spaceflight from a governmental activity to a sustainable economic activity undertaken by the private sector. China stands to fill another void left by this Administration's disinterest in maintaining leadership in exploration.

By abandoning plans to return to the Moon, the administration invited the rise of China as a leader in space. By reallocating funding from exploration to Earth science, the administration has put our leadership in space exploration at risk. Our allies stand ready to partner in an ambitious exploration program. Unfortunately, the current administration won't allow NASA to propose one.

Thank you, Mr. Chairman, and I yield back.

[The prepared statement of Chairman Smith follows:]



COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
September 27, 2016

Media Contact: Kristina Baum
(202) 225-6371

Statement of Chairman Lamar Smith (R-Texas)
Are We Losing the Space Race to China?

Chairman Smith: Thank you, Mr. Chairman, and thank you to our witnesses for being here today.

Just this month, China launched its second experimental space station. While it's just a single module and is far smaller than the International Space Station, it signifies continued Chinese progress and persistence.

The Soviets flew their first large, modular space station, *Mir*, three and a half decades after the first cosmonaut went to space.

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Our allies stand ready to partner in an ambitious exploration program. Unfortunately, the current administration won't allow NASA to propose one.

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Chairman BABIN. Thank you. I appreciate it, Mr. Chairman.

Okay. Now we'll move on to—I don't see our Ranking Member here so I want to introduce our witnesses at this time.

The first one is the Hon. Dennis C. Shea, our first witness today. He is Chairman of the U.S.-China Economic Security Review Commission. He was reappointed by Senate Majority Leader Mitch McConnell for a term expiring December 31st, 2016, and Mr. Shea's government service began in 1988 when he joined the Office of Senate Republican Leader Bob Dole as Counsel and subsequently becoming the Senator's Deputy Chief of Staff in the Office of the Senate Majority Leader. He's an attorney with more than 25 years of experience in government, in public policy, and the Founder of Shea Public Strategies LLC, a public affairs firm based in Alexandria, Virginia. Mr. Shea received his J.D. and an M.A. in history and a B.A. in government from Harvard University.

Mr. Mark Stokes, our second witness today, Executive Director of the Project 2049 Institute. Previously, he was Vice President and Taiwan Country Manager for Raytheon International and later, Founder and President of Quantum Pacific Enterprises, an international consulting firm. Mr. Stokes has also served as Team Chief and Senior Country Director of the People's Republic of China, Taiwan and Mongolia in the Office of Assistant Secretary of Defense for International Security Affairs. He holds a B.A. from Texas A&M University and graduate degrees in international relations and Asian studies from Boston University and the Naval Postgraduate School. Thank you for being here.

Mr. Dean Cheng, our third witness today, Senior Research Fellow in the Asian Studies Center at the Heritage Foundation. Prior to joining the Heritage Foundation, he was a Senior Analyst with the China Studies Division at the Center for Naval Analysis from 2001 to 2009. He specialized on Chinese military issues with a focus on Chinese military doctrine and space capabilities. He has written a number of papers and book chapters examining various aspects of Chinese security affairs including the Chinese military doctrine, the military and technological implications of the Chinese space program, and Chinese concepts of political warfare. Mr. Cheng earned a bachelor's degree in politics from Princeton University. Thank you for being here.

And then our final witness today is Dr. James Lewis, Senior Vice President and Program Director for the Strategic Technologies program at the Center for Strategic and International Studies, or CSIS. Prior to joining CSIS, Dr. Lewis 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 included work on a range of political, military and Asian security issues as a negotiator on conventional-arms transfers and advanced military technology, and in developing policies for satellite exports, encryption, and the internet. Dr. Lewis received his Ph.D. from the University of Chicago.

So I now recognize Mr. Shea for five minutes to present his testimony. Mr. Shea.

**TESTIMONY OF THE HON. DENNIS C. SHEA, CHAIRMAN,
U.S.-CHINA ECONOMIC AND
SECURITY REVIEW COMMISSION**

Mr. SHEA. Well, thank you, Chairman Babin, Ranking Member Edwards, Chairman Smith, and the members of the Subcommittee for the opportunity to testify before you today.

I have to note these are my own personal views and not necessarily the judgments of the U.S.-China Commission though I draw heavily from the Commission's work.

Examining China's space program has never been more crucial. Over the next six years, China is poised to take major steps that will draw significant attention to its efforts in space and potentially set the stage for a larger leadership role.

Specifically, China plans to collect soil samples from the Moon and return them to Earth in 2017, send an unmanned spacecraft to land on the Moon's dark side before 2020, send a Rover to Mars in 2020, and complete a space station in 2022.

In this testimony, I want to briefly address three main points: the key characteristics of China's space program, the contributions it provides in economical, political and diplomatic terms, and the implications it presents for future U.S. leadership in space. The military aspects of China's space program are covered more fully in the Commission's report of last year.

China's climb to its current status is one of the world's top space powers as the result of decades of leadership attention and steady investment. It has also involved a significant effort to buy or otherwise obtain technologies from foreign sources, especially the United States. In particular, China's large-scale state-sponsored theft of intellectual property through cyber espionage has no doubt helped fill knowledge gaps in its space R&D.

China's space initiatives have progressed as a much slower, more deliberate and more methodical pace than those of the United States. For example, the United States achieved manned spaceflight for the first time in 1961 and the Moon landing in 1969, whereas China conducted its first manned spaceflight in 2003 and may not plan to land on the Moon until the 2030s, as revealed just this year. However, China is also pursuing multiple large-scale efforts at the same time rather than the more sequential approach taken by the United States, making it difficult to compare the two directly.

As pointed out by Chairman Smith, China does not have distinctly separate military and civilian space programs as the United States does. Rather, China's military controls the majority of the country's space assets and operations and state-owned defense conglomerates are the key actors in the commercial space sector. Thus, even apparently civilian projects such as space exploration can directly support the development of PLA, space, counter-space, and conventional capabilities. Beijing also provides little transparency regarding its intentions in space, for example, does not release detailed budget information on its space activities.

China's space program has furthered its leaders strategic ambitions. China's advancements in space, specifically its plans for a

space station, lunar exploration, and Mars exploration provide domestic legitimacy and international prestige.

China's global commercial efforts in areas such as space launch services, satellite exports and satellite application technologies provide revenues and are expected by policymakers to spark spin-off developments in key economic sectors. Both space exploration and commercial activities open the door to China's participation in key international and bilateral initiatives, which I list in my written testimony.

China has sought to work with advanced space powers where possible to improve its capabilities, most notably the European Space Agency. China has seen its greatest success in marking commercial space services to developing countries, which are less likely to demand advanced technologies subject to U.S. ITAR restrictions.

China's space program has economic implications for the United States in the areas of commercial satellite and spaced launch services, downstream satellite navigation industries, and the potential for European countries and their industries to pursue non-U.S. technologies in order to reach the Chinese market. The full deployment of China's BeiDou satellite navigation system plans to provide global service by 2020, and the introduction of policies to promote its adoption in downstream industries may affect U.S. firms and these industries in the future.

On the political side, China's activities have implications for U.S. leadership and international cooperation efforts in space. If the United States has a Mars program but no space station and no lunar program in the near future while China has all three, China will be able to dictate participation in manned spaceflight as well as in scientific projects involving its space station. China has already signed agreements with the U.N. Office for Outer Space Affairs and the Russian and European space agencies regarding space station cooperation.

Although the United States is prepared to maintain its leadership in the space domain, China's highly controlled, methodical and comprehensive approach will open up opportunities for Beijing in the near term.

Despite the fact that China's accomplishments and investments in space have been far outpaced by our own, it will likely appear over the next six years that China is reaching major milestones and gaining ground. Meanwhile, the United States will be focused on longer-term exploration projects and observers will be well aware of the planned deorbiting of the International Space Station in 2024. This underscores how important it is for the United States to see through its long-term space exploration projects so this apparent disparity does not continue.

Thank you very much, Mr. Chairman.

[The prepared statement of Mr. Shea follows:]

**Testimony before the House Space Science and Technology Committee, Subcommittee on Space
Hearing on “Are We Losing the Space Race to China?”**

**Dennis C. Shea
Chairman, U.S.-China Economic and Security Review Commission
September 27, 2016**

Thank you, Chairman Babin, Ranking Member Edwards, and members of the subcommittee, for the opportunity to testify today. While this testimony represents my personal views and not necessarily the judgments of the U.S.-China Economic and Security Review Commission, my comments largely reflect the Commission’s analysis of China’s space activities contained in our *2015 Annual Report to Congress*.

Examining China’s space program, including its “soft power” and military implications, has never been more crucial. Over the next six years, China is projected to take major steps in its manned spaceflight and space exploration programs, drawing significant attention to its efforts in space and potentially setting the stage for a larger leadership role. Beijing specifically plans to land and return a lunar rover in 2017, send a rover to Mars in 2020, and complete a space station in 2022.

To answer the question of how China’s activities in space compare with those of the United States and how they impact U.S. interests, this testimony begins by addressing key characteristics of China’s space program, then examines the contributions provided by a range of its activities in space, including space exploration and international cooperation efforts. It then assesses the implications of these developments in both economic and political terms for the United States, and concludes by providing several recommendations drawn from the Commission’s previous studies of China’s space program. This testimony emphasizes the economic and political aspects of China’s space activities and does not address in any significant detail its “counterspace” programs, which are examined more fully in the Commission’s 2015 annual report.

For the foreseeable future, the United States is prepared to retain scientific and commercial leadership in the space domain. However, China’s more deliberate and comprehensive approach will open up opportunities for Beijing to derive important economic, political, and diplomatic benefits from its space program in the near term. The series of high-profile activities China has planned over the next six years will be particularly influential, as it may appear China is reaching major milestones that the United States has already achieved and is thereby gaining ground, during a time in which the United States is readying for longer-term exploration projects, and observers are cognizant of the planned International Space Station (ISS) deorbit date approaching in 2024. This assessment underscores the importance of U.S. commitment to its objectives in space—specifically, its discussions on manned asteroid and Mars missions in the 2020s and 2030s—so that this apparent disparity does not continue after this period.

Characteristics of China’s Space Program

The Commission’s section on “China’s Space and Counterspace Programs” in its 2015 annual report, as well as its 2015 sponsored report on China’s space program by experts at the University of California Institute on Global Conflict and Cooperation, explain the drivers and structure of China’s space program in great detail. For the purposes of this testimony, it is useful to note several key characteristics:

- *Concentrated effort.* China has become one of the top space powers in the world after decades of high prioritization and steady investment from its leaders, indigenous research and development, and a significant effort to buy or otherwise appropriate technologies from foreign sources,

especially the United States. Specifically, China's large-scale, state-sponsored theft of intellectual property and proprietary information through cyber espionage has helped fill knowledge gaps in its space R&D, provide insights into U.S. space plans and capabilities, and identify vulnerabilities in U.S. space systems, enabling future space and counterspace operations.¹ While China does not release budget information for its space activities, its spending on space is likely growing, although still dwarfed by that of the United States. Public reports have estimated that China spends \$2 billion to \$6.1 billion per year on its space program,² in comparison with the OECD's estimates of \$39.3 billion spent by the United States and \$5.3 billion by Russia in 2013.³

- *Methodical approach.* Unlike the swift pace of U.S. missions during the Space Race (achieving manned spaceflight for the first time in 1961 and the Moon landing in 1969), China has opted for a longer-term, more deliberate approach.⁴ Jeffrey Plescia, chairman of NASA's Lunar Exploration Analysis Group, has argued that China "has had a well-developed, focused plan" for lunar exploration and has used incremental steps to carry it out, while the United States "has been floundering around for decades, trying to figure out what to do" in its lunar exploration program.⁵ On the other hand, China is pursuing multiple large-scale efforts at the same time (a space station, a lunar program, and a Mars program) rather than the more sequential approach taken by the United States, making direct pace comparisons difficult.
- *Civil-military integration.* Unlike the United States, China does not have distinctly separate military and civilian space programs. Chinese Communist Party (CCP) leaders provide policy guidance and authorize allocations of resources for the program, and various organizations within the People's Liberation Army (PLA) execute space policy and oversee the space research, development, and acquisition process. China's military also exercises control over the majority of China's space assets and space operations. Thus, even its ostensibly civilian projects, such as human spaceflight, directly support the development of PLA space, counterspace, and conventional capabilities.⁶
- *Lack of transparency.* Related to the predominance of China's military in its space program, Beijing provides little information regarding its intentions in space. It provides limited public strategic guidance beyond short white papers and does not release timetables and technical information when announcing a new program, as is done by NASA and the European Space Agency.⁷

The key actors in China's space activities that provide important economic and political contributions are military and defense industry organizations. While the China National Space Administration is often incorrectly referred to as China's equivalent of NASA and coordinates and executes international agreements, it does not have a direct role in overseeing China's space policy; space research, development, and acquisition process; space assets; or space operations.⁸ The China Aerospace Science and Technology Corporation (CASC) and China Aerospace Science and Industry Corporation (CASIC) are the primary state-owned defense industrial enterprises that support the military in the research, development, and manufacturing of space technologies and systems. The China Great Wall Industry Corporation, a firm subordinate to CASC, is China's sole commercial satellite and launch services provider. A military entity, the China Satellite Launch, Tracking, and Control General (formerly subordinate to the PLA General Armaments Department and likely now situated under the Equipment Development Department⁹) is responsible for managing China's space launches and the telemetry, tracking, and control functions for its spacecraft systems. As such, it is responsible for constructing and operating China's space launch centers and control centers.¹⁰

Economic, Political, and Diplomatic Contributions of China's Space Program

China's space program furthers its leaders' strategic ambitions by adding to the country's "comprehensive national power," a far-reaching term used by sources in China.¹¹ Beyond direct security contributions centered on its key role in China's ongoing military transformation, China's space program provides a wide range of contributions in economic, political, and diplomatic areas. These can be observed primarily in the following categories of space activities: 1) launch services and satellite exports; 2) satellite application technologies; 3) human spaceflight; 4) space exploration; and 5) international space cooperation efforts.

Launch Services and Satellite Exports

Beijing has heavily emphasized both commercial launch services and satellite exports as its space industry has developed. Both activities provide China's space industry with revenues, opportunities to measure the quality of its products and services against international competitors, and industrial development synergies through integration with its military space sector. Furthermore, promoting exports of domestic satellites helps increase demand for Chinese launch services: because U.S. restrictions in place since 1999 prohibit exports of satellites and components to China (including for launch service purposes),¹² China has relied on "delivery in orbit" contracts in which it both builds and launches a satellite for a customer.¹³

Chinese officials frequently stress both the significant impact of U.S. restrictions and the resolve shown by China's space industry in response. Executives at the China Great Wall Industry Corporation noted in a July 2015 briefing to the Commission that although the company's products and practices are "just as good" as those of U.S., European, and Russian providers, it is unable to compete in the "whole [global] market" due to U.S. export controls.¹⁴ Experts also stress the reliability of China's Long March series of launch vehicles: China successfully completed 125 of 128 launches for a 98 percent success rate over the 12-year period from 2001 to 2013, a rate comparable with international competitors.¹⁵ Failures such as the loss of a satellite on September 2, 2016—the same day as the better-publicized explosion of a SpaceX Falcon-9 launch vehicle¹⁶—have been rare exceptions.

China began its return to the international market in 2007 with a satellite launch for Nigeria. It launched a satellite for European satellite communications provider Eutelsat in 2011, its first launch of a foreign-made satellite for a foreign client since 1999 (all foreign satellite launches since 2007 are listed under "international space cooperation efforts" below).¹⁷ China has still struggled in both the launch services and satellite export markets, however. Beijing aimed to capture 15 percent of the global launch services market by 2015, but while it achieved this objective with roughly 19 and 16 percent market share in 2011 and 2012, respectively (not including launches for China's government and state-owned enterprises), it conducted no commercial launches in 2013 and 2014, the last years for which data is available.¹⁸ In the commercial satellite field, China set the goal of capturing 10 percent of the market by 2015 but only achieved 5 percent in 2013 and 4 percent in 2014.¹⁹ In 2015, China announced that it is designing a launch vehicle that could be exported to customers outside China, potentially bypassing U.S. restrictions by selling rockets themselves rather than just launch services.²⁰

Satellite Application Technologies

Chinese analysts emphasize the importance of China's space program in the development of satellite application technologies—supplementary products that build upon the information provided by space technologies to add value for consumers. In their view, China's space program has facilitated the development of these technologies in three primary areas. First, it has led to the development of satellite communications applications such as satellite television and telecommunication services. Second, China has launched several lines of Earth observation satellites that provide remote sensing data, which many of China's civil government agencies rely on for functions such as agricultural use monitoring, environmental protection, and municipal planning. Many of China's civil-government agencies are dependent on this data. Third, it has helped foster growth associated with the Beidou satellite navigation system.²¹

The Beidou satellite navigation system, which currently provides regional coverage and is projected to achieve global coverage by 2020,²² is the most important of China's space programs associated with satellite application technologies and the one that contributes most clearly in soft power terms. China reportedly spent \$2.57 billion on the program from 1994-2012 and planned (as of 2013) to spend an additional \$6.41-\$8.02 billion from 2013 to 2020, indicating it is one of the largest space programs the country has undertaken.²³ Beidou is also one of China's 16 "megaprojects" under the 2006-2020 Medium and Long-term Plan for Science and Technology Development funded by China's Ministry of Science and Technology, which identifies and coordinates Beijing's top state-directed R&D efforts across government, military, and commercial spheres (three other megaprojects—a high-definition Earth observation system, human spaceflight, and lunar probes—are also space-related).²⁴

Beidou is first and foremost a military system, built to end the Chinese military's reliance on GPS, as Chinese scientists and military officers have advocated since the early 1980s. It has applications in other areas as well. In 2016, China published a white paper announcing for the first time that Beidou (like GPS) would be free to all users worldwide, and calling for a massive push to build a commercial industry compatible with the system.²⁵ China, no doubt, sees an opportunity for significant profits from this effort: the market for downstream global navigation satellite system products in China is projected to reach approximately \$65 billion by 2020,²⁶ and a Chinese academician chairing the 2013 China Satellite Navigation Conference noted the market could be worth "hundreds of billions" in the future.²⁷ China's military could also benefit from civil-military integration in the industry: in August 2015 Alibaba, a private Chinese firm, and China North Industries Corporation, a Chinese state-owned defense conglomerate, formed a joint venture worth roughly \$310 million to "build applications and technology to support and work with the [Beidou] system."²⁸

Beidou may offer China political opportunities as well. As China moves from a regional to a global position, navigation, and timing (PNT) service provider, Beijing could use the Beidou system as leverage to obtain more influence over PNT-related decisions in international and regional organizations such as the International Telecommunications Union, the International Committee on Global Navigation Satellite Systems, the Asia-Pacific Economic Cooperation forum, and the International Civil Aviation Organization.²⁹ China has specifically stated that it plans to expand Beidou coverage to most of the countries covered in its "One Belt, One Road" initiative by 2018 on the way to global coverage in 2020,³⁰ indicating it sees the system as contributing to its economic diplomacy efforts.

Human Spaceflight

Human spaceflight is a clear contributor to China's soft power and international prestige—to date, China is only the third country behind the United States and Russia to have independently launched a human into space. China's human spaceflight program is one of the country's largest and most technologically-advanced projects, involving some 3,000 organizations and several hundred thousand personnel. The program has proceeded methodically along three phases, and is poised to achieve its most significant successes over the next six years. In phase one (1992–2005), China launched several unmanned Shenzhou spacecraft to develop technologies necessary for its first manned spaceflights in 2003 and 2005. In phase two (2005–2013), China conducted both manned and unmanned docking maneuvers between the Shenzhou spacecraft and the Tiangong-1 space lab. In phase three, scheduled for completion by 2022, China plans to launch a permanent manned space station into orbit.³¹ Importantly, news reports in September 2016 revealed that China has likely lost control of the Tiangong-1 and will not be able to control its descent to earth in late 2017,³² indicating that Beijing is still catching up technologically as a space power and faces the same obstacles encountered by other nations' programs.

Beijing has specifically planned the following activities for 2016 and the next several years:

- Launch of China's two largest launch vehicles to date—the Long March-7 (LM-7) in June 2016 (completed) and the LM-5 in late 2016 (forthcoming)—required to launch China's 60-ton permanent manned space station*
- Launch of a second space lab, the Tiangong-2, in September 2016 (completed)
- Launch of the Shenzhou-11 spacecraft in October 2016, China's first manned space mission since 2013 and 11th overall, to link with Tiangong-2
- Launch of the Tianzhou-1 cargo-resupply vehicle to resupply Tiangong-2 and Shenzhou-11 in the first half of 2017, China's first such mission, aboard an LM-7 launch vehicle³³
- Launch of the Tianhe-1, the experimental "core module" of the planned space station, in 2018³⁴
- Launch of the remaining two modules in 2020 and 2022³⁵

At 60 tons, China's space station will be closer in size to Skylab, the United States' first space station, than the approximately 450-ton ISS. Should the ISS be deorbited in 2024, however, China will potentially have the world's only active space station.³⁶ China is already engaged in diplomatic efforts involving this project: in June 2016 the director of the China Manned Space Agency signed two agreements with the director of the U.N. Office for Outer Space Affairs, based on which China will solicit, evaluate, select, and finance future experiments from foreign nationals through the UN (although these will also require bilateral agreements with countries involved). China has additionally signed agreements with the Russian Roscosmos space agency and the European Space Agency regarding space station cooperation, and European astronauts are reportedly already learning Chinese in preparation for trips to the station.³⁷

Importantly, manned platforms could also play a role in space warfare, as referenced in several writings by Chinese analysts. Among other activities, manned space platforms can, depending on their type, conduct reconnaissance and surveillance against targets, service military satellites in orbit, and serve as platforms for kinetic and directed energy weapons.³⁸

Space Exploration

China's lunar and Mars missions represent the premier examples of Beijing's pursuit of political and scientific objectives through its space program, and each has seen major developments over the past year.

In April 2016, a senior PLA officer and deputy commander of the China Manned Space Program stated that China plans to send astronauts to the Moon before 2036, the first public reference to this objective by a Chinese space official.³⁹ In its 2011 white paper on space, Beijing acknowledged that it was "researching the critical technologies for manned lunar exploration," and China began a feasibility study that same year for a manned mission to the Moon with a potential launch date of 2020, 2025, or 2030.⁴⁰ The official's 2016 statement noted, however, that it will require 15 to 20 years to land astronauts on the lunar surface, a 2031-2036 timeframe.⁴¹ Given the secrecy surrounding China's space program, it is difficult to confirm exactly when China intends to complete such a mission.⁴²

* The LM-7 can carry 13.5 tons into low Earth orbit, a significant increase from China's LM-2F at 8 tons and the more frequently-used LM-2C and LM-2D at 3.9 tons. The forthcoming LM-5, expected to be launched later this year, will be able to carry 25 tons into low Earth orbit and 14 tons to geostationary transfer orbit (as opposed to the LM-3E at 5.5 tons) as China's largest launch vehicle to date. Xinhua (English edition), "China Focus: Long March-7 Rocket Launches China's Five-Year Space Plan," June 26, 2016. http://news.xinhuanet.com/english/2016-06/26/c_135467899.htm; Xinhua (English edition), "Backgrounder: A Quick Guide to China's Long March Rocket Series," June 25, 2016. http://news.xinhuanet.com/english/2016-06/25/c_135465906.htm; Jeffrey Lin and P. W. Singer, "Next Generation of Chinese Launch Vehicles Begins its Long March (by Standing Up)," *Popular Science*, January 29, 2016. <http://www.popsci.com/next-generation-chinese-space-vehicles-begins-its-long-march-standing>; Kevin Pollpeter, *China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States* (Prepared for the U.S.-China Economic and Security Review Commission by the University of California Institute on Global Conflict and Cooperation, March 2, 2015), 80-82.

According to the State Administration of Science, Technology, and Industry for National Defense, China's lunar exploration program was the result of a "major strategic decision by the CCP Central Committee, State Council, and Central Military Commission" aimed at "promoting [China's] space enterprise development, promoting [its] S&T advancement and innovation, and improving [its] comprehensive national power." Although primarily motivated by prestige and scientific objectives, China may also seek to use its lunar program to exploit the Moon's natural resources. Chinese analysts have noted that the Moon contains large amounts of elements including iron, titanium, and uranium that could be useful for economic development. Helium-3 appears to be of specific interest to these analysts, although utilizing it would require the development of a commercially viable nuclear fusion reactor, a technology not yet demonstrated. China's lunar exploration program consists of multiple phases involving the Chang'e spacecraft and several lunar landing vehicles:

- In phase one (2004–2007), the Chang'e-1 and the Chang'e-2 spacecraft orbited the Moon to map the lunar surface. The missions also tested China's ability to control objects in deep space.
- In phase two (2007–2014), the Chang'e-3 spacecraft landed a lunar vehicle on the Moon, making China the third country behind the former Soviet Union and the United States to conduct a soft landing on the Moon, and the first to do so since 1976. The vehicle deployed a rover, designated "Jade Rabbit," to study the lunar surface and analyze its soil. Later in the second phase, China employed the Chang'e-5 spacecraft to test technologies required to retrieve and return a lunar sample to Earth.
- In phase three, China plans to send a rover to the Moon and bring it back to Earth after it collects soil samples. The mission will use the Chang'e-6 spacecraft and is scheduled for 2017.
- In a potential fourth phase, China announced in September 2015 that it would send the Chang'e-4 spacecraft to land on the Moon's "dark side" before 2020, which would make China the first nation to do so. The stated objective of this mission is to study geological conditions on the dark side, which could eventually lead to the placement of a radio telescope for use by astronomers.⁴³

China announced for the first time in November 2015 that it plans to send a rover to Mars in 2020.⁴⁴ China's defense industry and the Chinese Academy of Sciences have been conducting studies on the feasibility of such a project.⁴⁵

In other areas related to scientific development, China plans to launch a space telescope described by Chinese officials as akin to the Hubble Space Telescope in the mid-2020s, which will be housed in a separate unit but orbit alongside the space station.⁴⁶ Using a space station as a permanent support base for any type of satellite has not been previously tried.⁴⁷ China reportedly launched the world's first experimental quantum communications satellite in August 2016, which will test technology that could eventually enable secure digital communication using a virtually unbreakable encryption key.⁴⁸

International Space Cooperation Efforts

China's space program has opened doors for international cooperation with several countries and international organizations, which in turn has provided benefits to China:

Asia Pacific:

- China led the founding of the **Asia Pacific Space Cooperation Organization (APSCO)** in 2008, its primary vehicle for multilateral cooperation on space. APSCO is a formal, membership-only organization headquartered in Beijing, with seven other member countries (Bangladesh, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey, with Indonesia as a signatory state but not yet a full member), all of which have less advanced space programs than that of China. APSCO members

hold conferences, engage in joint training efforts, and cooperate on multilateral research and development projects. These efforts allow China to position itself as a purveyor of space technology and expertise to less-developed states. China's leaders also use Beijing's central role in APSCO to promote the export of its space technology and services in order to gain support for its space goals from the Asia Pacific region, as well as to obtain supplementary data and geographic coverage for its space situational awareness efforts.⁴⁹

- Regarding China's **One Belt, One Road** initiative, China has stated that it plans to expand Beidou coverage to most of the countries involved by 2018 on the way to global coverage in 2020.⁵⁰
- China has constructed a telemetry, tracking, and control (TT&C) station in **Pakistan** and leases access to a station in **Australia**. China uses five such overseas stations, in addition to 10-20 in China and seven naval space tracking vessels, to maintain communication with spacecraft that travel beyond the area visible from Chinese territory.⁵¹
- With **Brunei, Laos, Pakistan, and Thailand**, China has signed agreements to provide Beidou-equipped receivers for government and military customers at heavily subsidized costs. These agreements include provisions allowing Beijing to build satellite ground stations in each country. The stations will be used to increase Beidou's range and signal strength.⁵²
- China has provided launch services for Chinese-made satellites to **Laos, Pakistan, and Sri Lanka**. China has also launched a foreign-made satellite for **Indonesia** and launched an experiment for **Japan's** space agency.⁵³

Eurasia:

- With **Russia**, China established a space cooperation subcommittee within the countries' bilateral prime ministers' dialogue in 1997, after a break in cooperation beginning in 1958. This has resulted in the opening of a Chinese space program office in Russia and a corresponding Russian office in China, as well as collaboration on a range of human spaceflight and space exploration activities. Future cooperative activities could include joint rocket engine development, Russia's participation in China's future space station, and a joint Russia-China space station. China likely gains valuable knowledge from cooperating with the world's number-two space power, particularly in the area of launch vehicle technology.⁵⁴
- With **Ukraine**, China implemented three consecutive five-year programs guiding cooperation on large-scale space projects from 2001-2015. These have included cooperation on projects involving remote sensing satellites, space weather satellites, space rocketry, and the Ionosat space system. The two countries have also discussed projects in engine manufacturing and even for exploring the Moon and Mars, but these have not yet seen further action. This collaboration has likely assisted China's development of launch vehicle technology as well.⁵⁵
- With the **European Space Agency**, China's joint space cooperation efforts are thriving, particularly in the areas of space science, space exploration, and human spaceflight. In the mid-to late-2000s, China extracted important gains from the relationship through its early co-development work on Europe's Galileo satellite navigation network. Europe later declined China's continued participation in the project, primarily due to concerns over the dual-use nature of satellite navigation and questions regarding China's plans for its own Beidou satellite navigation system. The project no doubt provided Beijing with essential technology and experience needed for the development of Beidou. Beidou satellites even use frequencies previously allocated to Galileo, for which EU and Chinese diplomats jointly negotiated in the early 2000s. China generally seeks access to

Europe's advanced space technology to improve its own space capabilities, while Europe seeks greater cooperation primarily in order to compensate for the reduced funding of the European Space Agency and to facilitate greater economic ties between China and Europe.⁵⁶

- China has signed a contract to launch a Chinese-made satellite for **Belarus**, launched foreign-made satellites for a **Luxembourg** company and **Turkey**, and launched an experiment for the **European Space Agency**.⁵⁷

Africa:

- With **Nigeria**, China hosted a delegation in April 2016 that reportedly discussed "logistics and investment for a manned space mission," related to Nigeria's announcement in 2016 that it intends to send an astronaut to space by 2030.⁵⁸ China reportedly agreed to provide scholarships and training to Nigerian engineers in the space sector to assist this effort.⁵⁹
- China has built a TT&C station in **Namibia** and leases access to a station in **Kenya**.⁶⁰
- China has provided launch services for a Chinese-made satellite to **Nigeria** and signed contracts to launch foreign-made satellites for **Algeria** and the **Democratic Republic of the Congo** in the future.

Americas:

- With the **United States**, China's space cooperation has been limited since 1999, and official visits have been limited since 2011. However, space officials from the two countries have held meetings, inaugurated the "U.S.-China Civil Space Cooperation Dialogue" in 2015 in an effort to establish regular bilateral consultations, and discussed measures for satellite collision avoidance. In 2015 the two sides determined to undertake a joint project in "space security" within the East Asia Summit, the Association of Southeast Asian Nations (ASEAN) Regional Forum, or another multilateral framework in the Asia Pacific region.⁶¹
- With **Brazil**, China has cooperated on joint satellite development and space launches, most notably the China-Brazil Earth Resources Satellites project, which developed a series of remote sensing satellites from 1988 to 2016. In addition to their scientific mission, these satellites likely benefit PLA satellite coverage, and the project also probably helped Beijing lay the groundwork for its most advanced Earth observation satellite series, which has military applications.⁶²
- With **Venezuela**, China signed a memorandum of understanding on space technology cooperation and established a special joint subcommittee on technology, industry, and space in 2005. Since then China has built and launched two satellites for Venezuela and is helping Venezuela build small satellites, supplying Venezuela's space industry with Chinese technology, and training Venezuelan engineers.⁶³
- With **Bolivia**, China has trained Bolivian scientists and lent the majority of the funds needed for Bolivia to purchase its first satellite.⁶⁴
- China has built a TT&C station in **Chile**. In **Argentina**, China is constructing its sixth overseas TT&C station at a reported investment of over \$300 million, in exchange for providing Argentina a share of the antenna's usage time and access to imagery from its surveillance satellites.⁶⁵

- China has provided launch services for Chinese-made satellites to **Bolivia** and **Venezuela**, with a contract signed for a future launch for **Venezuela**. China has launched foreign-made satellites for **Argentina** and **Ecuador**.

Several observations can be made regarding patterns in China's international space cooperation activities: 1) China has sought to work with advanced space powers where possible; 2) it has sought to market commercial space services to developing countries, which are less likely to demand advanced technology subject to U.S. restrictions; 3) these activities often involve practical requirements, such as the placement of TT&C stations around the globe to track spacecraft; and 4) they often appear to relate to China's larger foreign policy efforts in given regions. The fact that China has reportedly subsidized many of its satellite launch and satellite navigation services suggests its motivations are not restricted to commercial interests, although the intention could also be to gain a foothold in these regional markets.⁶⁶

In conclusion, apart from the military imperatives of China's space program, key political, economic, and diplomatic benefits have arisen from Beijing's space activities as well. China's overall achievements in space and its specific plans for a space station, lunar exploration, and potentially the exploration of Mars provide domestic legitimacy and international prestige. Commercial efforts such as space launch services, satellite exports, and satellite application technologies provide revenues and are expected by policymakers to spark wider growth in key economic sectors. Both types of activities supply a product desirable to many international governments and open the door to China's participation in key bilateral and multilateral initiatives. Importantly, these drivers frequently overlap. For example, although Beidou's development was driven by security needs, it is now envisioned to facilitate a widespread downstream commercial industry, and it may provide diplomatic influence as well. Considerations for the United States must thus be assessed along a wide spectrum of possible impacts.

Implications for the United States

Economic Implications

I would like to highlight three areas where China's expanding space program presents economic implications for the United States.

First, China's persistent global marketing of its commercial satellite and space launch services has the potential to cut into U.S. firms' market share, though it has had little effect on established satellite manufacturers or the international launch market thus far. China has been focused on growing its satellite exports to lower-income buyers but will almost certainly seek to expand to higher-end markets in the future. Its launch service costs compare favorably with those of Arianespace, the major European provider, and may be able to compete with those of SpaceX, the low-cost leading U.S. private firm. In addition, according to one former European space executive, China has broken into the launch services market by offering prices as low as three-quarters of the launches' cost, suggesting that heavy government assistance on top of low initial costs could enable China to successfully compete for broader market share in the future. Furthermore, China often packages its satellite exports and launch services together, and also reaps cost and experience benefits from blending its civilian and military space launch infrastructure. An executive for U.S. company SpaceX, which has led a resurgence in U.S. commercial launch market share, stated in 2013 that the company views China as its main competition.⁶⁷

Second, China's designation of the Beidou satellite navigation system—planned to provide global service by 2020—as “national infrastructure,” and introduction of preferential policies to promote its adoption in downstream industries, may affect U.S. firms in these industries in the future. The United States receives no revenue from GPS, and the global downstream PNT industry is moving rapidly towards “multi-constellation” devices built to receive signals from two, three, or all four satellite systems,⁶⁸ meaning U.S.

firms may benefit in the near term by selling Beidou and GPS-equipped products in China's market. However, the long-term outlook for U.S. firms in the industry will likely be negative. A recent Commission-sponsored report notes that ultimately U.S. suppliers will be replaced by local ones for Chinese government and military users seeking "secure and controllable" options, while in the civilian market most financial tax incentives will likely be given to local Chinese companies.⁶⁹ †

Third, U.S. International Trafficking in Arms Regulations (ITAR) were altered by the FY13 National Defense Authorization Act to no longer include exports of many satellites and satellite technologies but are still in force for China. This has prompted many European countries and their industries to pursue "ITAR-free" exports in order to reach the Chinese market—necessitating the exclusion of U.S. technologies from these products. At the Commission's hearing on China's space and counterspace programs last year, one witness explained that this shift has been driven by concerns over U.S. export controls on space-related items, confusion over which items are on the list of banned items for export, and uncertainty over which ones will be on the list in the future. He also suggested that China probably already has access to many ITAR-restricted products from foreign partners, particularly Europe.⁷⁰ In May 2015 General James Cartwright, former vice chairman of the Joint Chiefs of Staff, and Sean O'Keefe, former NASA administrator, reiterated that U.S. ITAR regulations are not currently in line with the pace of technological innovation and are therefore in need of reform in order to protect the U.S. space industry's global competitiveness.⁷¹

Political and Diplomatic Implications

China's space initiatives have important political and diplomatic implications as well, most importantly in their potential to present a future challenge to U.S. leadership in space and to further China's foreign policy objectives.

In terms of "milestones," China will not surpass the United States over the next two decades, if U.S. support for its space program continues as planned. Based on goals outlined in the NASA Authorization Act of 2010 and the U.S. National Space Policy issued in 2010, NASA is working to develop the capabilities needed to send humans to an asteroid by the mid-2020s and to Mars in the 2030s.⁷² These objectives, if achieved, would continue to demonstrate unmistakable U.S. technological leadership in space science and exploration. To place the two countries' programs in perspective, should the U.S. and Chinese space programs both hypothetically achieve their planned objectives, by the late 2030s the United States would have conducted a manned mission to a planet 140 million miles away (based on the average distance from the Earth to Mars), while China would have conducted a manned mission 239,000 miles away to the Moon, 70 years after this was first accomplished. China's achievements should certainly not be minimized, given the steady progress it has demonstrated over time, the milestones it has already achieved, and its success in narrowing the gap with the established space powers, the United States and Russia. But the United States is positioned to remain a leader in pushing the frontier in space exploration.

Despite these considerations, U.S. decisions regarding its space program's direction have incidentally opened up opportunities for China to expand its influence and narrow the gap in perceived achievements.

First, taking a simplistic view, the United States will potentially have a Mars program, but no space station, and no lunar program in the future, while China will have all three.⁷³ The United States may view the latter two programs as extraneous, having already achieved these objectives, but China's engagement in these areas could provide unique leadership opportunities and diplomatic advantages. Nations with developing space programs—particularly those that have already purchased satellite launches or manufactured their

† See the Commission's forthcoming report "China's Alternative to GPS and its Implications for the United States," for more information on the potential security and economic implications of China's efforts to promote Beidou.

own satellites—may view the prestige of achieving manned spaceflight as highly desirable. For example, Nigeria announced plans in 2016 to send an astronaut to space by 2030, and in April 2016 sent a delegation to Beijing to discuss “logistics and investment for a manned space mission.”⁷⁴ China reportedly agreed to provide scholarships and training to Nigerian engineers in the space sector to assist this effort.⁷⁵ Besides being able to offer direct programmatic assistance, China could benefit from its space station serving as a destination for spaceflights and scientific experiments in the coming decades—European Space Agency astronauts are reportedly already being trained for visits to the station.⁷⁶ Should the ISS be deorbited in 2024 as currently planned,⁷⁷ China would be the only supplier in the field to meet such demand.

While China stresses that it is open to its space station hosting non-Chinese experiments, payloads, astronauts, and modules,⁷⁸ Beijing will be able to impose limits regarding participation, launch vehicles used, component sourcing for payloads, and data sharing if it so desires. Given current restrictions, the United States would of course not participate in China’s space station program regardless, barring changes to annual appropriations legislation.⁷⁹ The space station will thus likely serve as a diplomatic tool China can leverage to execute its broader foreign policy goals and as a way to exert leadership in space.

Second, beyond large-scale projects, China may reap geopolitical benefits from its broad-based efforts in space. International cooperation on space activities usually follows progress in countries’ overall relationships and is more of an indicator of the state of a relationship than a critical component.⁸⁰ However, a growing number of governments are desirous of a presence in space and the prestige and domestic political benefits this will bring. Now that China’s space program has reached a high level, cooperation on space projects has become another tool for Beijing to use within its larger foreign policy approach toward the developing world. The space-related agreements China has signed often correlate with the announcement of other investments: China-Pakistan space cooperation was discussed in conjunction with the China-Pakistan Economic Corridor,⁸¹ and the agreement regarding China’s TT&C station in Argentina was made during a state visit that discussed a wide range of military and economic agreements.⁸² The United States should thus anticipate that space will play a role in China’s foreign policy toolbox going forward.

Importantly, China is far from alone in pursuing these international efforts. NASA has longstanding partnerships with an even wider range of countries than China, despite not engaging on the commercial side in the same way China does. Although most of its activities are with developed countries, NASA is also engaging in projects with Argentina, Bermuda, Brazil, India, and Thailand; leading a program that provides satellite-based Earth observation data and science applications to developing countries; and participating in several other international programs geared towards assisting developing countries.⁸³ In its own region, China may face competition from Japan, which had a space budget of roughly \$2.75 billion in 2015,⁸⁴ has launched microsatellites for Vietnam and the Philippines and engaged heavily with Vietnam’s space program,⁸⁵ and has engaged in numerous other international partnerships.⁸⁶ India may be another competitor: it spends roughly \$1 billion annually on its space program,⁸⁷ recently launched a satellite for Indonesia,⁸⁸ and has reportedly been concerned about China’s space cooperation with nearby Sri Lanka.⁸⁹ While China may reap benefits from space-related international cooperation activities, it should not be seen as having a monopoly on such efforts.

Third, China has been able to achieve several small public relations “victories” in Western media related to the question of competition vs. collaboration with the United States in space. As China’s space program continues to develop, this has served to draw attention to ways in which the United States has elected to restrict cooperation with China in space. A few recent examples include the 2016 announcement that China’s space station will be open to all users,⁹⁰ the 2015 CNN documentary on “China in Space” that featured Chinese astronauts discussing their inability to visit the ISS,⁹¹ news coverage of the ban mistakenly placed on Chinese scientists’ participation at an international NASA conference in 2013,⁹² several editorials arguing for greater U.S. cooperation with China,⁹³ and even scenes featuring cooperation in the 2015 movie *The Martian* (highly successful in China), which according to the director of the China National Space

Agency showed that “our U.S. counterparts very much hope to cooperate with us.”⁹⁴ These narratives have generally downplayed the legitimate concerns underlying U.S. restrictions on space cooperation with China. The scale of this public relations contest has been minor thus far, but does warrant attention due to its potential to grow.

Recommendations

In previous examinations of China’s space program, the Commission has made the following recommendations for Congressional action:

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

On a personal level, I note the value of U.S. leadership in space far exceeds that of achieving technical superiority or a high “medal count” in space exploration for its own sake. Having grown up in the 1960s and early 1970s, I can attest to the powerful impact the Apollo program had on me and on many other Americans, and the sense of patriotism and national purpose it inspired. In addition to the security and commercial reasons for U.S. leadership in this domain—the “ultimate high ground” according to experts in China—a visionary U.S. space exploration program can again strengthen our national purpose, inspire new generations of leading scientists and engineers, and continue to benefit mankind. As I consider this issue from my vantage point at the U.S.-China Commission, examining China’s expanding activities in space, the need for continued U.S. leadership becomes even more imperative.

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Biography of Dennis C. Shea
Chairman, U.S.-China Economic and Security Review Commission

Chairman Dennis Shea was reappointed by Senate Republican Leader Mitch McConnell for a term expiring December 31, 2016. An attorney with more than 25 years of experience in government and public policy, he is the founder of Shea Public Strategies LLC, a public affairs firm based in Alexandria, Virginia. Before starting the firm, he served as Vice President for Government Affairs – Americas for Pitney Bowes Inc., a Fortune 500 company.

Chairman Shea's government service began in 1988 when he joined the Office of Senate Republican Leader Bob Dole as counsel, subsequently becoming the Senator's deputy chief of staff in the Office of the Senate Majority Leader. In these capacities, he advised Senator Dole and other Republican Senators on a broad range of domestic policy issues, was involved in the drafting of numerous pieces of legislation, and was recognized as one of the most influential staffers on Capitol Hill. In 1992, Chairman Shea's service with Senator Dole was interrupted when he ran for Congress in the Seventh District of New York.

During the 1996 elections, Chairman Shea continued to help shape the national public policy debate as the director of policy for the Dole for President Campaign. Following the elections, he entered the private sector, providing legislative and public affairs counsel to a wide range of clients while employed at BKSH & Associates and Verner, Liipfert, Bernhard, McPherson, and Hand.

In 2003, Chairman Shea was named the Executive Director of the President's Commission on the United States Postal Service. Many of the Commission's recommendations were subsequently adopted in the landmark 2006 postal reform legislation.

In 2004, Chairman Shea was confirmed as Assistant Secretary for Policy Development and Research at the U.S. Department of Housing and Urban Development. As Assistant Secretary, Chairman Shea led a team responsible for conducting much of the critical analysis necessary to support the Department's mission. In 2005, Chairman Shea left to serve as Senior Advisor to Senator Elizabeth Dole in her capacity as chairman of the National Republican Senatorial Committee.

Chairman Shea received a J.D., an M.A. in History, and a B.A. in Government, from Harvard University. He is admitted to the bar in New York and the District of Columbia. The Chairman currently resides in Alexandria, Virginia with his wife Elizabeth and daughter Juliette.

Chairman BABIN. Thank you, Mr. Shea.
I now recognize Mr. Stokes for five minutes to present his testimony. Mr. Stokes.

**TESTIMONY OF MR. MARK STOKES,
EXECUTIVE DIRECTOR,
PROJECT 2049 INSTITUTE**

Mr. STOKES. Thank you. Mr. Chairman, Members of the Subcommittee. It's an honor and privilege to be able to have this opportunity to come and present before you today.

I'd like to make three points. The testimony should be able to speak for itself, and I can provide more details in the question-and-answer session. But I'd like to make three points to sort of emphasize various aspects of developments in China's space capabilities.

Number one, it's important to draw upon and augment what Mr. Shea mentioned about the difficulty between distinguishing military capabilities and civilian capabilities in China's space program, and this is part of a conscious policy referred to these days as military-civilian fusion—MCF for short. There is a long history behind military-civilian fusion dating back perhaps to the 1980s. Dong Zhou Ping, he had a 16-character slogan in which military programs or military projects or civilian projects and investments were intended to support each other with the military taking priority. The term previously was referred to in English as integration so the military integration, not military-civilian fusion, presumably to imply a greater degree of cooperation between the two sectors.

It is difficult to distinguish military and civilian programs but one can at least make an attempt to identify an end user or sponsor, in other words, who is actually managing the program. There are some aspects of China's space program that are managed by civilian organizations, and then there are some military end users. This was not always the case. When China embarked upon their space program in the beginning, there was very much of even more of a blurring. Over the last decade or 10, 15 years, there's been an increasing effort with PLA developing dedicated military systems, particularly, for example, remote sensing programs, and there also of course are other organizations, civilian organizations, that have their own systems, say, for example, there's an ocean organization under the state council that's important. But, you know, part of this has to do with both spin-on and spin-off capabilities in space.

The second point I'd like to make is related to technological progresses being made, particularly in the research, development and acquisition system. This is probably where China has made the most significant achievements, not necessarily in the technology itself but in the ability to mobilize resources and to organize in a very progressive and reasonable fashion in terms of increasing capabilities.

As mentioned in the written testimony, there is sort of a stage-phase pathway to fielding systems ranging from preliminary research or basic research to concept development, to engineering, research and development, then all the way up to testing and then fielding. It's important to understand where each individual program is in the cycle to get a feel for how far along that they are. There's a pretty wide body of information that outlines the various

programs all the way from satellites, remote sensing satellites, communication satellites, guidance navigation satellites, significant increasingly diverse set of launch vehicles that are being fielded to include starting last year a solid-fuel launch vehicle, one of their first to be deployed and operationalized. There's significant investments in the counter-space systems to include the ability to be able to track and surveil space assets, and of course, the manned space program. So there are significant capabilities that are being developed in this field.

There are three goals, to put it simply, in my view. One of the key goals of course is political, political legitimacy. One has to remember that ultimately the People's Republic of China is a one-party system, that the Chinese Communist Party seeks legitimacy in various ways and which the space program is certainly one of these. There are military goals, and again, there's a wide body of literature that outlines these goals and capabilities. And then there are economic goals as well.

And then finally, directly addressing the issue of the Space Race. It's difficult to define exactly what the Space Race is, and it's not even clear if we're even competing or we even view space as an area of competition with the People's Republic of China. And there may be different playing fields. For example, the political playing field, I think, is significant. But regardless from a technology perspective, Beijing and authorities in Beijing are closing the technology gap. It's my view that the United States technologically is likely to maintain advantage, bearing in mind that I'm not an expert on U.S. space systems, given the United States makes proper investments in our space capabilities.

In terms of future and goals in terms of what the United States should do in order to understand this better, in terms of defining what the competition would be, there's technological aspects. There's the ability to be able to apply capabilities that are being deployed, and then some comparison of the ability to mobilize resources in terms of personnel, budgets, and then organization.

And with that, I will save the rest of my comments for the question-and-answer session.

[The prepared statement of Mr. Stokes follows:]

**Prepared Statement of
Mark A. Stokes
Executive Director
Project 2049 Institute
Before
The United States House Committee on Science, Space, and Technology
Space Subcommittee**

Are We Losing the Space Race to China?

**Tuesday, September 27, 2016
2318 Rayburn House Office Building
Washington, DC**

Mr. Chairman, thank you for the opportunity to participate in today's hearing on an issue that is important to U.S. interests in peace and stability in the Asia-Pacific region. It is an honor to testify here today. The evolving capacity of the People's Republic of China (PRC) to leverage space assets presents a number of challenges for the United States, allies, and friends in the Asia-Pacific region. In my presentation this morning, I will focus my remarks on PRC investment into militarily relevant space technologies and offer a basic outline of its research, development, and acquisition system. Under an evolving policy of military-civilian fusion, the line dividing civil and military space is becoming increasingly blurred.

The PRC has embarked upon an ambitious dual-use, civil-military space program that is predominantly driven by the desire to stand among equals in the international community. However, as in most space programs around the world, there is a prominent military application. The Chinese People's Liberation Army (PLA) is gradually developing a capacity to project military power vertically into space and horizontally beyond its immediate periphery. Senior civilian and military leaders view the aerospace sector – the space and missile industry -- as one aspect of a broad international competition in comprehensive national strength and science and technology (S&T).

The PRC is improving its ability to research, develop, and field innovative capabilities and advanced weapon systems. Increasingly sophisticated space-based systems expand PLA battlespace awareness and support extended range conventional precision strike systems. Space assets enable the monitoring of naval activities in surrounding waters and the tracking of air force deployments into the region. The PLA is investing in a diverse set of increasingly sophisticated electro-optical (EO), synthetic aperture radar (SAR), and electronic reconnaissance assets. Space-based remote sensing systems also provide the imagery necessary for mission planning functions, including automated target recognition technology that correlates pre-loaded

optical, radar, or infrared images on a missile system's computer with real time images acquired in flight. A constellation of small electronic reconnaissance satellites, operating in tandem with SAR satellites, could provide commanders with precise and timely geolocation data on mobile targets. Satellite communications also offer a survivable means of linking sensors to strike systems, and will become particularly relevant as PLA interests expand further from PRC borders. Existing and future data relay satellites and other beyond line of sight communications systems could transmit targeting data to and from theater command elements. An increasingly diverse and reliable family of launch vehicles is available to support various missions and payloads. In addition, the PLA is developing mobile or air launched solid-fuelled launch vehicles for placing small tactical satellites into orbit during crisis situations.

The PLA also is modernizing its ground-based surveillance and tracking system in order to meet demands presented by its expanding presence in space and defend against perceived air and space challenges. Supported by an improved surveillance and tracking system, the PLA has demonstrated a rudimentary ability to engage flight vehicles in space, such as polar orbiting satellites and medium range ballistic missiles. The PLA appears to be investing resources into ground-based radar systems capable of providing queuing quality data for engaging targets in space. The PLA also has invested in electronic countermeasure technologies that could degrade an adversary's satellite communications, navigation satellite signals, or SAR satellites operating within line of sight of an emitter.

Overview of Military Space Organization and Requirements

Guided by the Chinese Communist Party Central Committee Political Bureau, the Central Military Commission (CMC) and State Council establish national space and counterspace requirements. Within a broad and fragmented party and state policy framework, a diverse set of end users develop space-related requirements for CMC/State Council approval, based on organizational roles and missions. The end user of a particular system most likely drafts detailed requirements documentation based upon short (e.g., five year) to long term (e.g., 15 or more years) plans. Civilian organizations, such as the State Oceanic Administration, appear to develop requirements for satellite programs in support of their unique missions.

The PLA's requirements development system remains opaque. However, second level departments within the newly established CMC Joint Staff Department (JSD) and PLA Strategic Support Force (PLASSF) presumably develop and coordinate operational requirements for militarily relevant space-based surveillance, communications, and navigation systems. More specifically, the JSD probably develops operational requirements for navigation, weather, and mapping satellites. The SSF most likely is responsible for dedicated military EO and possibly SAR satellites, and possibly space-based electronic reconnaissance systems and possibly satellite electronic countermeasures. The CMC JSD would establish requirements for dedicated military

communications satellites. Operational requirements presumably are coordinated with the PLA Navy, Air Force, Rocket Force, and the five theater commands.

The CMC Equipment Development Department (EDD) supports the CMC/State Council in the development and acquisition of technical solutions to satisfy operational requirements. Like its predecessor, the General Armaments Department, the EDD develops, coordinates, and oversees defense acquisition and technology policies for the CMC. It also oversees large national-level space engineering projects, such as the manned space program. However, the former GAD's space launch mission appears to have transferred to the newly established PLASSF. The PLASSF likely is responsible for development of launch vehicle requirements, as well as space surveillance and control. The PLASSF also likely manages China's National Space Command and Control Center. The CMC Science and Technology (S&T) Commission functions as the CMC's principle advisory group addressing China's long term military technology policies. The commission manages working groups, comprised of leading authorities from across China's civilian and military S&T community, which establish technology development priorities. The State Council's China National Space Administration coordinates and executes international space cooperation agreements.

Space Research, Development, and Production

Presumably influenced in part by the U.S. Planning, Programming, and Budgeting System (PPBS) and Soviet design system, basic principles for China's space-related R&D were established in the 1960s and, with some exceptions, appear to have changed little over time. How much China spends on civil-military space R&D remains unclear. Based on CMC/State Council planning, programming, and budget guidance, however, space-related R&D may consist of four phases. A phased approach calls for multiple variants of the same basic space system to be in the R&D cycle at any one time.

Preliminary research is focused on initial development of basic technologies that eventually could be applied to multiple programs. A strong preliminary research program helps reduce engineering R&D time and risk. Preliminary research can also focus on technologies applicable to a specific system, for instance, a movable spot beam antenna for a communications satellite or a new launch vehicle propulsion system. Funded in part through national-level technology development efforts such as the 863 Program, the EED, CMC S&T Commission, and other end users function as important supervisory bodies for projects in this phase.

During the *concept development and program validation phase*, an end user, working in conjunction with defense industry, identifies key technologies, determines the feasibility of a program, and assesses alternatives that could meet basic operational and technical requirements. The concept and program validation phase draws heavily on results from preliminary research

projects. PLA equipment research academies, technical bureaus, and research institutes appear to play a major role during this phase. Major programs likely require CMC/State Council-level approval before investing in engineering research and development (R&D).

During the *engineering R&D phase*, two civilian defense industrial enterprises -- the China Aerospace Science and Technology Corporation (CASC) and China Aerospace Science and Industry Corporation (CASIC) support the CMC/State Council and end users in the R&D and production of space and counterspace systems. CASC and CASIC research academies specialize in certain space-related core competencies, such as heavy lift launch vehicles, tactical solid fueled launch vehicles, and satellites. A research academy is roughly analogous to a US defense corporate business division. CASC/CASIC academies are organized into design departments (or systems engineering institutes); research institutes focusing on sub-systems, sub-assemblies, components, and materials; testing facilities; and manufacturing plants.

CASC is China's primary supplier of satellites and large launch vehicles, while CASIC appears to serve as a lead systems integrator for tactical microsatellite and space intercept systems. Other defense industrial enterprises, such as the China Electronics Technology Corporation (CETC), may supply sub-systems, such as space-based electronic reconnaissance receivers or data links. Increasingly accountable for profit and loss reporting, trends indicate growing competition between research academies in securing R&D and manufacturing contracts.

Engineering R&D programs are managed through a dual command system that divides administration and technical responsibilities. Administrative responsibilities reside with a program manager, while technical aspects of a program are the responsibility of the chief designer and his/her design team. The program manager, or literally *general commander*, ensures timeliness standards are being met, quality is assured, schedules testing, and manages the program budget. Program managers of major satellite and launch vehicle projects often are dual hatted as deputy directors of CASC research academies.

Members of the technical design team appear to have concurrent positions within an academy's design department and research institutes. For example, chief designers of major satellite programs hold concurrent positions within CASC's China Academy of Space Technology (CAST) General Design Department and Shanghai Academy of Space Technology's Institute of Satellite Engineering. Chief designers are also assigned for space launch vehicles, including those delivering anti-satellite kinetic kill vehicles. To ensure requirements are met, PLA end users maintain industrial representative offices within CASC and CASIC design departments, research institutes, and factories.

During the *design finalization phase*, end users and industrial program managers evaluate whether or not a design satisfies operational and technical requirements. For major programs, a

design finalization committee is comprised of members of the CMC and State Council (Premier or Vice Premier). A joint CMC-State Council standing office appears to support the design certification committee.

Concluding Remarks

In short, PRC space-related ambitions are driven by political, economic, and military considerations. With a broad mandate granted by party and state authorities, the PLA plays a leading role in developing operational requirements for civilian and militarily-relevant space systems, overseeing technology development that could satisfy operational requirements, and managing the national space launch, tracking, and control system. Under a national policy of military-civilian fusion, the line dividing civil and military space is becoming increasingly blurred.

China adopts an incremental, phased approach to space-related R&D. In supporting CMC/State Council-approved acquisition projects, the CMC JSD, EED, PLASSF, and other end users rely on the space and missile industry for engineering R&D. Engineering R&D is characterized by an industrial dual chain of command that divides administrative and technical responsibilities. China's space and missile industry – CASC and CASIC – stands out as perhaps the most technically successful defense enterprises in China today. While basic approaches to R&D appear to have changed little over the decades, innovative organizational changes within the PLA and space industrial structure could enable significant advances over time. Among these include establishment of formal and informal organizations intended to facilitate collaboration between the PLA, civilian authorities, defense industry, and academia for purposes of diffusing space technology.

In closing the technological gap with the United States, the PRC's capacity to field increasingly sophisticated space systems is largely a reflection of its organizational efficiency and an expanding pool of capable engineers. Chinese space development also has benefitted from foreign successes. In addition to formal bilateral space cooperation relationships with Russia and other space-faring nations, each industrial academy oversees an information collection and dissemination institute that diffuses publicly available technical data from around the world. PLA operational requirements, technology development, and engineering R&D are also likely informed by intelligence collected through traditional clandestine human sources and signals intelligence (including cyber espionage).

END

BIOGRAPHY
MARK A. STOKES
(as of September 15, 2016)

Lieutenant Colonel (retired) Mark A. Stokes is Executive Director of the Project 2049 Institute. The Project 2049 Institute, established in January 2008, seeks to guide decision makers toward a more secure Asia by the century's mid-point. The organization fills a gap in the public policy realm through forward-looking, region-specific research on alternative security and policy solutions. In addition to Taiwan issues, Mark's primary research focus includes Chinese People's Liberation Army (PLA) strategic missile forces, space and missile industry, signals intelligence, Chinese Communist Party (CCP) political leadership and foreign security policymaking, and cross-Strait relations.

Mark has served in a variety of military and private sector positions. A 20 year U.S. Air Force veteran, he was assigned to electronic warfare, intelligence, planning, and policy positions. He began his career as a signals intelligence officer. From 1984-1986, he was assigned to the 6922nd Electronic Security Squadron, Clark AB, Philippines. From 1986-1989, he served as a signals intelligence and electronic warfare officer in the 6912th Electronic Security Wing, Berlin, West Germany. After graduate school and Chinese language training, Mark served as assistant air attaché at the U.S. Embassy in Beijing from 1992 to 1995. His primary responsibility was monitoring and reporting on PLA space and missile developments. He was a recipient of the Director of Central Intelligence's Collector of the Year Award in 1995.

From 1995 to May 1997, he was assigned as a strategic planner within the U.S. Air Force Plans and Operations Directorate. Between 1997 and 2004, he served as team chief and senior country director for the People's Republic of China (PRC), Taiwan, and in Mongolia in the Office of the Secretary of Defense. In this position, he was responsible for developing, coordinating, and managing U.S. defense policy with respect to the PRC, Taiwan, and Mongolia.

After retiring from military service as a lieutenant colonel, he worked in the private sector on Taiwan for more than three years. He served as executive vice president of Laifu Trading Company and subsequently as Taiwan country manager for Raytheon International. Mark also was a member of the Board of Governors of the American Chamber of Commerce in Taiwan.

Mark began work with the Project 2049 Institute upon its establishment in 2008. He holds a BA from Texas A&M University and graduate degrees in international relations and Asian studies from Boston University and the Naval Postgraduate School. He has working proficiency in Mandarin Chinese.

Chairman BABIN. Thank you, Mr. Stokes.
Now I recognize Mr. Cheng for five minutes to present his testimony.

**TESTIMONY OF MR. DEAN CHENG,
SENIOR RESEARCH FELLOW,
ASIAN STUDIES CENTER,
HERITAGE FOUNDATION**

Mr. CHENG. Chairman Babin, Ranking Member Edwards, Chairman Smith, distinguished Members of the Committee, my name is Dean Cheng. I'm the Senior Research Fellow for Chinese Political and Security Affairs at the Heritage Foundation but I'd like to emphasize that my comments today are my own.

Directly to the point of whether or not there is a space race underway between the United States and China, I would like to suggest that there is not a space race per se but rather that there is a race between the United States and China on multiple different aspects and fronts, political, diplomatic, security, all of which have a space component, and that is the Chinese perspective because the Chinese view space as being an essential part of the larger effort to raise China's comprehensive national power.

Comprehensive national power is how the Chinese basically look at various countries including themselves, how they rank with each other how capable they are. It includes economic, diplomatic, political, cultural, science and technology, as well as military aspects, and from the Chinese perspective, space development contributes to every one of those elements of comprehensive national power.

With regards to the economy, space is seen as a pivotal technology. Because it is so dense, as the Chinese put it, in science and technology, in high technology, because it touches on such aspects as advanced materials, telecommunications, computing, and above all, systems engineering and systems integration. The Chinese see an advancing space capability that's almost like a locomotive that will pull along other parts of the Chinese economy. The space workforce in particular is seen as building expertise in key areas including systems integration, and we have seen key leaders in China's space industry transfer to areas such as the Commercial Aircraft Corporation, China's effort to build their own wide-bodied aircraft in the belief that their experience in the space sector can be translated into building Chinese challengers to Boeing and Airbus.

We also see this in terms of the Chinese folks on indigenous innovation. The perception is that China's ability to field a full-blown space program will spark innovation in other areas, other key sub-technologies.

In addition, of course, we also see the Chinese using space in terms of their political efforts, and this is both domestic and foreign relations. Space is a source of prestige, and prestige in this case supports both the legitimacy of the Chinese Communist Party but also the prestige of the People's Republic of China. For example, space achievements are often described as CCP achievements, and so China's space program, which grew out of the so-called two bombs, one satellite program, not only is a reflection of the relationship the Chinese view space with regards to key strategic

weapons but also as a means again of promoting innovation. We also see the expectation that economic development through space will basically again help spark a revival of the Chinese economy, which right now seems to be slowing down.

With regards to foreign relations, again, we see space being used as a key diplomatic tool in both the bilateral and the multilateral aspects, bilaterally, in terms of sales of satellites to such states as Venezuela, Bolivia, Bangladesh, Pakistan, all of whom are key sources of raw materials that help power the Chinese economy, but also at the multilateral level, again such as the Asia-Pacific Space Cooperation Organization, which brings in Thailand, Malaysia, Mongolia. These are not major space powers per se, but they are key neighbors of the People's Republic of China, and they are using APSCO as a diplomatic tool.

Of course, it is implicit that the ability to maintain space-based surveillance and to put payloads into orbit obviously affects Taiwan, obviously affects Japan. I would also suggest to the Committee that when, not if, the Chinese are able to go to the Moon, first with a robotic lander on the far side, to think about how you will communicate with something on the far side of the Moon. In order to do that, it will require the establishment of a lunar satellite, satellites that will orbit the Moon. The implications for military and security aspects are self-evident. But also, the day that the Chinese land a human being on the Moon will be an enormous impact on the United States because how often have we heard we've gone to the Moon, why haven't we, you know, solved the common cold, why haven't we solved traffic problems in downtown DC. The reality is that the day the Chinese are able to do the same thing is the day that American uniqueness will be openly challenged and Chinese prestige will be put on the same level as that of the United States.

Thank you very much, members of the Committee, for your time.
[The prepared statement of Mr. Cheng follows:]



CONGRESSIONAL TESTIMONY

U.S.-China Competition in Space Testimony before Subcommittee on Space Committee on Science, Space, and Technology

U.S. House of Representatives

September 27, 2016

Dean Cheng
Senior Research Fellow for Chinese Political and Security Affairs
The Heritage Foundation

Subcommittee Chairman Babin, Ranking Member Edwards, and Members of the House Subcommittee on Space. My name is Dean Cheng, and I am the Senior Research Fellow for Chinese political and security affairs with The Heritage Foundation. The views I express in this testimony are my own and should not be construed as representing any official position of The Heritage Foundation.

My comments today will be about the evolving Chinese views on space operations, with a particular focus on Chinese military thinking.

It is important to first recognize that the United States and the People's Republic of China (PRC) are not in a "space race," as was the case between the United States and the Soviet Union from 1957 through at least 1969. The Chinese are not competing with the United States to set new "firsts." Instead, the PRC is pursuing a methodical program of space exploitation, building upon both its own experiences, and those of the United States, the Soviet Union, Russia, and Europe.

Where there is a clear competition, however, is in the arena of military space.

The Chinese People's Liberation Army (PLA) has been a close observer of other nations' wars. Since the early 1990s, Chinese military analysts have carefully analyzed such conflicts as the first Gulf War (Operation Desert Shield/Desert Storm), the NATO

intervention in the Balkans, the American invasion of Afghanistan, the 2003 Iraq War, as well as earlier conflicts such as the 1973 Arab-Israeli War and the 1982 Falklands conflict.¹

From their analysis, Chinese military thinkers and planners have concluded that future wars will be very different from those of the past. This is in part because of the larger changes in technology, society, and economics. In the Chinese view, we are now in the Information Age, rather than the Industrial Age. The comprehensive shift towards an information society is inevitably reflected in how wars are fought, just as Industrial Age wars were different from those fought in the age of feudalism. Moreover, because of the changes in technology, future wars will involve not only the traditional domains of land, sea, and air, but also outer space (and the electromagnetic spectrum). Indeed, outer space is seen as playing a key role in fighting and winning future wars.

This emphasis on the military importance of space is reflected in a range of Chinese military publications. Many of these are textbooks and teaching materials, used to teach the importance of space to the PLA.

For example, the 2005 volume *Military Astronautics* was a PLA textbook for space operations. Its author, General Chang Xianqi, was formerly director of the General Armament Department's (GAD's) Academy of Equipment Command and Technology (

装备指挥技术学院), described as the main training site for China's space operators. It may have been renamed the Academy of Equipment (装备学院).

In the 2011–2013 period, the PLA's Academy of Military Science (AMS) issued a series of teaching materials for its master's degree candidates. This series of 65 volumes included ones focused on the conduct of space operations, joint campaign command, and outlining what kinds of operational capabilities need to be built in the future.

Finally, the PLA has published *The Science of Military Strategy*, authored by the AMS Military Strategy Research Department as a PLA textbook, and a follow-on to an earlier 2001 edition (which the AMS translated into English in 2005).

Based on a review of these and other PLA writings, it is clear that there has been a steady evolution of how the PLA views future warfare, which provides the context for the progression in how the PLA thinks about space operations.

PLA analyses concluded, first, that future wars will involve joint operations. From observations stemming back to the first Gulf War, the PLA's analysis indicated that current, and therefore future, conflicts would involve not only land, sea, and air domains, but also outer space and cyberspace. This is based upon a number of factors, including the deployment of land-based, sea-based, and air-based precision-guided munitions and the ability of military forces to observe opponents from over the horizon. Thus, future wars would be "local wars under modern, high-technology conditions." In order to fight such wars, the PLA would have to jettison the old ideas of relying on masses of obsolescent equipment, and instead field more sophisticated, high-tech weapons that would allow them to fight on an even footing against opponents.

This expansion of warfare would also therefore require the participation of all the various services, operating in those domains, in order to achieve victory. Few wars will be won through land, sea, or air-power alone. Instead, it will be necessary to employ diverse forces, operating across multiple domains, both in order to overwhelm enemy defenses and to compensate for weaknesses in any particular set of forces.

These forces would engage an adversary through coordination of joint operations. That is, forces at

the *juntuan* level, group armies, military region air forces, and entire fleets would be brought into the same area and coordinate their respective operations to generate synergies that would allow them to match, and hopefully overwhelm, their enemies.

But the ability to conduct joint operations, spanning millions of cubic kilometers, reaching from outer space to the ocean depths and crossing continents, requires common situational awareness, which in turn involves extensive communications networks and arrays of networked sensors. Thus, future wars will not be based on contests between individual weapons or even weapon systems, but conflicts between systems of systems (*tixi*; 体系).² These systems of systems, in turn, will be bound together through information.

As the relative importance of information grew, the PLA has concluded that wars in the Information Age will typically be "local wars under informationized conditions (*xinxihua tiaojian xia jubu zhanzheng*; 信息化条件下局部战争)," much as wars in the Industrial Age were mechanized wars. The forces required to fight such local wars under informationized conditions, in turn, could no longer be individual services coordinating their activities, but instead would have to be integrated, unified forces, with joint activities pushed ever further down to the operational and even tactical level. Thus, from "coordinated operations (协同联合战役)," the PLA has sought to field forces capable of conducting "integrated, or unified, joint operations (一体化联合战役)."

The key to being able to fight such operations rests upon the ability to gather, transmit, manage, analyze, and exploit information faster and more accurately than your adversary, while preventing them from doing the same. This is termed establishing "information dominance (*zhi xinxi quan*; 制信息权)."

To this end, space plays an essential role. Based on PLA assessment of recent "local wars" (which encompasses most wars since at least the Vietnam War and the 1973 Arab–Israeli war), space has been of steadily growing importance. More and more essential data, from meteorological information to weapons guidance and communications, is gathered from or transmits through satellites. Consequently, establishing "space dominance (*zhi tian quan*; 制天权)" has assumed greater importance, as it is

1. Throughout this paper, Chinese names are provided surname first. These are capitalized.

2. BAI Bangxi and JIANG Lijun, "Systems Combat" Is Not the Same as "System Combat," *China National Defense Newspaper*, January 10, 2008, http://www.chinamil.com.cn/site1/xwpdxw/2008-01/10/content_1084469.htm (accessed September 21, 2016).

seen as an essential element of achieving “information dominance.”

This higher profile is reflected in some of the most recent official documentation regarding the PLA and Chinese national security. In the new National Security Law, passed in July 2015, outer space is specifically mentioned as an area where Chinese security interests must be preserved. In the 2015 Chinese defense white paper, outer space is referred to several times as a “commanding height” in the international strategic competition. In the newest edition of *Science of Military Strategy*, a chapter is devoted to discussing military conflict in the space and cyber (as well as nuclear) domains, where it is noted that the importance of space has grown significantly for both military and broader national purposes.³

This growing emphasis on the importance of space builds upon a longer term Chinese analysis of other peoples’ wars dating back to the 1990s, where the Chinese concluded that space plays an increasing role in American warfighting. It also builds on Hu Jintao’s 2004 “new historic missions” speech to the Central Military Commission, where he talked about the tasks before the military. Hu observed that China’s national interests and security had gone beyond the traditional land, sea, and air and shifted towards the oceans, space, and the electromagnetic domain. “Maritime security, space security, electromagnetic spectrum security,” he noted, “are already vital regions for national security,” where a small number of major powers are seeking to secure the advantage. Hu elevates space security, along with maritime security and electromagnetic security, to the equivalent of the security of land, sea, and air territories.⁴

Evolution in the Guiding Thoughts for Military Space Operations

What is consistent in these various PLA writings is an emphasis on securing space dominance as part of any joint campaign. At this point in time, it is still not yet clear, based on open-source materials, whether the PLA has promulgated a formal doctrine

for military space operations to support securing space dominance. However, PLA writings do discuss key attributes that any doctrine would likely contain. For example, it would appear that there is a “guiding thought (*zhidao sixiang*; 指导思想)” for space operations. For the PLA, the “guiding thought” establishes certain principles that are expected to inform doctrine, activities, and acquisition. In the case of the PLA, the “guiding thought” for space operations, like the assessment of the importance of space dominance, appears to have been evolving over the past decade.

The View from 2005

In 2005, GAD General Chang Xianqi published the second edition of *Military Astronautics*, which was used as a textbook for teaching the PLA about military space operations. In that volume, General Chang proposed a “guiding thought” that for space operations of “unified operations, key point is space dominance.”⁵

Unified Operations

According to Chang, the establishment of space dominance (*zhitian quan*; 制天权) will entail unified operations (*yiti zuozhan*; 一体作战), which will in turn involved unified forces, techniques, and operational activities.⁶

Unified Forces. Unified forces involves two aspects. One is the integration of civilian and military space systems, both in prewar planning and wartime application. This provides a more robust capability, at a lowered cost. The other is unifying space forces with land, sea, air, and electromagnetic forces in joint operations. Terrestrial forces benefit from space support—they can both degrade opponents’ space forces (e.g., through attacks against ground stations) and preserve one’s own space capabilities (by defending against comparable attacks).⁷

Unified Techniques. Unified techniques refer to combining soft-kill and hard-kill methods. It should be noted that both hard-kill and soft-kill techniques serve the same ends, which is to reduce

3. AMS Military Strategy Research Department, *The Science of Military Strategy* (Beijing: Military Science Publishing House, 2013), pp. 178-188.

4. HU Jintao, “Understanding Our Military’s New Historic Missions in the New Phase of the New Century,” December 24, 2004, <http://gfjy.xnews.com.cn/system/2010/04/16/011353408.shtml> (accessed September 21, 2016).

5. CHANG Xianqi, *Military Astronautics*, 2nd ed. (Beijing: Defense Industries Press, 2005), pp. 273-279.

6. Note that *yiti* may be translated as either “integrated” or “unified.” While the former translation is common, in the context here the latter would seem to be more appropriate. For that reason, as well as to avoid confusion with the term *zhengti*, which is also translated as “integrated,” we will use the translation “unified” in the body of the paper.

7. CHANG Xianqi, *Military Astronautics*, 2nd ed., pp. 275 and 276.

an opponent's advantage in space while preserving one's own, in order to secure space dominance. Soft-kill techniques such as dazzling or cyber attacks are less likely to incur international repercussions, but may allow an opponent to recover.⁸ Hard-kill techniques may also be aimed at destroying not only satellites (such as in the 2007 anti-satellite (ASAT) test), but also includes physical attacks against tracking, telemetry, and control (TT&C) facilities and launch sites.

Unified Operational Activities. Unified operational activities involve coordinating offensive and defensive operations. Offensive activities, which may include both soft-kill and hard-kill methods, are likely to be undertaken at the earliest possible moment, in order to seize the initiative and force the enemy into a reactive mode.⁹ Defensive activities, meanwhile, will also be implemented from the onset of operations, so as to limit the effectiveness of enemy efforts to interfere with, seize, destroy, or disrupt one's own space systems.¹⁰ These will include active defenses such as air defense, and passive measures such as camouflage and concealment of space-related facilities, as well as redundancy and mobility. Mobile TT&C facilities, for example, should be developed and deployed to concealed locations, ready to replace fixed sites should the latter be attacked.¹¹

Key Point Is Space Dominance

The purpose of the unified operations outlined above is to establish space dominance or space superiority (*zhitian quan*; 制天权): the ability to exploit space for one's purposes, at times and places of one's choosing, while denying an opponent that same freedom of action. In order to obtain space dominance, one needs to sustain the uninterrupted operation of space information collection and transmission systems. This includes the smooth operation of satellites, launch facilities, TT&C systems, and the attendant data-links that bind the components together. Successful efforts at establishing space dominance therefore must also take into account

the sustainment of this entire structure of terrestrial and space systems and associated data and communications links, while striving to degrade or destroy an opponent's.¹²

To this latter end, Chang proposed that one needs to conduct unified operations against an opponent's most important space targets. These are the key information and space assets which will most affect the enemy's capabilities, located in the main strategic direction. They should be attacked by one's best forces, at the crucial moments of the campaign, with the aim of degrading the enemy's ability to field unified space power.

The View from 2013

In the 2013 *Science of Space Operations Teaching Materials*, the "guiding thought" has evolved. It is now described as: "active defense, all-aspects unified, key point is dominating space."¹³ Each of these phrases embodies a number of essential concepts.

"Active Defense." Active defense is integral to all Chinese military strategy, and is not limited to space-related operations. While assuming the strategic defensive, the PLA concept of active defense emphasizes the importance of seizing the initiative at the tactical and operational level. In the context of space operations, active defense again assumes a more strategically defensive stance, although one which nonetheless seeks to deter aggression and maintain national security and interests. At the same time, however, it involves the PLA undertaking space-combat preparations so as to be able to seize the initiative in space-related operations. In particular, it presumes "offensive actions at the campaign and tactical level to secure strategically defensive goals."¹⁴

While there are always references to the "active defense" in Chinese writings, its inclusion in the "guiding thought" may reflect the elevation of space operations to a strategically significant role.

"All Aspects Unified." All aspects unified refers to the need to unify thinking about a number of

8. Ibid., p. 290.

9. Li Daguang, "The Characteristics and Rules of Law of Space Strategy," *China Military Science*, Vol. 1 (2002).

10. FAN Xuejun, "Militarily Strong Nations Are Steadily Developing 'Space Information Warfare,'" *People's Liberation Army Daily* (April 13, 2005).

11. GUAN Weiqiang, QIN Daguo, and XIAO Lianggang, "Research on Requirements for Aerospace TT&C Systems for Integrated-Style Joint Operations," *Journal of the Academy of Equipment Command and Technology*, Vol. 17, No. 6 (2006).

12. CHANG Xianqi, *Military Astronautics*, 2nd ed., pp. 278-279.

13. JIANG Lianju, *Space Operations Teaching Materials* (Beijing: Military Science Publishing House, 2013), p. 40.

14. Ibid.

different aspects of space operations. As in the earlier version, it involves viewing the various domains of military activity, including not only outer space, but land, sea, air, and the electromagnetic spectrum (e.g., cyber and electronic warfare operations), in a joint fashion. Space operations support terrestrial operations, while land, sea, air, and computer network operations can help achieve space superiority. But a further important aspect of all aspects unified is the integration of space operations into the larger joint campaign planning and command and control functions. Space operations must also be integrated into larger, joint campaign plans to help achieve terrestrial objectives; command and control of space operations must therefore reconcile space-related requirements, timing, and structure with those of the overarching joint campaign.¹⁵

At the same time, the phrase also signals the PLA officer to view all the various space activities, including offensive and defensive operations, provision of information support and fire support, and hard-kill and soft-kill methods, in an integrated or unified fashion. The PLA officer should not view it as either hard-kill or soft-kill, for example, but employing the best tool for the task at hand.

“Key Point Is Establishing Space Dominance.”

Key point is establishing space dominance in part builds upon the PLA's emphasis on striking the enemy's key points (*zhongda yao hai*; 重打要害), especially those nodes within the enemy's combat system of systems (*zuozhan tixi*; 作战体系). One must concentrate one's best forces and capabilities to precisely strike such key targets with a combination of hard-kill and soft-kill weapons, with the goal of paralyzing the adversary. At the same time, one must be able to exploit space for one's own ends, whether in the provision of information support to friendly terrestrial operations, undertaking space deterrence, or engaging in operations against remaining enemy space assets.¹⁶

Key point is space dominance therefore has several meanings. On the one hand, it is reminding PLA officers and staff that *an important priority must be securing space dominance over an opponent*. Resources must be applied against an enemy's space systems (e.g., terrestrial facilities, orbiting platforms, data links) to disrupt and deny an opponent

the ability to exploit space over the course of the entire campaign.

As important, *one must also be prepared to defend one's own space infrastructure, since the enemy is likely to be striving to secure space dominance as well*. This is essential since even with the full range of national space assets it provides only a limited resource base. Chinese analysts recognize that space systems are fragile; as important they are extremely expensive, so even wealthy nations are unlikely to have a substantial reserve of platforms. Nor do many nations have a multiply redundant terrestrial space launch and mission control network. (In this regard, it is worth noting that, with the inauguration of the Hainan Island space port, China will have four space launch facilities.) Therefore, the other aspect of key point is space dominance is that *space operations need to be focused, with a specific focus, a key point, and not scattershot*. Attacks against adversary space infrastructure need to be carefully coordinated and undertaken at essential moments in the overall campaign to maximize effect.

Mission Areas Associated with Space Operations

PLA analysts believe that military space operations are likely to entail five broad styles (*yangshi*; 样式) or mission areas: space deterrence, space blockades, space strike operations, space defense operations, and provision of space information support.¹⁷ While the tasks have not changed between 2005 and 2013, the ordering, reflecting importance, has.

Space Deterrence (*kongjian weishe*; 空间威慑).

Space deterrence is the use of space forces and capabilities to deter or coerce an opponent, preventing the outbreak of conflict or limiting its extent should conflict occur. By displaying one's own space capabilities and demonstrating determination and will, the PLA would hope to induce doubt and fear in an opponent so that they would either abandon their goals, or else limit the scale, intensity, and types of operations. It is important to note that space deterrence is not aimed solely, or even necessarily, at deterring actions in space, but rather, in conjunction with nuclear, conventional, and informational deterrence capabilities and activities, they seek to influence an opponent's overall perceptions and activities.

15. *Ibid.*, p. 43.

16. *Ibid.*, p. 44.

17. This section draws upon *ibid.*, pp. 126–154.

Both the earlier textbook and more recent teaching materials suggest that there is a perceived hierarchy of space deterrence actions, perhaps akin to an “escalation ladder” involving displays of space forces and weapons; military space exercises; deployment or augmentation of space forces; and employment of space weapons.

Displays of Space Forces and Weapons (kongjian lilang xianshi; 空间力量显示). Displays of space forces and weapons occur in peacetime or at the onset of a crisis. The goal is to warn an opponent in the hopes of dissuading them from escalating a crisis or pursuing courses of action that will lead to conflict.

Military Space Exercises (kongjian junshi yanxi; 空间军事演习). Military space exercises are undertaken as a crisis escalates if displays of space forces and weapons are insufficient to compel an opponent to alter course. They can involve actual forces or computer simulations, and are intended to demonstrate one’s capabilities but also military preparations and readiness. At the same time, such exercises will also improve one’s military space force readiness. Examples include tests for ballistic missile defense, tests for ASAT units, exercises demonstrating space strike (*kongjian tuji; 空间突击*) capabilities, and displays of real-time and near-real-time information support from space systems.

Space Force Deployments (kongjian lilang bushu; 空间力量部署). Space force deployments are seen as a significant escalation of space deterrent efforts. It occurs when one concludes that an opponent is engaged in preparations for war and involves the rapid adjustment of space force deployments. As with military space exercises, this measure is not only intended to deter an opponent, but should deterrence fail, is seen as improving one’s own preparations for combat. (Such deployments, which may involve moving assets that are already in orbit and/or reinforcing current assets with additional platforms and systems, are intended to create local superiority of forces so that an opponent will clearly be in an inferior position.) It may involve the recall of certain space assets (e.g., space shuttles), either to preserve them from enemy action or to allow them to prepare for new missions. This may be akin to the evacuation of dependents from a region in crisis as a signal of imminent conflict.

The Chinese term the final step of space deterrence as “space shock and awe strikes (*kongjian*

zhenshe daji; 空间震慑打击).” (The term *zhenshe*, however, can be found in Tang Dynasty writings, so they did not get this from our 20th Century discussions.) If the three previous, non-violent deterrent measures are insufficient, then the PLA suggests engaging in punitive strikes so as to warn an opponent that one is prepared for full-blown, comprehensive conflict in defense of the nation. Such strikes are seen as the highest and final technique (*zuigao xingshi he zui hou shouduan; 最高形式和最后手段*) in seeking to deter and dissuade an opponent. Employing hard-kill methods, soft-kill methods, or a combination, one would attack an opponent’s physical space infrastructure or data links, respectively. If this succeeds, opposing decision makers will be psychologically shaken and cease their activities. If it fails, an opponent’s forces will nonetheless have suffered some damage and losses.

Space Blockade (kongjian fengsuo zuozhan; 空间封锁作战). Space blockades involve the use of space and terrestrial forces to prevent an opponent from entering space, and from gathering or transmitting information through space. Chinese writings suggest that there are several different varieties of space blockade activities. One is to *blockade terrestrial space facilities*, including launch sites, TT&C sites, and mission control centers. They can be disrupted through the use of kinetic means (e.g., special forces or missiles), or through computer and information network interference.

Orbit Obstruction. Another means is to obstruct orbits. This can include actually destroying satellites that are in orbit, or else obstructing orbits, such as by creating clouds of space debris or deploying space mines.

Launch Window Obstruction. Another alternative is the obstruction of launch windows. If one can delay a launch, whether through interfering with its onboard systems or otherwise disrupting the schedule, then a satellite may not be able to reach its proper orbit. In the past, some American space launches have been delayed because fishing and pleasure boats were present down-range.¹⁸ This alternative also includes the possibility of a boost-phase intercept of a space launch vehicle.

Information Blockade Imposition. Finally, one can impose an information blockade. By interfering with and disrupting an opponent’s data links

18. “Atlas 3 Scrubbed to Tuesday,” *Space Daily*, May 21, 2000, <http://www.spacedaily.com/news/eutelsat-00g.html> (accessed September 21, 2016), and Jessica Orwig, “A Rocket Launch Monday Was Delayed Because of a Boat,” *Business Insider*, October 28, 2014, <http://www.businessinsider.com/why-rocket-launch-delayed-by-a-boat-2014-10> (accessed September 21, 2016).

between terrestrial control stations and the satellite, one can effectively neutralize an orbiting satellite by hijacking the satellite's control systems or preventing ground control from issuing instructions. Alternatively, one can interfere with the data that the satellite is transmitting, i.e., rather than tampering with the satellite's controls, one can contaminate or block the data that it is gathering or transmitting. A third form of information blockade involves "dazzling" a satellite using low-powered directed-energy weapons against sensors or other systems. In each case, the intent is to effect a "mission kill," whereby the satellite cannot perform its functions, but is not necessarily destroyed.

Space Strike Operations (*kongjian tuji zuozhan*; 空间突击作战). Space strike operations involve space and other forces undertaking offensive operations against an enemy's land, sea, air, and space assets. They are therefore not limited to attacks against the space infrastructure, and certainly not only against orbital platforms. In general, space strike operations are expected to be against vital strategic and operational targets, i.e., "key points."

Space strike operations, in the Chinese view, are marked by "integrated operations; stealth and surprise; key point strikes; rapid, decisive action." Integrated operations reflects all the aspects discussed earlier, with an additional emphasis on exploiting stealth and surprise.

Key point strikes are part of what might be the guiding thought for space operations in general. An additional consideration in this context is that neither side is likely to field large numbers of space systems, so planning for maximum effect and efficiency is important.

Rapid, decisive action denotes the need to use space strikes to seize the overall initiative in a campaign. By overwhelming an opponent, and then sustaining strikes afterwards, one cannot only retain the initiative, but ideally achieve operational goals and conclude the conflict. At the same time, due to the limited numbers of space platforms and weapons likely to be available, their fragility, and their expense (which limits numbers acquired), space strike operations are likely to be of relatively limited duration.

Defensive Space Operations (*kongjian fangyu zuozhan*; 空间防御作战). Defensive space

operations are intended to counter an opponent's space strike operations by safeguarding one's own space forces and defending key strategic and campaign targets from enemy space strike capabilities. Defensive space operations include defense against ballistic and cruise missiles, spacecraft defensive operations, and defense of space-related bases and infrastructure.

Spacecraft defensive operations involve a combination of active and passive defensive measures. These include camouflage and reduction of spacecraft radar, infrared and electronic signatures so that their capabilities and identity are obscured; shifting to "swarms" of small satellites, to improve resilience in the event one or more component satellites are lost; and hardening of satellite systems to allow them to survive attacks from directed energy weapons. In addition, ground controllers can move satellites if there are indications that they might be attacked.

Space Information Support Operations (*kongjian xinxi zhiyuan zuozhan*; 空间信息支援作战). In the 2005 edition of *Military Aerospace*, a PLA textbook on military space activities, provision of information support by space systems was listed as the second task, after space deterrence.¹⁹ In the 2013 PLA teaching materials, it is now the fifth of five tasks. This would suggest that space information support operations, while still important, are being eclipsed by more active space offensive and defensive measures. Indeed, as one Chinese assessment observes, as space resources become ever more important, and military aerospace technology, especially those related to offensive space operations, steadily develop, space force development will shift from providing information support towards securing space dominance.²⁰

The New PLA Strategic Support Force

The massive overhaul of the PLA announced at the end of 2015 saw the creation of the PLA Strategic Support Force (PLASSF). This entity is arguably better labeled the PLA's Information Warfare Force, as it brings under a single structure China's space, electronic warfare, and network warfare forces. As one of the earliest adopters of the concept of integrated network and electronic warfare (INEW), the PLA has long had a holistic view of warfare in the

19. CHANG Xianqi, *Military Astronautics*, 2nd ed., pp. 304-309.

20. TAN Rukun, *Operational Strength Construction Teaching Materials* (Beijing, PRC: Military Science Publishing House, 2012), p. 170.

electromagnetic domain. As important, the PLASSF is consistent with the two decades of evolving PLA views on the role of information and future warfare.

As the PLA prepares to fight and win “informationized local wars,” it has repeatedly emphasized the importance of establishing “information dominance (*zhi xinxi quan*).” This is achieved through achieving a combination of space dominance (*zhi tian quan*), network dominance (*zhi wangluo quan*), and electronic dominance (*zhi dianzi quan*). That the forces associated with establishing dominance in these domains are now assigned to a single service is unlikely to be a coincidence. As important, by grouping them together, Chinese doctrinal developers can look for synergies and areas of mutual support, in pursuit of information dominance.

The creation of the PLASSF suggests that the Chinese military is putting into place the organizational structures necessary to undertake a concerted effort to establish information dominance. The PLASSF is therefore likely to hone its skills not only in the conduct of offensive and defensive space operations, but coordinate them with electronic and network warfare activities. As important, INEW operations are likely to be waged at both elements of adversary space infrastructure, as well as terrestrial systems.

Chinese Assessment of Required Space Capabilities

In order to meet the demands of the “guiding thought” for space operations and fulfill the various mission areas, PLA analysts conclude that a nation must be able to fulfill certain tasks. These include the ability to enter space, to exploit space, and to control space. PLA assessments on requirements for “army-building” (i.e., military modernization) include several areas for improving China’s military space capabilities.

Rapid Space Launch Capability. In terms similar to how American analysts describe “operationally responsive space,” Chinese analysts cite the need for rapid launch of satellites to augment current constellations in time of crisis, and to replace lost assets

in time of conflict. Intriguingly, it is also suggested that it may not be necessary to deploy a complete constellation in peacetime; if one possesses a rapid launch capacity, it would be possible to augment a minimal peacetime constellation in time of crisis or conflict.²¹ In this regard, Chinese development of the Kuaizhou solid rocket space launch system would seem to suggest that the PLA has already prioritized improvements in this area.²²

More Robust Space Situational Awareness.

An important likely focus in the coming years will be improving China’s space situational awareness (*kongjian taishi ganzhi*; 空间态势感知) (SSA) and strategic early warning capacity. This will include both ground-based and space-based sensors to provide PLA planners with better strategic early warning about changes in the space environment.²³ At the same time, there is recognition that China’s growing investment in countering orbiting systems requires improved SSA to ensure that it can identify the right targets and then engage them successfully. Improved SSA will also benefit efforts at space defense, as adversary orbital ASATs can be detected and characterized earlier, allowing Chinese space operators more time to move their own assets.²⁴ The PRC is therefore likely to develop space surveillance systems that will provide real-time tracking data on the tens of thousands of space objects currently in orbit.

Improved Offensive and Defensive Space Capabilities.

China is clearly developing a number of ASATs, including a demonstrated capacity for direct-ascent kinetic-kill vehicles, co-orbital ASATs, and cyber tools that could interfere with space control systems. Future developments may include more soft-kill options that would lead to “mission kills” on satellites, preventing them from gathering or transmitting information, rather than physically destroying the system. The PLA suggests that these efforts might include co-orbital jammers and satellites that could eavesdrop on a target satellite’s control and data transmission in peacetime, and perhaps hijacking or other interference with the satellite in time of crisis or conflict.²⁵

21. *Ibid.*, p. 157.

22. Rui C. Barbosa, “China Launches Kuaizhou-2 in Second Launch Within 24 Hours,” *NASASpaceflight.com*, November 21, 2014, <http://www.nasaspaceflight.com/2014/11/china-launches-kuaizhou-2-second-launch-24-hours/> (accessed September 21, 2016), and Richard Fisher Jr., “China Launches Second Kuaizhou Mobile SLV,” *Jane’s Defence Weekly*, November 26, 2014, <http://www.janes.com/article/46360/china-launches-second-kuaizhou-mobile-slv> (accessed September 21, 2016).

23. TAN Rukun, *Operational Strength Construction Teaching Materials*, pp. 158–159.

24. *Ibid.*, pp. 161–162.

25. *Ibid.*, p. 161.

Other areas that the PLA is likely to pursue include defensive measures that would counter adversary attempts at establishing space dominance by allowing Chinese space systems to either survive enemy space attacks or repair and otherwise ameliorate damage. These might include robots capable of on-orbit repairs, or a greater emphasis on small satellites that could allow rapid reconstitution of key space information support functions.²⁶

Prospects for U.S.–China Space Competition

All of these developments reflect the reality that the U.S. and China are engaged in a competition regarding the ability to access and exploit space in support of national security objectives. For the Chinese, it seems clear that they hope to limit our ability to employ space systems, while ideally preserving their own capacity. This is an asymmetric situation, however, because the United States is far more reliant on space to conduct military operations than the PRC. Most American conflicts, after all, occur at a significant distance from our own shores and the Western Hemisphere. Communications, intelligence gathering, even weather prediction all rely more on space assets.

By contrast, the PRC is mostly focused on military operations in the land, sea, and air spaces adjacent to continental China. The PLA can therefore rely on a variety of non-space platforms, whether it is unmanned aerial vehicles, aerostats, aircraft, or fishing boats to gather and relay information.

This does not mean that the U.S. and China are necessarily locked in only a zero-sum relationship in outer space. There can be benefits from engagement, in at least gaining some familiarity with each other's organizational patterns and behavior. However, the expectations need to be tempered. China's space capabilities are intended first and foremost to serve the interests of the PRC, including the PLA, and those interests are often not congruent to our own.

Identifying where there is real interest, based on analysis of Chinese doctrine and policies and not mirror-imaging, is essential. At the same time, recognizing where our interests are at odds, including in the security arena, is vital. And maintaining the ability of the United States to establish space dominance, meaning preserving our own access to space as well as denying it to an adversary, is central to that.

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26. *Ibid.*, p.158.

Dean Cheng, Senior Research Fellow

Dean Cheng is currently the Senior Research Fellow for Chinese Political and Military Affairs at the Heritage Foundation. He is fluent in Chinese, and uses Chinese language materials regularly in his work.

Prior to joining the Heritage Foundation, he was a senior analyst with the China Studies Division (previously, Project Asia) at CNA from 2001-2009. He specialized on Chinese military issues, with a focus on Chinese military doctrine and Chinese space capabilities.

Prior to joining CNA, he was a senior analyst with Science Applications International Corporation (SAIC), and an analyst with the US Congress' Office of Technology Assessment in the International Security and Space Division.

He has written a number of papers and book chapters examining various aspects of Chinese security affairs, including Chinese military doctrine, the military and technological implications of the Chinese space program, and Chinese concepts of "political warfare." Recent publications include:

- "Space and the Evolving Chinese Military," in *Crisis Stability in Space*, with Bruce MacDonald, Admiral Dennis Blair, Karl Mueller, and Victoria Samson (Washington, DC: Foreign Policy Institute, 2016).
- "The PLA's Wartime Structure," in *The PLA as Organization v. 2.0*, ed. by Kevin Pollpeter and Kenneth Allen (Merrifield, VA: DGI, 2015). www.pla-org.com
- "Converting the Potential to the Actual: Chinese Mobilization Policies and Planning," in *The People's Liberation Army and Contingency Planning in China*, ed. by Andrew Scobell, Arthur S. Ding, Philip C. Saunders, and Scott W. Harold (Washington, DC: NDU Press, 2015).
- "Chinese Concepts of Space Security" in *Springer Handbook of Space Security*, ed. by K.U. Schrogl (NY: Springer Publishing, 2015).
- "Information Dominance: PLA Views of Information Warfare and Cyberwarfare," in *Chinese Cybersecurity and Cyberdefense*, ed. by Daniel Ventre (Hoboken, NJ: Wiley Publishers, 2014).
- "Chinese Lessons from the Gulf Wars," in *Chinese Lessons from Other People's Wars*, ed. by Andrew Scobell, David Lai, and Roy Kamphausen (Carlisle, PA: Strategic Studies Institute, 2011).
- "Chinese Views on Deterrence," *Joint Force Quarterly* (#60, January 2011)

He has testified before Congress, and spoken at the National Space Symposium, the US National Defense University, the STRATCOM Deterrence Symposium, Harvard, and MIT. He has appeared frequently in print and broadcast media to discuss Chinese space and military activities. He is the author of the forthcoming *Cyber Dragon: Inside China's Information Warfare and Cyber Operations* (Praeger Publishing).

Chairman BABIN. Thank you very much, Mr. Cheng.
I now recognize Dr. Lewis for five minutes to present his testimony.

**TESTIMONY OF DR. JAMES LEWIS,
SENIOR VICE PRESIDENT AND DIRECTOR,
STRATEGIC TECHNOLOGIES PROGRAM,
CENTER FOR STRATEGIC &
INTERNATIONAL STUDIES**

Dr. LEWIS. Mr. Chairman, I'd like to thank the Committee for the opportunity to testify on whether we're in a space race with China, but it's also useful to ask if we have the right strategy for space exploration in what's become a very different international environment.

A comparison of the U.S. and Chinese space programs suggests each reflects different goals rather than being a race. China's goals are political. Ours are scientific. There is a degree of parallelism between the U.S. and Chinese efforts but with the exception of human space exploration, the two programs are not really comparable.

In most areas, the United States remains unmatched in its space capabilities. Our unmanned space exploration program has no equal in its successes, but when we talk about a space race, we're talking about human spaceflight, the area of activity where the United States is weakest. The classic space race between the United States and the Soviets centered on human spaceflight and landing on the Moon. Each side tried to surpass the exploits of the other. I think it's now safe to say that the United States does not consider itself in a space race with China. The United States is focused on the manned exploration of Mars, and from a scientific perspective, going to Mars makes sense, but it doesn't make sense from a strategic perspective.

China does not talk about space races but there is an unavoidable comparison and competition with the United States. China's focus in space exploration is on human spaceflight and its leaders have a great interest in landing on the Moon.

In the United States and Soviet space race, the objectives are prestige and global influence. Having won the race, the United States largely lost interest in space. In contrast, China uses its space programs to gain political advantage. Its human space programs serve important domestic and foreign policy purposes.

Human spaceflight was a central part of the Cold War contest. The assumption was that the system that won the space race was superior. The competition between the U.S. and Chinese systems is not as clear-cut, but the rest of the world thinks we're in a competition with China and that space exploration is a part of this.

We should be clear that the Chinese space program largely duplicates U.S. and Soviet exploits from the 1970s and 1980s. What we do not want, however, is a tortoise-and-hare scenario where a slow-moving China passes the United States. American performance in space is an important element in how China will decide between confrontation or cooperation. We do not want a situation where

China's leaders think, as a PLA general said last year, that the United States has "great capability, no will."

The future of space exploration requires the United States to make difficult choices. These choices will determine the outcome of any space race with China. A strong case can be made that the United States would be best served by human spaceflight programs that focus on incremental and achievable goals. We're in a very difficult international situation, and our space programs need to adjust to this.

I thank the Committee, and look forward to your questions.

[The prepared statement of Dr. Lewis follows:]

Testimony
Committee on Science, Space, and Technology Committee
Subcommittee on Space
“Are We Losing the Space Race to China?”
September 27, 2016
James A. Lewis, Center for Strategic and International Studies

I would like to thank the Committee for the opportunity to testify on a topic of great importance to this nation. This topic is whether we are in a space race with China, but it is also useful to ask whether we have the right strategy for our own space exploration program.

A comparison of the U.S. and Chinese space programs suggests it is better to think of the space activities of each nation as reflecting different political goals rather than as an overt “race.” China’s space budget is a tenth of NASA’s, but Chinese budget figures are opaque, disguise some sources of funding, and do not reflect difference in purchasing power. The U.S. and China are roughly tied in the annual number of launches. The U.S. operates almost three times as many satellites of all types as China, but the number of Chinese satellites is steadily increasing. The U.S. participates with its partners and with the support of Russia, in operating the International Space Station, providing America with a presence in low earth orbit. China has its smaller Tiangong space station program. There is a degree of parallelism in the U.S. and Chinese programs, but with the exception of human space exploration, the two programs are not really comparable.

In fact, it is best in some ways to think of American as having several space programs, including space exploration, human flight, earth observation and, although it is not our topic today, military space programs. In some of these areas, areas, the U.S. remains unmatched in its space capabilities. Unmanned American spacecraft have gone beyond the edge of the solar system. We have launched satellites that have reached speeds no other nation can duplicate, and have robotic spacecraft exploring distant planets in a series of scientific triumphs. No other nation can yet land multiple robots on Mars and operate them for years. Our unmanned space exploration program is unparalleled in its successes.

Things are different when you look at America’s human spaceflight program. It is embarrassing that the U.S. has not for years had the ability to put a human in orbit and must rely on Russia. The International Space Station still provides both political and experiential benefits, but the value of the ISS as a platform for research and science has steadily decreased over time and its low earth orbit means it cannot really be considered exploration. The Cold War space race focused on human space flight as the primary metric for success, and the same metric applies to competition with China, so when we talk about a space race, we are talking about human flight, the area of activity where U.S. performance is weakest.

Then there is the issue of Mars. NASA hopes to transfer much of the responsibility for low-earth orbit activities to commercial entities – what some call “entrepreneurial space” - in order to focus its efforts on the exploration of Mars. NASA has settled on human exploration of Mars as the centerpiece of its human exploratory missions. Landing humans on Mars is an impressive goal, but it is beyond our current technological capabilities. If all engineering, propulsion and life

support problems that currently prevent a survivable flight to Mars can be solved, the U.S. will probably be able to land humans on Mars in fifteen to twenty years (China optimistically hopes to land humans on Mars in the late 2030s). The American timeline assumes steady progress in resolving the operational problems of a voyage to Mars, but there is no guarantee of success. More importantly, what do we do while we wait?

What we do while we wait is important for answering the question on whether we are in a Space Race with China. The classic space race between the U.S. and the Soviets centered on human spaceflight and, ultimately, landing on the Moon. Each side tried to match and surpass the exploits of the other. Now, it is safe to say that the U.S. does not consider itself in a space race with China. The U.S. may no longer even think of space exploration in competitive terms.

China does not talk of a space race, but there is an unavoidable degree of comparison and competition with the U.S. China's focus in space exploration is on human spaceflight, and its leaders have great interest in this space exploration leading to a lunar landing. The attitude of the American space community towards lunar exploration often seem to reflect a "been there, done that" attitude, that it is not worth repeating the successes of the 1970s. This underestimates the strategic implications of China becoming the only nation with a presence on the Moon. The implications are not military but political. China would gain political advantage on earth by landing on the Moon while we wait to go to Mars.

A disinclination by the U.S. to resume lunar exploration also overlooks the practical consideration that the Moon is much easier to reach with current technology, to explore, and even to establish a permanent presence. Human lunar missions do not face the technical difficulties of a flight to Mars and the creation of a permanent human lunar facility, while difficult, is not impossible and could avoid an outcome where the U.S. has no human presence in space after the ISS is deorbited. The Moon could be a useful test bed for human exploration of Mars, part of a staged campaign of exploration, but there is a concern that lunar missions would divert resources away from the Mars programs. From a scientific perspective, going to Mars is a sensible choice, but the same is not true from a strategic perspective, or from the perspective of getting results from our national investment in space and dealing with China's challenge to the U.S.

There is one other benefit to lunar exploration that is often unremarked. We can land on the Moon and with its light gravity, take off again. If we land on Mars, we have no way with current technology to achieve escape velocity and regain orbit. Perhaps this will change in twenty years, but escaping Martian gravity for a return flight to earth is impossible with current technologies and it would seem impolitic to send explorers to Mars without any chance of bringing them back.

In the U.S.-Soviet space race, the objectives were prestige and global influence. Having "won" the race to the Moon and ended the Cold War, the U.S. lost interest in space as a tool for political influence. In contrast, China's human space program is political. China uses space to gain political advantage and while there are clearly activities related to science and research, the primary purpose for China is to demonstrate power and to show that it has reclaimed its place among the major powers of the world.

President Xi's support for China's human program will likely continue because the exploratory programs, human and robotic, are important for the image of the Party, which has been damaged by rampant corruption and various public policy failures in environment, investment, and urban planning. The human space program serves an important domestic political purpose as the Party uses it to reinforce its legitimacy as the only institution capable of modernizing China and restoring its greatness.

We should not overlook the symbolism in China's human spaceflights. The Shenzhou 5 space capsule carried seeds from Taiwan in a symbolic assertion of China's sovereignty. The date for the return of China's first manned Shenzhou capsule in 2003 was October 16, the anniversary of when China exploded its first nuclear weapon. This was not a coincidence, but an indicator of how important China sees manned spaceflight for its status and strategy. China's successes in space also reinforce its claims to regional dominance by demonstrating that it is the most advanced Asian nation, with the technology and resources that others cannot match. China hopes that human spaceflight confirms to its neighbors the validity of China's claim to regional leadership and makes the point to both domestic and global audiences that under the Party's leadership, China has become a world leader with a claim to equal status with the U.S.

Space programs are one way China to asserts itself. In this, we should note that China is better at asserting power than leadership. The strategic effect of China's space program on its regional neighbors is unclear, in part because their perceptions of China are shaped more by its assertive foreign policy and its various maritime and border adventures. If there are any countries that believe they are in a space race with China, it is Japan and India, the two other regional space powers. These countries see space as an area of competition with China, with India in particular trying to match Chinese accomplishments. In these regional space races, however, China has a clear lead.

The U.S.-Soviet space race was a competition between two very different systems – communism and democracy. Human spaceflight was an important part of the Cold War contest, proving that market democracies could surpass scientific socialism. The assumption was that the system that won the space race would have showed its superiority. The competition between the U.S. and Chinese systems is in no way as clear cut, but the rest of the world thinks we are in competition. Media attention to the rise of China and the decline of the U.S. is cyclical and usually based on bad data or wishful thinking by those who dislike the U.S., but the differing pace of human exploration in each country forms a part of this narrative of competition and decline.

We could argue that China may be following an outdated recipe for superpower status, but this assumes that space activities have lost their political salience. What is more worrisome than China "winning" any race is the U.S. "losing" from indifference, and what this says about our national capabilities. If human space flight is an assertion by China of its growing power, what does the absence of a human program say about the U.S.? Human spaceflight is one of the trappings of superpower status. China currently lacks the technological capability to match the U.S. in space, but we lack the ability to put humans in orbit. If China "wins," it will not be because of better technology. It will be because of a better strategy and greater commitment. What we do not want is a tortoise and hare scenario. China is good at setting goals, supporting them with resources, and pursuing them for years. In contrast, there is reasonable concern that

the U.S. may have lost its ability to manage large-scale national projects.

We should be clear that Chinese space program is laboriously duplicating U.S. and Soviet exploits in the 1970s and 1980s. It is not breaking new ground and in that sense, this is not a race. But it is also not a race, or not much of a contest, if one country sits on the sidelines for fifteen years while the other makes progress, however plodding. The Chinese say they will land on the Moon, before the U.S. reaches Mars, and while they face serious technical obstacles, their steady pursuit of spaceflight suggests it is very likely they will eventually get there. We tend to dismiss the global political implications of China landing on the Moon while we wait to go to Mars, but Americans may be overconfident in this. If nothing else, when we watch China land on the Moon, we can expect another spate of stories about the U.S. in decline.

China is without doubt challenging the international order that the U.S. and its allies created after 1945. It seeks greater influence and control in Asia and in international institutions. This challenge need not end in confrontation or conflict, but those outcomes cannot be dismissed. Although the U.S. and China are in a quiet competition for military advantage in space, space exploration is so far only a peripheral element in this challenge. However, our performance in space is an important element in how China will judge the value of confrontation or cooperation. What we do not want is a situation where China's leaders decide, as a PLA General allegedly said last year, that the U.S. has "great capability, no will."

This is not a race, but the current state of the U.S. human space exploration program reflects the absence of strategic vision and a strategic imperative for space. The political and diplomatic motives of the Cold War are gone and a focus on space as a purely scientific endeavor cannot replace them. Space has been an area of disinterest by American leaders and this helps to explain the disconnect between exploration and strategic goals and why in any discussion of a space race, the U.S. appears to be lagging.

A good example of this lack of strategic vision is the constant flirting with the idea of cooperating with China in space, a discussion often accompanied by some bromide about how we could cooperate with the Soviets at the height of the Cold War, so why can't we cooperate now with China. This is a frivolous comparison, as the state of relations is completely different. Cooperation with the Soviets came as part of a long series of negotiations on arms limitations and stability. We have no similar negotiations with China, it may not be in our interest to accord China peer status as a negotiating partner, and China evinces no interest in serious negotiation on strategic issues. Technology transfer in the between the U.S. and Soviets was tightly constrained; in any cooperative effort now, China would gain valuable technology and the U.S. would not. U.S.-Soviet relations had found an uneasy stability when agreement to cooperate in space was reached, but our relations with China have entered a period of deterioration. In any case, the level of cooperation in space with the Soviets rose or fell depending on the state of the political relationship. Cooperation was a tool of diplomacy, not pure science or an end in itself. We may eventually want to cooperate with China, but only when the larger relationship improves and China is more amenable to partnership.

The future of space exploration requires the U.S. to make some difficult choices, including decisions on the targets of human exploration beyond low earth orbit (LEO), the ultimate fate of

the ISS, setting the balance between human and robotic exploration programs, and redefining cooperation in space with current partners and perhaps new ones, including China. The larger bilateral relationship with China also requires difficult choices, where we will need to identify areas where cooperation remains possible and can be strengthened and areas where China's behavior must be challenged and changed.

How the U.S. answers these questions will decide not only the pace and the direction of American exploration in space, but the outcome of any space "race" with China. A strong case can be made, however, that in the new and challenging environment for international security, the U.S. would be better served from a strategic perspective by human programs that focused on incremental, pragmatic and achievable goals rather than relying only on a long game that involves huge technological risk and long periods without visible progress.

One question I sometimes ask myself is that if our early space pioneers, people like Werner von Braun, were in charge, what would they do differently in our space program today? The question isn't entirely fair, since the objectives for the pioneers were straightforward – to get things into orbit. Having a clear, achievable, objective was a real benefit to the early space programs. But I wonder if they would be concerned with a lack of vision and even staleness in America's human space efforts. What the space pioneers also might notice is that American space exploration has become a largely scientific enterprise without the political or strategic motives that drove space programs in their time. The same is not true of China. Its space programs, and especially its human program, have both political and strategic objectives.

Since the 1950s, the U.S. has been committed to the peaceful use of space and to promoting the global benefits of space for science and research. These remain central goals for the space program, but not the only goal. A commitment to research and peaceful use does not mean that we can continue to safely ignore the implications and effects of space programs for security and international stability. Space is a tool of national power. China knows this, but it appears that we may have forgotten.

The U.S. had the luxury after 1989 of not facing challenges from major powers. We did not need to think strategically as we enjoyed a period of strategic stability where the U.S. could without risk pursue foreign adventures or diplomatic agendas that assumed America's global leadership was permanent. This is no longer the world we live in. The last few years have seen challenges to the post-Cold War order and efforts by Russia, China, Iran and North Korea to engage in coercive acts against U.S. interests and even in the U.S. itself. This is not the return of the Cold War, but we are in a period of change and conflict, where a more assertive and directed U.S. foreign policy will be necessary to protect our interests and our nation. Space exploration is part of this. It was a tool of diplomacy and national power used to protect democracy during the first space race. It is time to use this tool again.

I thank the Committee again for the opportunity to testify on whether we are in a space race with China and the right strategy for our own space exploration program and I look forward to our questions.

James Andrew Lewis
Center for Strategic and International Studies

James Andrew Lewis is a Senior Vice President and Program Director at CSIS where he writes on technology, security and innovation. 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 included work on a range of politico-military and Asian security issues, as a negotiator on conventional arms transfers and advanced military technology, and in developing policies for satellite exports, encryption, and the internet. Lewis led the U.S. delegation to the Wassenaar Arrangement Experts Group on advanced civil and military technologies and was the Rapporteur for the UN's 2010, 2013, and 2015 Group of Government Experts on Information Security. He was also assigned to U.S. Southern Command for Operation Just Cause and the U.S. Central Command for Operation Desert Shield. Lewis received his Ph.D. from the University of Chicago.

Chairman BABIN. Thank you very much, Dr. Lewis.

I thank all the witnesses for their testimony. I now recognize myself for five minutes.

Mr. Cheng, a July article in the Wall Street Journal reported that the Director General of the European Space Agency was open to the idea of cooperating with China onboard the International Space Station. China's long-term lunar plans are also consistent with Europe's lunar village concept. President Obama cancelled the Constellation program that would have returned the United States to the Moon and take astronauts onto Mars. In a speech announcing the cancellation, he argued against returning to the Moon by stating "We've been there before," rather arrogantly, I thought.

The NASA Administrator has stated the U.S. does not have to be the country that says we're going, follow us, we're all going back to the surface of the Moon, but it's just that the United States has no intention of leading that effort. We will support and be along with anybody that goes.

The National Academy of Sciences' report, "Pathways to Exploration," indicated that returning to the Moon would offer significant advantages as an intermediate step to Mars. It appears as though the Administration's policies are pushing our allies to cooperate with China rather than with us. Furthermore, it appears as though China may be adopting a more robust architecture for future exploration than the one proposed by this Administration.

What impact does that have on our nation's economic competitiveness, international standing, and national security?

Mr. CHENG. Sir, to begin with, it should be noted that the previous head of the European Space Agency opined that it would be very delighted to work with China on manned space literally within a week of the Chinese ASAT test in 2007, widely considered to be the single worst regenerating event in space. So I think it is safe to say that the current head of the European Space Agency apparently is continuing a policy of basically being open to Chinese behavior, cooperating with China regardless of Chinese behavior. I would suggest that the idea that we do not need to lead in the process of going to the Moon is consistent with a leading-from-behind philosophy that this Administration has enunciated with regards to terrestrial objectives as well.

But I would also emphasize here, sir, that the most important consideration is that China has been attempting to push the limits of its sovereignty into international common spaces. As I said in my spoken testimony, Chinese behavior is not about space, it is about terrestrial, but what we see in the oceans, what we see in outer space, what we see in cyberspace is China pushing its position into all of these international spaces, and if the United States does not lead, we will find ourselves operating in the Chinese framework.

Chairman BABIN. Thank you very much.

And now, Mr. Stokes, Mr. Shea's testimony highlights that the Chinese military and civil space programs are tightly intertwined. Some of you have already alluded to this. But I would like to hear it again. If not the same organization, they're tightly intertwined.

Some argue for increased cooperation with China on civil space. Could this be done without directly benefiting Chinese military capabilities?

Mr. STOKES. The short answer, it's possible, but I would recommend doing it very, very carefully.

Chairman BABIN. Amen. Okay. Thank you. Thank you very much.

And now, current U.S. plans called for a crewed mission to Mars in the 2030s, and from what we can tell, the Chinese plan to land a crew on the Moon in the same time frame. U.S. space exploration efforts have been characterized by uncertainty lately, particularly in the wake of the Administration's cancellation of Constellation, that would have returned the United States to the Moon no later than 2020 if the Administration had not raised NASA's exploration budget. Conversely, China has been fairly successful in accomplishing the goals that it sets for its space program, and Mr. Shea, in 15 years, could we find ourselves watching a Chinese astronaut land on the Moon when we are years away from a U.S. Mars mission and no capability to return to the Moon?

Mr. SHEA. It is possible. I mean, earlier this year, officials within the Chinese space program have indicated that they want to land a Chinese astronaut on the Moon in the 2030 time frame, so that is possible, yes, sir.

Chairman BABIN. Okay. Thank you. And I think we'll go to the next question. Ms. Edwards, the gentlewoman from Maryland.

Ms. EDWARDS. Thank you very much, Mr. Chairman, and thank you very much to our witnesses today.

I want to start with Dr. Lewis. The National Academies' Pathways to Exploration report recommended that NASA should vigorously pursue opportunities for international and commercial collaboration in order to leverage financial resources and capabilities of other nations and commercial entities. The report goes on to say an international collaboration would be open to the inclusion of China and potentially other emerging space powers in addition to traditional international partners.

Notwithstanding existing prohibitions on NASA's ability to engage in bilateral cooperation with China, do you agree with the National Academies' recommendation?

And then after you answer, I'd like to turn to Mr. Shea, because in your testimony, you point to some of the public relations wins that China has achieved, making it look like the resistance to peaceful kind of cooperation and scientific cooperation is—rests with the United States. And so Dr. Lewis first?

Dr. LEWIS. Thank you for the question. Essentially, people like—other countries like cooperating with the United States. We have better technology. We spend a little more money. It's more fun to visit here. But to get that cooperation, you actually need to have programs that promise immediate and tangible results. So I don't think that saying that working with the private sector or with other countries by itself is an adequate strategy.

On cooperation with China, just in the last few years, the relationship has changed to such a degree that I don't think that absent indications from China that they were more interested in a serious and peaceful relationship that cooperation would be a good

idea. We can cooperate with other countries if we can show them how working with the United States will get them goals in space, but at the moment, with the tensions, the bilateral tensions, I don't think cooperation with China is in our interest.

Ms. EDWARDS. Mr. Shea?

Mr. SHEA. Well, the question reminded me of something completely different but very much related: Hollywood. If you haven't noticed, the Chinese companies are buying a lot of Hollywood. One Chinese company, Wanda Dalian, owns what may be the largest or second largest theater chain, AMC, in the United States, and they are aggressively pursuing other Hollywood acquisitions, so this relates to the public perception. I think of—and there's pressure within Hollywood to portray China in a benevolent manner, to portray in a very positive manner in order to have access to the Chinese market, and I'm thinking of two movies that are space-related, American movies, like *The Martian*, where the Chinese come in at the end and—

Ms. EDWARDS. Save the day.

Mr. SHEA. —save the day, and the China National Space Administration is viewed as a civilian, genteel, you know, organization. I'm also thinking of gravity where—the movie where the Chinese space station helps Sandra Bullock get back to Earth, but also portrays the Russians as creating the largest space debris that put the Americans at risk rather than the fact that, as alluded to, the Chinese created the largest space debris with their antisatellite test in 2007. So I am—this is linking Hollywood with the space program, and I think we could see more of that.

Ms. EDWARDS. Dr. Lewis—thank you. Your report titled “Space Exploration in a Changing International Environment” states that the international environment for space has changed significantly. You pointed to that in your prepared testimony. Can you expand on that environment? And then the report also goes on to state that the new environment necessitates the development of a new framework for international cooperation. What would such a framework look like given the end of the operational life of the International Space Station in 2024?

Dr. LEWIS. Thank you. The fundamental change in the last few years, we are now in a contest, and not just with China but with other countries including Russia and maybe in particular Russia, and a space strategy, all of our international strategies need to recognize this. Now, a contest is not a war, it's not a new Cold War, but we are in a conflictual relationship, and I don't think that inactivity is the—or the perception of inactivity is the right way to deal with this.

The ISS is an interesting question. When it is deorbited, should it be deorbited, the United States could face a situation where it no longer has a presence in space. That would be really disastrous for our international reputation. So we need to think about the ISS. Some of the international partners are beginning to ask about the utility of the ISS. We really need a new project that they would be willing to fund and participate in, one where we could help lead the international community because given our technology, our budget, our past efforts, we are the default leader if we choose to exercise that. So we need a new project to take the place of the Space Sta-

tion or maybe a new way to think about the Space Station and the Moon to energize the nations that want to work with us. But among those nations, we should be very cautious not to work with those who are de facto opponents.

Ms. EDWARDS. Thank you, Mr. Chairman.

Chairman BABIN. Thank you very much.

I now recognize the gentleman from Alabama, Mr. Brooks.

Mr. BROOKS. Thank you, Mr. Chairman.

Today's hearing is entitled "Are We Losing the Space Race to China?" and if I were to try to summarize your collective testimony, as I understand it, you're saying that the United States is not losing the race to China but China is gaining ground.

Mr. Shea, would that be a fair summary of your remarks?

Mr. SHEA. I think that's a fair summary. I think over the next six years you'll see a lot of activity by China—Moon missions, sending a rover to Mars, completing a space station—while at the same time we won't see similar activity by the United States, and we'll see the deorbiting of the ISS scheduled for 2024. So within this window of time, I think you'll see that the public perception may very well be that the Chinese are gaining ground, significant ground, on the United States while the United States is standing still.

Mr. BROOKS. Mr. Stokes, did I accurately summarize your viewpoint?

Mr. STOKES. Yes, you did, sir. When you say space race, it implies a competition and it implies that we're aware of a competition. I just don't see that there's that much of an awareness, at least on the U.S. side.

Mr. BROOKS. Mr. Cheng, did I accurately summarize your view on this issue?

Mr. CHENG. Yes, sir, I believe you did.

Mr. BROOKS. And Dr. Lewis, did I accurately summarize your view on this issue?

Dr. LEWIS. The thing I wonder about is that we have such a successful space program in other areas, why doesn't that translate over to the manned space program? And unfortunately, when you talk about a race, you're talking about how do you keep scores, and the score is determined largely by the manned program. So I think, yeah, you did summarize my views.

Mr. BROOKS. I come from a district in the northern part of Alabama, home of the Marshall Space Flight Center, and some would say it's the birthplace of America's manned spaceflight program. I still have about 6,000 people who are employed either by NASA at the Marshall Space Flight Center or as support contractors for NASA, so in my district, people are pretty well educated about NASA and space, and why it is or is not important. But that having been said, in practical day-to-day terms, why should Americans care about whether the Chinese are catching the United States of America in the space race, or perhaps even one day surpassing us, and whoever would like to handle that question, please feel free to interject. Mr. Cheng.

Mr. CHENG. Sir, politics is as much about perception as it is about reality, and in this context here, the People's Republic of China has mastery of how to present itself as winning, and the

issue isn't necessarily to the good folks in your district. The problem is how we are perceived in the context of an international competition, whether it is conflictual or not, and whether or not we are seen as winning, and in that regard, a China that scores what is touted by a state-run media as winning that falls on receptive ears in Africa, in South America, in Southeast Asia, in East Asia winds up creating a situation that works against our interests.

Mr. BROOKS. Interesting concept. You're talking then in terms of geopolitical politics and perceptions of the different nations.

Mr. Shea or Mr. Stokes or Dr. Lewis, why should the American people care that China may be gaining on us, or perhaps one day surpassing us?

Dr. LEWIS. One of the lessons from the first Space Race was that space is part of being a superpower, it's part of being able to influence global politics. It's part of being able to shape how the world works. And if I had to choose, I'd rather have the United States shape the world than China.

There is this larger narrative that asks, is the United States in decline? And a lot of European outlets, every time the economists get a chance, they say the United States is in decline. They're wrong, but our inability to perform in manned space flights contributes to this narrative that the United States is in decline, China will be the most powerful nation in 2020 or 2030 or sometime. That's not an outcome we want.

Mr. BROOKS. Mr. Stokes or Mr. Shea, why should the average citizen, say, in Lexington, Massachusetts, care about whether the Chinese?

Mr. SHEA. Well, I agree with what Mr. Cheng and Dr. Lewis have said in terms of the diplomatic and geopolitical implications but also their economic implications. There's been a lot of technology and economic growth generated from a successful space program, and we need to keep those benefits here in the United States.

Mr. BROOKS. Mr. Stokes, do you have anything to add?

Mr. STOKES. Very briefly. One of the reasons why the United States chose to compete against the Soviet Union, the former Soviet Union, in the 1950s, 1960s, 1970s is—part of the explanation is that it was viewed as part of a broader competition in terms of legitimacy, that between that of a Marxist Lenin or the Soviet Communist Party and then free and open society, democracy, the United States. I would argue that the Chinese Communist Party should be viewed in a similar light, and that's just in terms of legitimacy, and that's just one of many, many reasons, I think.

Mr. BROOKS. Thank you, Mr. Chairman. I see my time is expired.

Chairman BABIN. Thank you, Mr. Brooks.

I now recognize the gentleman from Virginia, Mr. Beyer.

Mr. BEYER. Thank you, Mr. Chairman. Thank you all so much for coming.

Mr. Shea, you—in your written and oral testimony, you talked about—let me quote—“Beijing has heavily emphasized both commercial launch services and satellite exports as the space industry has developed, and both activities provide China's space industry with revenues, opportunities to measure the quality of its products

and services against international competitors, and industrial development synergies, et cetera.”

One of the things this Committee has done in a very bipartisan way is try to be champions for the development of the commercial space industry here in the United States. Does China represent a real threat to our commercial space industry or is the competition good for our commercial space industry?

Mr. SHEA. Not—it doesn’t represent a threat, not at the high end, but there is—one of our recommendations last year was to look at the ITAR regulations to see whether they’re overly restrictive and China would have access to technologies that are otherwise restricted by ITAR through non-U.S. sources so that’s one thing we recommended last year.

But China’s satellite launch services and satellite business is really for now at least directed at developing countries that don’t necessarily need the best technology but need a cheap solution or cheaper solution. So right now that’s where the Chinese are focusing their efforts. But they want to compete. When we went to Beijing last year, we met with the Great Wall Industry Corporation, which performs—state-led performs their satellite launch services for international customers, and they’re very negative about the ITAR restrictions, not surprisingly, but they want to have greater access to the market.

Mr. BEYER. Great. Thank you.

And Dr. Lewis, again, this Committee has tried to really be a champion for open data often directed in different political things, whether it’s the data that the EPA uses to proclaim its rules or our support for all the scientists that the U.S. Government funds making their data available to other scientists. Do you see any of the possibility for open data coming from the Chinese investments in space? What will we learn from their new telescope, for example, compared to what we’ll be able to make available to the world from James Webb or from Hubble?

Dr. LEWIS. The Chinese in some ways are still ambivalent about how to deal with the United States, and there’s a strong national sentiment that calls for confrontation, but there’s also a recognition of the benefits of cooperation and the strength of the United States, not somebody you might want to pick a fight with. So we have opportunities to—maybe niche opportunities—I don’t know what my other panelists would say—to cooperate with them. Their scientists are like our scientists but their scientists are not always in charge, so the Chinese will look for cooperation, Chinese scientists will look for cooperation, and perhaps their government will let them do it to some extent.

Mr. BEYER. Is the merging of their version of NASA with their version of the Department of Defense the real bar for us, that they don’t have an independent space agency that’s not militaristic?

Dr. LEWIS. No, I don’t think so, Congressman. I think that it’s the larger Chinese policies of pushing back on the United States, of challenging us in as many areas as possible. So even if it was a purely civilian space agency, they would still be answering to President Xi and the party.

Mr. BEYER. We had the author of *The Martian* here a few months ago, and as you will recall from the book and the movie,

they turned to China to help when the guy was stranded on Mars. Is that just a space fantasy?

Dr. LEWIS. I wouldn't use the book as a guideline for space policy. I loved the movie, great movie, but not—

Mr. BEYER. Mr. Stokes, you know, we've heard a number of times that China really lags, you know, they're 40 years behind us in terms of getting people into space but their quantum experiments, you know, QESS satellite, seem to be an exception, that they may be able to beam quantum encrypted information between orbiting satellites and ground stations, a revolutionary technology. Does this give them a specific advantage over us? Are they experimenting in places that we're ignoring?

Mr. STOKES. Sir, when you mentioned quantum satellites, I mean, it goes way over my head.

Mr. BEYER. Oh, okay.

Mr. STOKES. But in general, my understanding is that the end user of the sponsoring organization based in Shanghai under the China Academy of Sciences ostensibly civilian. It's experimental in nature. What the—I think it's safe to assume that it has military applications as well related to encryption and other aspects of military capabilities but it's something we should watch very carefully, and I'll leave it there.

Mr. BEYER. All right. Thank you.

Mr. Chair, I yield back.

Chairman BABIN. Yes, sir. Thank you, Mr. Beyer.

I now recognize the gentleman from Oklahoma, Mr. Bridenstine.

Mr. BRIDENSTINE. Well, thank you, Mr. Chairman, and thank you to all of our panelists. I'm glad to see there's so much agreement on our panel today. There's been a lot of talk about the Space Race. I want to be clear, we've put men on the Moon. We got two rovers currently operating on the surface of Mars. We have explored the furthest reaches of the solar system. The Space Race is over, and we won.

The question is now how are we utilizing space and how are our near-peer competitors utilizing space, and the question is, are we ceding leadership to the Chinese. China is building a new station, as has already been identified. It has a Moon rover, recently launched the world's quantum communications satellite, as we just talked about, which does have very specific military implications, and it's expanding its BeiDou PNT system. Taking into account that there is no distinction between China's peaceful and military space programs, and these developments become very alarming quickly. Given their notorious lack of transparency, we do not know their true intentions with a space station nor do we even know what they are currently doing on the Moon.

Quantum technology is virtually unhackable and would give the Chinese a distinct advantage over any current military communications that we have as a nation. Utilizing BeiDou gives the Chinese an outlet for PNT that is separate from our own GPS. As they are developing their own GPS-type constellation, they are also developing and undertaking direct ascent antisatellite missile capabilities such as the 2007 direct ascent test that destroyed a LEO satellite. They are advancing spoofing and dazzling technologies and carrying out pernicious state-sponsored cyber espionage including a

hack of the National Weather Service, which compelled us to shut down ground stations for two days in this country, deteriorating forecasts and putting my constituents in danger, and that threatened also the safety of millions of Americans including the constituents of everybody on this panel.

It is clear that China views space as the ultimate high ground and they are rapidly making moves to establish themselves in a position of strength while also improving their ability to deny us the use of space. Given the threat from China, we cannot afford to have the DOD doing extraneous activities not within its mission. As a point of departure, we must give the responsibility for providing space situational awareness for commercial and foreign entities to a civil agency, namely FAA's Office of Commercial Space Transportation. The Department of Transportation and the DOD concurred and endorsed this proposal in a recent report ordered by Section 110 of the Commercial Space bill recently enacted in 2015. I urge all of my colleagues to read the Section 110 report.

Next, we have a chance to pass a NASA authorization this year. That bill should direct NASA to utilize the Moon on our journey to Mars. Mr. Chairman, I think that's a great idea that you said and I think we need to go forward with that. Our allies want to go there as does a wide swath of our domestic commercial space industry. If we do not, our allies will work with China. They're either going to come into our orbit or they're going into their orbit—no pun intended.

Further, the bill should include the formation of a plan for a post-ISS world. We cannot afford a gap in LEO platforms similar to our gap in human transportation that currently exists. Including these policies will go a long way toward ensuring that we do not leave a power and leadership vacuum for China to fill.

Unfortunately, NASA under this Administration seems more focused on forcing partnership with China than in maintaining our leadership. Former Chairman Frank Wolf was a leader on this, and our country is grateful for his work. He first codified restrictions on cooperation with China in space.

On top of their belligerent space activity, China is run by a brutal regime that imprisons dissidents and persecutes minorities. State-sponsored cyber-crimes have robbed our companies of billions of dollars of intellectual property, doing untold damage to our economy. When does it stop is the question?

Mr. Chairman, any NASA bill should permanently codify the restrictions on cooperation with China while also discouraging others from partnering with the Chinese. We must treat China's actions in space for the threat that they are and ensure that we stay ahead of them technologically while preventing any vacuums in leadership that they might exploit.

Mr. Cheng, my question is for you. Given that China considers space security equivalent to maritime security, as you've kind of already talked about, is it reasonable to expect that China will behave in space similar to how it has behaved in the South China Sea?

Mr. CHENG. Representative, obviously it's going to be a little bit difficult to build artificial islands in space but I think that what we should expect to see is the Chinese attempting to redefine the

international rules to new sets that will basically benefit the Chinese. There have been comments about, for example, the requirement that foreign aircraft and ships should turn off their radars when operating in China's claimed waters. It would not be surprising if there was a comparable effort to basically say to operators of space-based surveillance systems, you turn them on over China at your own risk.

Mr. BRIDENSTINE. I'm out of time.

Chairman BABIN. The gentleman's time is expired. Thank you.

I now recognize the gentlewoman from Texas, Ms. Johnson.

Ms. JOHNSON. Thank you very much.

I'd like each member to comment on this. What are the implications that China might match or surpass the U.S. civilian space capabilities in the near future or the distant future? And if they do, what are the key areas, what are the implications of that possibility, and also comment, the risks and benefits associated with NASA collaborating with China in space activities? So let me start with Mr. Shea, but I'd like each panel member to comment on that.

Mr. SHEA. Well, I'll answer, Congresswoman, your second question first. I agree that we need to be very skeptical with cooperative efforts with China. It has been well documented they've engaged in a large-scale cyber and other types of espionage directed at the United States. Their space program is predominantly a military program as we've outlined in our report. They're heavily engaged in counter-space activities such as antisatellite, kinetic anti-satellite missiles, co-orbital anti-satellite systems like robotic arms that could grab satellites. They know that the United States is heavily dependent on space for its projection of military power so they are, you know, engaged in a very robust counter-space program to deter us from taking action or to attack our satellites in the eventuality of a conflict.

So, you know, I think it would be—you know, your first question, the broader answer, I think it would be an absolute shame—I don't see it happening but I think it would be an absolute shame if the United States somehow were behind China technologically because of all the political implication—in space because of the political implications of that, because of the economic implications of that for our own country, so I don't see it happening, as I said in my testimony. I think over the next six years people might perceive the Chinese as gaining significant ground, which just reinforces the need for the United States to keep its eye on the ball and to have a very strong and robust space program.

Ms. JOHNSON. Thank you.

Mr. STOKES. If I can make two quick points. First of all, as previously discussed, I wouldn't automatically rule out cooperation in certain aspects of space. I would advocate looking at our relationship with the People's Republic of China for a much broader perspective in terms of competitive sense, that is, a competition in universal values and a competition in principles. From that perspective, there may be areas of cooperation, and if there are areas of cooperation, they should be done from the perspective of how it creates leverage for the United States in terms of our fundamental interests and our fundamental values. That's the first one.

The second point is, there are other areas of which I'm not—I don't sense that we are really competing and China is making heavy investments. It's in an area—I'm not sure how one would describe it—but near space. That's that domain between, let's say, 20 kilometers in altitude and perhaps 100 kilometers in altitude. Normally it's an area to get through, for example, in terms of returning through the atmosphere to get back to Earth, but this is an area where they're making significant investments including the establishment of dedicated research institutes in the defense industry both in terms of precision—long-range precision strike weapons systems as well as reconnaissance systems able to linger in that particular domain.

Mr. CHENG. One of the great areas of American strength is our private sector, and we are seeing with folks like SpaceX and Blue Horizon an interesting revival of the private sector's interest in space. Where they are likely to go in terms of innovation I suspect is something the Chinese are desperately afraid of because they understand that companies are more flexible and can often be driven harder because of the vision of their directors. At the same time, as a result, one suspects that the Chinese are likely to therefore try and, quote, unquote, partner with our private sector or simply buy, you know, controlling interests in stock and the like. In that regard, I think that one of the areas that we need to be wary of is quote, unquote, collaboration between Chinese state-owned enterprises and our private sector.

Dr. LEWIS. Thank you for the question. You know, just to maybe put this a little bit in perspective, the real issue here is who lands first, and I don't care if it's on the Moon or on Mars but when you see that picture, do you want the picture of the astronaut holding the flag to be holding an American flag or a Chinese flag. We all remember the picture from the Apollo program. So if we could land on Mars before China can go to the Moon, great, let's do it, but I don't feel confident in saying that, who lands first.

On cooperation with the Chinese, and this might be the first question where the panel sort of disagrees a little bit so I'm glad we finally got there, they're hostile but they're also pragmatic. They can be engaged. You can come to arrangements with them. I think the agreement on commercial cyber espionage is a good example of that. They are pragmatic in a way that the Russians are not but we need engagement and agreement on the rules for how we will operate in space before we can cooperate. The Chinese will test us, and right now if we don't push back, cooperation is not in our interest. It's a complicated relationship but it's one where we have many of the advantages, particularly in technology, and in most of the areas of space, we just do better. So the question is, how do we take advantage of our leadership? How do we come up with a strategy to lead, and not only with the rest of the world but with China?

Ms. JOHNSON. Thank you very much.

Thank you, Mr. Chairman.

Chairman BABIN. Thank you.

I recognize the gentleman from California, Mr. Knight.

Mr. KNIGHT. Thank you, Mr. Chair.

You know, competition is part of life. I think that America has led in this endeavor for many, many years. But there's so much that is going on right now with the technological advances that are happening today. There are so many things that we can do.

Back in the early 1960s, we were trying to go to the Moon because I do believe it was part of the competition. We also had many programs that were going on in the early 1960s like maybe the X-20 Dinosaur program that would've been the first space shuttle, and we decided not to do that. We decided to go to the Moon, and which is the goal that everyone looks to today.

But the point is, is we always have an awful lot of things that are happening, and I think the Chinese are now discovering that maybe if they put their goals on some finite situations, they might be able to beat us at certain things so we broke the sound barrier first, we were on the Moon first. We did all of these things first, and they might be able to do some of these finite goals and we might be looking at a hundred different goals.

So is that what we're kind of looking at today that competitively, look, we want to be on Mars first, we want to do this first, or are we looking at the expanse of space exploration and achieving some of these goals for a much bigger product, a much bigger program?

Mr. SHEA. I think that's a fair point, Congressman. I think the Chinese, it's my understanding that if they fulfill their goal of landing an unmanned spacecraft on the Moon's dark side before 2020, they'll be the first country to have done that. So you're right, they may be seeking smaller niche goals, maybe not the big-picture goals but to proceed with a domestic audience seeking goals that have maybe not as powerful but goals nonetheless.

Mr. KNIGHT. And I'll jump in just real quick. I want to thank the Chairman for talking about one of the programs that's in my district, the SOFIA program, that is an American-German kind of connection there that we have a telescope that goes into space and goes above the water vapors and we can do that type of exploration on a daily basis and change the technology on a daily basis. Is that something that we should be better having and having better connections with other countries that can help us, not just with money but with technology, with all of the things that we're looking at to advance and maybe advancing with a connection to other countries and saying this is what we're trying to get to. Mr. Cheng, go ahead.

Mr. CHENG. Representative, leadership is a matter of not simply saying we are going to head in a particular direction but being able to persuade others to join us, and as my fellow panelists have also pointed out, other nations do want to join us. It does entail, however, having a vision, having an objective, having a target, and having the persistence, which is the one great advantage the Chinese have. Their manned space program dates back at least to the late 1980s and it has enjoyed consistent top-level support through multiple changes of leadership. Whether or not we have that persistence is something the Chinese are looking at but also our allies, and so I would hope that the SOFIA program and other programs will be the start, not the end of that kind of cooperation.

Let me also just note very quickly that we are the main explorer of the outer solar system. We have sent more, I believe, probes out beyond Mars than any other nation or even a group of nations com-

bined, and that too is an area that could be one of leadership and encouraging cooperation with our friends and allies.

Dr. LEWIS. Maybe to follow up, thank you for the question. I think the real issue is, you know, what do we want to do about exploration beyond low-Earth orbit, and low-Earth orbit we know how to do it. It's great. But what do we get out of LEO, right? And what's the best way to do that? And there's some issues that I think fall under the purview of this Committee but also the larger discussion. Do we focus on manned missions or do we focus on robotic? We've had tremendous success in robotic. Do we go for Mars or do we go for the Moon? I tend to like the Moon because I know we can get there. Mars, it's kind of a long shot but it's a legitimate question. And finally, we need to rethink the outlines of cooperation both with our European partners, with the other space-faring partners but maybe also with China, and in that sense, to your original point, I think having a clear goal helps. Having a lot of efforts may not be the best way to achieve cooperation.

Mr. KNIGHT. Thank you.

Thank you, Mr. Chairman. I yield back.

Chairman BABIN. Yes, sir.

I now call on the gentleman from Colorado, Mr. Perlmutter.

Mr. PERLMUTTER. Thanks, Mr. Chair, and gentlemen, thank you for your testimony today. I really do appreciate the panelists almost nodding as each of you is speaking because you all seem to be pretty much on the same page, and I think for the Members up here, very similar kind of view of this, and so I appreciate your testimony. I'm not often on the same page as the Heritage Foundation, I can tell you that, Mr. Cheng.

Mr. Bridenstine—so we agree, this panel on a lot of the space exploration components and this potential for a space race that we're not winning. We've been able to win in the past, and Mr. Bridenstine is pretty single-minded in talking about commercial space and the ability to expand that and the potential innovation that our private sector brings to, you know, exploring at least low-Earth orbit if not farther. There's a thing I'm pretty single-minded about, and Mr. Knight will start laughing at me, but 2033, okay, so we've had testimony by NASA engineers and other experts that 2033 orbits of Mars and Earth are in pretty good alignment to save a lot of space travel time, and that 17 years helps us put the building blocks in place to get to Mars, get our astronauts to Mars, so human spaceflight, Dr. Lewis, which is what you've been talking about, and one of those building blocks certainly could be going back to the Moon. Now, I'm not the engineer, I'm not the scientist, I don't know the best way to do it, but I do know as a Member of Congress, we need to have long-term mission that we as Members of Congress stand behind from Administration to Administration.

So Mr. Cheng, to your point, we've seen different Administrations change how we looked at our space program. So I think we do have a potential for a mission that is long-term in nature that will continue to add to our expertise and our leadership in space.

Here's my question. We do—we've had testimony by prior panels that one of the last places where we've had some decent diplomatic dialog between ourselves and the Russians has been with respect to our scientists and our space programs, continue to use their

rockets to help us get to the Space Station. Is there the potential for us to have that kind of dialog with the Chinese scientists? Is it—you know, you've all used words like "wary" and "skeptical." You've used "cooperation" and "competition," "hostile" and "pragmatic." Is there a way for us to work with their scientists to really start broadening cooperation, if you will? And I'll open it to anybody on the panel if you feel like answering.

Mr. STOKES. If I can just draw one thread that you put out. You mentioned about the United States using Russian launch vehicles for some of our satellites and space programs. Of course, I think it's well known that we formerly did both satellites to the People's Republic of China and also licensed some of our companies to be able to use Chinese launch vehicles in terms of delivering payloads into space. That was restricted in 19—let's call it 1996, and if I'm not mistaken, it continues to be restricted until today. I mean, this is something that every once in a while it's raised again in terms of allowing the licensing of U.S. satellites and in terms of sales of satellites and also allowing U.S. companies to contract launch vehicle providers. The main restrictions that requires, if I'm not mistaken, a munitions license and there are restrictions under the 1989 Tiananmen sanctions that exist until today and perhaps for good reason. But that's certainly something that could be looked at again, I suppose. It's not cooperation but it's actually licensing and a technical issue.

Mr. SHEA. You know, in our report, I think in my testimony as well, we outlined—the Wolf restriction doesn't prohibit all sorts of interactions between Chinese scientists and U.S. scientists so there are some interactions that are not covered by the Wolf law. We do cooperate in collision avoidance. My colleagues could correct me. There's debris. U.S. space operators inform their counterparts in China when debris is getting near a Chinese satellite or other—so we do cooperate in that sense.

You raised the Russians. I mean, one thing I would be looking at is increased China-Russian cooperation. We see that here on planet Earth, China and Russia engaged in joint naval exercises in the South China Sea recently, so I could see China-Russia cooperation on joint rocket engine development, maybe Russian participation in the Chinese Tiangong-2, Chinese space station, going forward. So I'd keep an eye on that well.

Mr. PERLMUTTER. Okay. Thank you.

And I just think there's this yin and the yang going on between competition and cooperation to the degree the competitive juices of America start flowing, I think that's to the benefit of all of us but also cooperation just to keep peace in our time doesn't hurt us.

I yield back.

Chairman BABIN. Thank you, Mr. Perlmutter.

Now I recognize the gentleman from Ohio, Mr. Davidson.

Mr. DAVIDSON. Thank you, Mr. Chairman.

Mr. Cheng, in your comments you mentioned a Chinese program called One Satellite, Two Bombs. What does that mean and what does it stem from?

Mr. CHENG. In the 1960s, China under Mao Zedong basically said that in order to be a competitive major power, China first off needed to develop nuclear weapons, and in fact, there's all sorts of

rather breathtaking language by Mao about how the Chinese people will eat grass if necessary. But what that led to was in 1964 on its own without external assistance, China exploded its first atomic bomb. In 1967, it exploded its first hydrogen, or fusion bomb, and in 1970 it launched its first satellite, the Dong Fang Hong I, two bombs, one satellite. It is now embodied in Chinese terminology as evidence of two things: one, how far China is prepared to go in order to achieve strategic objectives, and two, the self-reliance. Now, self-reliance doesn't mean that you don't do cyber espionage and other things but it does mean that at the end of the day, China sets goals and they will achieve them.

Mr. DAVIDSON. Thanks for that.

One of the ways that the United States collaborated with China with commercial technology, pseudo-commercial technology, was to help them launch multiple low-Earth orbit satellites off of one launch vehicle. Is anyone familiar with this program wherein the early 1990s almost immediately after removing release-of-sensitive-technology authority from Defense and giving it to Commerce, we helped China develop this technology? Was that good collaboration?

Mr. STOKES. If I can take the first hack at it, that was the Motorola program, if I'm not mistaken.

Mr. DAVIDSON. Iridium, I think.

Mr. STOKES. The Iridium, yeah, the Iridium program. In particular, I believe it was certifying their what's called smart dispenser that has direct application, of course, to a MIRV capability, and if you look at the timeline, research and development timelines that match up, it's kind of hard to not conclude that there was a connection.

Dr. LEWIS. It's difficult to answer this question in an unclassified setting but it was not purely advantage to China.

Mr. DAVIDSON. Okay. Mr. Chairman, could I yield 30 seconds to my colleague, Mr. Bridenstine?

Chairman BABIN. Yes, sir.

Mr. BRIDENSTINE. I just wanted to directly respond to something that my good friend, Mr. Perlmutter from Colorado, said, which was the cooperation with the Russians and using their launch capabilities for our civil space programs. It was an article in Aviation Week and Space Technology probably about seven months ago. I read the defense minister for Russia stated very clearly—they were asking how are you financing your military communication, space-based communications programs, how are you financing your military remote sensing and imagery capabilities, and he said very clearly in the article that they're financing it with off-balance-sheet financing from expenditures from launching foreign satellites and astronauts. So when we cooperate in that way, we have to be really clear about what we're doing: we are financing the defense and military capabilities of the Russians. And I just wanted to get that on the record.

Mr. DAVIDSON. Thank you.

And I want to tie that together in terms of collaboration, sometimes perhaps some ways that have benefited us, some ways that have not been beneficial to us. Clearly, the whole panel has talked a lot about soft power, and I'm curious, where is China particularly successful with existing space powers like Russia, like European

countries, but also with non-space powers. So how has China been successful with their use of soft power in their space program?

Mr. SHEA. Well, China is using space—I think Mr. Cheng mentioned this earlier. China is using space as part of a broader relationship with countries, less-developed countries. With Pakistan, it provides space assistance but it's tied into this China-Pakistan economic corridor which is on the ground. China is building out something called One Belt, One Road initiative, and it intends to provide BeiDou coverage to most One Belt, One Road countries by 2018. So space is a component of a broader foreign policy diplomatic outreach to less-developed countries.

Mr. DAVIDSON. Thank you, and I apologize because I have very little time, but I was glad you connected the One Belt, One Road, and Mr. Cheng in particular referenced China's ability to stay on a unified, coherent national strategy, and I would argue that since the end of the Cold War, they have been the single nation that has done that with success.

Mr. Chairman, my time is expired.

Chairman BABIN. Yes, sir. Thank you very much, Mr. Davidson.

Mr. PERLMUTTER. Mr. Chairman, may I—

Chairman BABIN. You sure can. Go ahead.

Mr. PERLMUTTER. Thanks. I'd like to just say to my friend from Oklahoma, I agree. I wasn't talking about the fact we're paying for these launch vehicles but to have a back channel for diplomatic purposes sometimes is very important if the political systems between the two countries aren't working. So scientists sometimes lend us that back channel. That's really what I intended to convey.

Thank you, and I yield back.

Chairman BABIN. Thank you, Mr. Perlmutter.

This concludes this hearing. It's been very informative, very educational. I want to thank the witnesses profusely for their valuable testimony and the members for your questions. The record will remain open for two weeks for additional comments and written questions from the members.

So this hearing is adjourned.

[Whereupon, at 11:36 a.m., the Subcommittee was adjourned.]

Appendix I

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Hon. Dennis C. Shea

**Testimony before the House Space, Science, and Technology Committee, Subcommittee on Space
Hearing on "Are We Losing the Space Race to China?"
Responses to Questions for the Record**

**Dennis C. Shea
Chairman, U.S.-China Economic and Security Review Commission
November 22, 2016**

Please note the responses below represent my own views and not necessarily those of the Commission itself or other members of the Commission.

Responses to questions submitted by Rep. Brian Babin, Chairman, Subcommittee on Space:

1. How do the two space programs compare in terms of relative funding and relative national importance?

While China does not release budget information for its space activities, its spending on space is likely growing, though still dwarfed by that of the United States. Public reports have estimated that China spends \$2 billion to \$6.1 billion per year on its space program,¹ in comparison with the OECD's estimates of \$39.3 billion spent by the United States and \$5.3 billion by Russia in 2013.²

China's space program appears to enjoy a level of importance (among its smaller set of decision-makers) roughly commensurate with that of the U.S. space program, but with potentially different motivations. China's space program has benefited from decades of high prioritization and steady investment from its leaders.³ Space has kept pace with China's other objectives, playing a key role in the "Two Bombs, One Satellite" initiative during the Mao Zedong era⁴ and featuring prominently in China's later military modernization efforts.⁵ While China has not pursued a highly accelerated manned spaceflight project as the United States did during the Space Race, this can be attributed to its position as a technological latecomer. However, China's space program is intended to further its leaders' strategic ambitions by adding to the country's "comprehensive national power" (a far-reaching term used by sources in China⁶). Motivations related to security and political prestige have likely been the most prevalent, while the pursuit of scientific discovery for its own sake appears to have been a weaker factor than in the United States.

2. The U.S. still maintains a significant edge in space exploration beyond the Moon, particularly in the outer solar system. Aside from the scientific benefits, what kinds of comparative technological, political, or security benefits does the U.S. enjoy from its relative dominance in this area?

The large amount of global scientific knowledge regarding the outer solar system and beyond that can be attributed to U.S. investments in space exploration likely confers a significant soft power advantage to the U.S. space program. The nonmilitary focus of these programs is unmistakable, and contrasts with China's approach to space. This advantage has the potential to incentivize China to devote some resources to mostly scientific activities (e.g., its plans for a telescope similar to the Hubble Space Telescope⁷) and strengthen the United States' position as it invites international collaboration in its space efforts.

- 3. Although we are neither fully competing nor fully cooperating with the Chinese, we can still benefit from observing how another space program operates. Based upon your studies, what Chinese activities or practices, if any, could the U.S. adopt?**

China's space program has benefited from a concentrated effort featuring decades of high prioritization and steady investment from its leaders. While the United States has also viewed space as a priority and invested much more into its space program than China has, it could benefit from more sustained commitment to its goals over time.

Other aspects of China's space program, such as its decision to slowly move forward on a wide range of programs (many already accomplished by other nations), the overwhelming role played by its defense industry, and its extreme lack of transparency would likely not be a good fit for a technological leader and representative democracy such as the United States.

- 4. Your testimony makes several recommendations, most of which pertain to the Department of Defense. What role do you see NASA playing in this discussion? Do you have any recommendations on how our nation's civil space programs might help further our interests at home and abroad?**

In my view, NASA will play a leading role in addressing each of the political and diplomatic implications outlined in my testimony. First, NASA has responsibility for conducting the "milestone" space exploration activities that can demonstrate enduring U.S. technological leadership in space, such as sending humans to an asteroid by the mid-2020s and to Mars in the 2030s.

Second, NASA has longstanding partnerships with an even wider range of countries than does China, despite not engaging on the commercial side in the same manner as China's national space program. Although most of its activities are with developed countries, NASA is also engaging in projects with Argentina, Bermuda, Brazil, India, and Thailand; leading a program that provides satellite-based Earth observation data and science applications to developing countries; and participating in several other international programs geared towards assisting developing countries.⁸ Continuing to engage in these efforts will ensure that China does not monopolize space-related international cooperation activities, particularly with developing countries.

Lastly, in regards to the public relations "victories" that China has been able to achieve in Western media related to U.S. restrictions on collaboration with China in space, NASA will continue to have a clear nonmilitary focus in contrast with China's ostensibly "civil" space activities. This distinction could potentially allow the U.S. to better convey the legitimate concerns underlying U.S. restrictions on space cooperation with China.

- 5. Would it be in our interest to actually encourage the development of a Chinese civil space organization that is separate from the military? Would it make any sense within the context of China's political organization? What could the U.S. do to encourage this separation?**

The China National Space Agency could already be viewed as such an organization (though it does report to the entity that exercises administrative authority over China's defense industry). However, it

⁸ The China National Space Agency is subordinate to the State Administration of Science, Technology, and Industry for National Defense (SASTIND), and is led by the SASTIND director. SASTIND is subordinate to the State Council's Ministry of Industry

does not have a direct role in overseeing China's space policy; space research, development, and acquisition process; space assets; or space operations and therefore cannot be viewed as the equivalent of NASA in any real sense.⁹ This is due to China's reliance on its massive state-owned defense conglomerates to undertake large-scale space programs,¹⁰ as well as to the importance of the military driver in China's space efforts. For context, China's military and defense industry are leading players in many of its other high technology industries as well.

Due to these factors, efforts to encourage the development of a separate and significant civil space organization would not make sense, and would likely make no difference, within the context of China's political organization.

6. It seems that our witnesses agreed that China's civil space effort is moving forward at a steady pace. What kind of reaction are we seeing from neighboring countries? Does China's space program encourage or intimidate those in the region?

Most regional countries seem to be encouraged by China's civil space effort, as evidenced by their willingness to cooperate with China in areas that are not strictly civil. A few examples of this are referenced in my testimony:

- China led the founding of the **Asia Pacific Space Cooperation Organization (APSCO)** in 2008, its primary vehicle for multilateral cooperation on space. APSCO is a formal, membership-only organization headquartered in Beijing, with seven other member countries (Bangladesh, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey, with Indonesia as a signatory state but not yet a full member), all of which have less advanced space programs than that of China. APSCO members hold conferences, engage in joint training efforts, and cooperate on multilateral research and development projects.¹¹
- Regarding China's **One Belt, One Road** initiative, China has stated that it plans to expand Beidou coverage to most of the countries involved by 2018 on the way to global coverage in 2020.¹²
- With **Brunei, Laos, Pakistan, and Thailand**, China has signed agreements to provide Beidou-equipped receivers for government and military customers at heavily subsidized costs.¹³
- China has provided launch services for Chinese-made satellites to **Laos, Pakistan, and Sri Lanka**. China has also launched a foreign-made satellite for **Indonesia** and launched an experiment for **Japan's** space agency.¹⁴

As noted in my testimony, China may face competition in the region from Japan, which had a space budget of roughly \$2.75 billion in 2015,¹⁵ has launched microsattellites for Vietnam and the Philippines and engaged heavily with Vietnam's space program,¹⁶ and has engaged in numerous other international partnerships.¹⁷ Japan has also strongly emphasized the importance of participating in creating norms in space,¹⁸ which may clash with China in areas such as weapons testing and militarization.

7. Are there any indications about the kinds of international engagement China is pursuing with its planned space station or lunar exploration?

and Information Technology. U.S.-China Economic and Security Review Commission, *2015 Annual Report to Congress*, November 2015, 274.

China has already begun diplomatic efforts with regards to its planned space station. In June 2016, the director of the China Manned Space Agency signed two agreements with the director of the U.N. Office for Outer Space Affairs, based on which China will solicit, evaluate, select, and finance future experiments from foreign nationals through the UN (although these will also require bilateral agreements with countries involved). China has also signed agreements with the Russian Roscosmos space agency and the European Space Agency regarding space station cooperation, and European astronauts are reportedly already learning Chinese in preparation for trips to the station.¹⁹ Fu Zhiheng, vice president of the China Great Wall Industry Corporation,[†] stated in November 2016 that “many nations have reached out to China, seeking to play a part in the country’s future manned space station.” He noted that China is already conducting cooperation projects with foreign space agencies that involve carrying experiments on the Tiangong 2 space lab and Shenzhou 11 spacecraft, but did not specify which countries were involved.²⁰

Wu Weiren, chief designer for China’s moon and Mars missions, expressed in an April 2016 interview that China would welcome cooperation with the United States on lunar exploration in particular, while also delivering a standard criticism of U.S. restrictions.²¹ Russia’s Deputy Prime Minister Dmitry Rogozin announced in July 2016, following a meeting with Wang Yang, Vice-Premier of China’s State Council, that the two sides were “developing an understanding ... for possible interaction” in the future exploration of the Moon and Mars.²² Sino-Russian cooperation on lunar exploration appears to be very much in aspirational stages.

8. Please discuss China’s “One Belt, One Road” policy and how space fits into that and the broader Chinese grand strategic vision?

China’s “One Belt, One Road” initiative, announced in 2013 by President Xi Jinping, involves major infrastructure projects in ports and railways throughout the region. It is composed of a land-based “belt” through Central Asia and a maritime “silk road” counterpart that will run through Southeast Asia and the Indian Ocean to Africa and the Mediterranean Sea.²³

China has specifically stated that it plans to expand Beidou coverage to most of the countries covered by the initiative by 2018 on the way to global coverage in 2020,²⁴ indicating it sees the system as contributing to its economic diplomacy efforts. However, space cooperation is best seen as following and supporting rather than preceding or driving Beijing’s broader foreign policy efforts.²⁵ Also, some of Beijing’s space cooperation efforts involve practical requirements, such as the placement of telemetry, tracking, and control stations around the globe to track spacecraft, or the placement of differential Beidou stations to improve the system’s local accuracy²⁶ and thereby benefit Chinese companies’ commercial prospects.

9. Please discuss China’s international engagement with other spacefaring powers, particularly Russia and Europe.

China and Russia established a space cooperation subcommittee within the countries’ bilateral prime ministers’ dialogue in 1997, after a break in cooperation beginning in 1958. This has resulted in the opening of a Chinese space program office in Russia and a corresponding Russian office in China, as well as collaboration on a range of human spaceflight and space exploration activities. China has signed

[†] The China Great Wall Industry Corporation is the state-owned defense subsidiary which handles China’s space launches and commercial space activity. U.S.-China Economic and Security Review Commission, *2015 Annual Report to Congress*, November 2015, 279.

agreements regarding cooperation on its forthcoming space station with the Russian Roscosmos space agency.²⁷ Russia's Deputy Prime Minister Dmitry Rogozin announced in July 2016, following a meeting with Wang Yang, Vice-Premier of China's State Council, that the two sides were "developing an understanding ... for possible interaction" in the future exploration of the Moon and Mars.²⁸ In June 2016, during Russian President Vladimir Putin's visit to Beijing, the two sides established a legal framework for protecting intellectual property rights in potential joint projects such as launch vehicles and rocket engines.²⁹ China likely gains valuable knowledge from cooperating with the world's number-two space power, particularly in the area of launch vehicle technology.³⁰

China's joint space cooperation efforts with the European Space Agency are thriving, particularly in the areas of space science, space exploration, and human spaceflight. In the mid-to late-2000s, China extracted important gains from the relationship through its early co-development work on Europe's Galileo satellite navigation network.³¹ China has signed an agreement with the European Space Agency regarding cooperation on its forthcoming space station, and European astronauts are reportedly already learning Chinese in preparation for trips to the station.³² Lastly, European Space Agency Director Jan Woerner implied in a March 2016 interview endorsing the "Moon Village" concept that China's participation in the project would be welcome, in the context of hoping the United States and China would cooperate.³³ China generally seeks access to Europe's advanced space technology to improve its own space capabilities, while Europe seeks greater cooperation primarily in order to compensate for the reduced funding of the European Space Agency and to facilitate greater economic ties between China and Europe.³⁴

10. Please discuss China's international engagement with non-spacefaring nations, particularly in Africa, South America, Europe, and Southeast Asia.

Southeast Asia:

- China led the founding of the **Asia Pacific Space Cooperation Organization (APSCO)** in 2008, its primary vehicle for multilateral cooperation on space. APSCO is a formal, membership-only organization headquartered in Beijing, with seven other member countries (Bangladesh, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey, with Indonesia as a signatory state but not yet a full member), all of which have less advanced space programs than that of China. APSCO members hold conferences, engage in joint training efforts, and cooperate on multilateral research and development projects. These efforts allow China to position itself as a purveyor of space technology and expertise to less-developed states.³⁵
- With **Brunei, Laos, and Thailand**, China has signed agreements to provide Beidou-equipped receivers for government and military customers at heavily subsidized costs. These agreements include provisions allowing Beijing to build satellite ground stations in each country.³⁶
- China has provided launch services for Chinese-made satellites to **Laos and Sri Lanka**, and launched a foreign-made satellite for **Indonesia**.³⁷

Europe:

- With **Ukraine**, China implemented three consecutive five-year programs guiding cooperation on large-scale space projects from 2001-2015. These have included cooperation on projects involving remote sensing satellites, space weather satellites, space rocketry, and the Ionosat space system. The two countries have also discussed projects in engine manufacturing and even for exploring the Moon and Mars, but these have not yet seen further action.³⁸

- China has signed a contract to launch a Chinese-made satellite for **Belarus** and launched a foreign-made satellite for **Turkey**.³⁹

Africa:

- With **Nigeria**, China hosted a delegation in April 2016 that reportedly discussed “logistics and investment for a manned space mission,” related to Nigeria’s announcement in 2016 that it intends to send an astronaut to space by 2030.⁴⁰ China reportedly agreed to provide scholarships and training to Nigerian engineers in the space sector to assist this effort.⁴¹
- China has built a TT&C station in **Namibia** and leases access to a station in **Kenya**.⁴²
- China has provided launch services for a Chinese-made satellite to **Nigeria** and signed contracts to launch foreign-made satellites for **Algeria** and the **Democratic Republic of the Congo** in the future.

South America:

- With **Brazil**, China has cooperated on joint satellite development and space launches, most notably the China-Brazil Earth Resources Satellites project, which developed a series of remote sensing satellites from 1988 to 2016.⁴³
- With **Venezuela**, China signed a memorandum of understanding on space technology cooperation and established a special joint subcommittee on technology, industry, and space in 2005. Since then China has built and launched two satellites for Venezuela and is helping Venezuela build small satellites, supplying Venezuela’s space industry with Chinese technology, and training Venezuelan engineers.⁴⁴
- With **Bolivia**, China has trained Bolivian scientists and lent the majority of the funds needed for Bolivia to purchase its first satellite.⁴⁵
- China has built a TT&C station in **Chile**. In **Argentina**, China is constructing its sixth overseas TT&C station at a reported investment of over \$300 million, in exchange for providing Argentina a share of the antenna’s usage time and access to imagery from its surveillance satellites.⁴⁶
- China has provided launch services for Chinese-made satellites to **Bolivia** and **Venezuela**, with a contract signed for a future launch for **Venezuela**. China has launched foreign-made satellites for **Argentina** and **Ecuador**.

11. What is the difference in the way that the U.S. and Japan compete with China in the soft power use of space?

The United States and Japan derive soft power benefits from space in similar ways; for example, both seek to participate in the creation of international norms in space⁴⁷ and engage in international partnerships, particularly with developing countries.⁴⁸

One difference is that Japan’s space agency contracted with China to launch an experiment in April 2016,⁴⁹ while the United States does not undertake cooperative activities with China’s space program. Another is that NASA does not involve itself in the commercial space sector to the extent that Japan’s space agency does.

- 12. A July article in the Wall Street Journal reported that the director general of the European Space Agency was open to the idea of cooperating with China onboard the International Space Station. China's long-term lunar plans are not inconsistent with Europe's "lunar village" concept. How should we as a nation respond when our international partners who decide to cooperate with China in matters related to civil space?**

The United States faces a fundamentally different landscape than it did during the Space Race. Rather than a direct competition with one strategic adversary, it faces a wide range of developed, developing, and aspirational space powers; intersecting security, economic, and diplomatic interests involved in its relations with each one (and with multilateral groups, international organizations, and commercial actors); and growing competition with some.

In this environment, priorities for U.S. civil space programs must be carefully determined at the highest levels of U.S. leadership. To answer the question of how to respond to U.S. partners choosing to cooperate with China, the United States must first decide (1) whether it seeks "milestone" space exploration activities that will clearly demonstrate U.S. leadership; (2) whether involvement in a major international partnership effort following the ISS fits broader U.S. foreign policy objectives; (3) whether both are feasible; and (4) if both are not feasible, which is a higher priority. In my view, pursuing a milestone activity (like the Journey to Mars) and leading in a major international partnership would be preferable.

- 13. What are some ways that the U.S. can formulate a strategy for engaging China that appropriately balances cooperation, assimilation, and containment in space? What should be the long term aim of such a strategy?**

Considering all factors, the primary concerns regarding the current U.S. approach are diplomatic rather than security, technical, or commercial in nature. On our current trajectory, U.S. allies will likely continue to slowly seek out technologies not subject to U.S. restrictions, and will understandably gravitate towards the programs they want to pursue (i.e. the "Moon Village" over the Mars program). They will also likely want to leverage the resources and abilities of China, one of the world's largest players in space, in these efforts—particularly if China is interested in the same programs.

The United States could take several steps to address these challenges. First, it could prioritize investments in a project that matches the desires and capabilities of U.S. partners (a follow-on to the International Space Station) in order to remain at the center of international space collaboration while maintaining restrictions on China's participation. Second, it could prioritize investment in "milestone" space exploration activities (i.e. the current Journey to Mars initiative) that can conceivably be restricted to the most advanced and trusted U.S. partners. Third, it could determine the minimum acceptable amount of technology transfer that would be involved in a cooperative space program with China, and support some multilateral cooperative projects on that basis. This step could provide flexibility to U.S. decision makers, particularly if pursuing the first and second steps together is not possible due to resource limitations. Finally, the United States could take the step outlined by the Commission in its 2015 Annual Report:

Congress should direct appropriate jurisdictional entities to undertake a review of (1) the classification of satellites and related articles on the U.S. Munitions List under the International Trafficking in Arms Regulations and (2) the prohibitions on exports of Commerce Control List satellites and related technologies to China under the Export Administration

Regulations, in order to determine which systems and technologies China is likely to be able to obtain on the open market regardless of U.S. restrictions and which are critical technologies that merit continued U.S. protection.

The long-term aim of such a strategy should be threefold: 1) to maintain clear U.S. technological leadership in space; 2) to ensure the United States retains a seat at the table—indeed leadership—in the largest international space cooperation effort at a given time; and 3) to prevent access to the most sensitive dual-use technologies in order to avoid unnecessarily assisting China’s military space program.

- 14. Our nation’s space program pays significant soft power dividends. But this power does not come for free. How useful is this soft power and can it justify the cost? Because the U.S. has already completed many of the space goals that China is pursuing, does soft power and prestige through space necessarily cost more?**

U.S. soft power dividends from its space program serve crucial U.S. goals on earth. Ultimately, U.S. leadership in space contributes to upholding the rules-based international order, which the United States has identified as an enduring interest.⁵⁰ These contributions span security, economic, and diplomatic areas.

It is difficult to assess whether U.S. or Chinese soft power dividends from space activities cost more, because the dividends that have been reaped are not the same. China has been able to build prestige through its space program—particularly in the eyes of its domestic audience—as it ticks off previously achieved milestones, and its space activities provide a wide range of contributions in economic, political, and diplomatic areas. This is not equivalent to the benefits of U.S. leadership, however, or the influence the United States wields over international norms in space and in related areas. A decision by Beijing to pursue this level of technological leadership would likely be associated with steeper costs.

- 15. In your testimony you allude to the possibility that if the International Space Station were deorbited in 2024, as is likely, China would potential have the world’s only active space station. Of course NASA is working on deep space habitation capabilities as part of its Journey to Mars, and plans to send astronauts beyond low-Earth orbit after ISS. Do you foresee a Chinese space station competing with American commercial space stations in low-Earth orbit?**

Given the blending of Chinese military, civil, and commercial efforts in space, a Chinese space station would almost certainly compete with American commercial space stations in low-Earth orbit.

- 16. In your written testimony, you write that China will not pass the U.S. in terms of space exploration “milestones” over the next two decades? Would this include objectives related to lunar exploration, such as number of people on the lunar surface, duration, and establishment of a permanent base?**

This assessment does account for those areas. As noted in the testimony, if both countries’ programs hypothetically proceed as planned, by 2036 the United States could conduct a manned mission to Mars while China could conduct one to the Moon. China has only recently confirmed this objective and has offered no insights into the number and duration of trips it has planned, or whether it will seek to establish a permanent Moon base. Given the slow and methodical nature of China’s manned space program thus far,⁵¹ it seems unlikely that these would be added within that specific timeframe.

Regardless, completing the “Journey to Mars” would ensure the United States retained an unmistakable lead in space exploration.

17. In your discussion of China’s lunar ambitions, you mention a potential mission to the far side of the Moon and the establishment of a radio telescope. In July, this committee held a hearing on our nation’s astronomy projects and goals for the future. How does China determine its science priorities? What influence does the U.S. scientific community have, if any, on these priorities?

China’s determination of its science and technology (S&T) priorities can best be characterized as a top-down approach that has become increasingly fragmented and bureaucratic, with the government now working to bring more market drivers into the system. The Commission’s July 2016 report *Planning for Innovation: Understanding China’s Plans for Technological, Energy, Industrial, and Defense Development* describes this process and China’s current priorities in detail.⁵²

The report specifically notes there are as many as 100 top-down, state-directed innovation plans for S&T alone. The Chinese innovation system has evolved from a centralized, top-down apparatus into an increasingly ad hoc and fragmented structure where duplication is rampant, oversight is limited, and bureaucratic interests dominate over scientific needs, with around 40 agencies at the central government level alone involved. President Xi’s administration is seeking to broaden China’s long-standing model of top-down, state-led science, technology, and innovation development to embrace market-driven and bottom-up drivers. The report notes that these reforms are ongoing.⁵³

Importantly, the report also describes the influence of “techno-nationalism” on China’s S&T approach; this view dictates that a state-controlled and closed-door approach to technological and industrial development is the best way to safeguard national security, economic competitiveness, and international status. Based on this view, China’s leaders prioritize the acquisition and development of technologies that will serve broader strategic goals. Aerospace and advanced materials are often identified as target sectors in this regard.⁵⁴ As an example of the high level of leadership input in setting priorities, the report notes the following space objectives under the Made in China 2025 Plan:

China’s space industry ... will develop a next generation of launch vehicles and heavy launch vehicles. It will expedite the development of national civil-use space infrastructure, new types of satellites, air-space-ground broadband Internet systems, long-term, persistent satellite remote sensing, communications, and navigation technologies, promote human spaceflight and lunar exploration, and develop deep space exploration at a moderate pace. While no definition has been given as to what “moderate pace” means, it could suggest that priority is being placed on remote sensing, communication, and navigation over manned space flight and lunar exploration.

With these characteristics in mind, the influence of the U.S. scientific community on China’s S&T priorities is likely quite limited. However, China clearly welcomes opportunities to absorb foreign technology and expertise, indicating it may prioritize areas in which it anticipates opportunities to do so.

18. How do Chinese launch vehicles compare to other launch vehicles around the world in capability, price, and reliability?

On capability, China is generally seen as having matched the leading launch vehicles in current use with its launches of the Long March-7 (LM-7) and LM-5 rockets this year. As noted in the

Commission's 2016 Annual Report to Congress, the LM-7 can carry 13.5 tons into low Earth orbit, a significant increase from the LM-2F at 8 tons and the more frequently-used LM-2C and LM-2D at 3.9 tons;⁵⁵ the LM-5 is reportedly able to carry 25 tons into low Earth orbit and 14 tons to geostationary transfer orbit (as opposed to the LM-3E at 5.5 tons⁵⁶) as China's largest launch vehicle to date.⁵⁷ Both the LM-7 and LM-5 also use a less toxic and more efficient fuel than previous Chinese rockets.⁵⁸ However, China's position as on par with top global capabilities will only last until NASA begins using its Space Launch System rocket. China is planning to develop its own "heavy-lift launch vehicle" in the next 15 years.⁵⁹

On price, figures on the cost of Chinese launches are scarce, as the Commission described in its 2015 Annual Report. According to one source, however, the costs were in one case lower than those of Arianespace, the leading European launch company. A spokesperson for the China Great Wall Industry Corporation, which handles the contracting of China's commercial launch services, predicted that going forward its launches will be offered at the same price level as those of SpaceX, though officials from China's space industry had previously stated that they could not beat SpaceX's price.⁶⁰

Other factors are more likely to influence pricing for Chinese launches going forward. First, China's integration of its commercial and military launch infrastructures is expected to provide cost-saving effects, as it provides both sectors with synergies in economies of scale, "experience effects" such as increased reliability and fewer failures, and the ability to utilize modular designs. Second, China often packages its satellite exports and launch services together. Third, according to one former European space executive, China has broken into the launch services market by offering prices as low as three-quarters of the launches' cost, suggesting that heavy government assistance on top of low initial costs will enable China to successfully compete for broader market share in the future.⁶¹ China should therefore be expected to compete on price, and compensate with government subsidies in pursuit of larger objectives if necessary.

On reliability, China's Long March launchers have improved dramatically since 2000 and have reached international standards. Certain launchers, such as the LM-2E and LM-3, still have lower success rates than the more commonly-used versions and are not marketed to international customers.⁶²

- 19. In an April, 2011, article featuring an interview with Lei Fanpei, vice president of the China Aerospace Science and Technology Corporation, an unnamed Chinese official expressed skepticism at SpaceX launch prices. More recently, ChinaRocket, a newly formed subsidiary of the China Academy of Launch Vehicle Technology, announced that it intends to "reduce launch costs by 30 percent" and intends to pursue suborbital space tourism in 5 to 10 years.³ How realistic are these goals? How would the private sector view this company given its direct connection to the Chinese government? How does that involvement impact how private sector entities can engage with such a company?**

In general, China should be expected to compete on the price of its launches, and compensate with government subsidies in pursuit of larger objectives if necessary. According to one former European space executive, China has already broken into the launch services market by offering prices as low as three-quarters of the launches' cost.⁶³

Regarding private sector engagement with a company like ChinaRocket, current U.S. restrictions prevent any ITAR-accountable exports to China, including for launch purposes, whether these involve

³ Leng Shumei, "New company set up to develop space economy," Global Times, October 21, 2016. Accessed at <http://www.globaltimes.cn/content/1012793.shtml>.

a government buyer or not.⁶⁴ A private sector company would otherwise not be affected by this government connection.

- 20. The U.S. certainly has many valuable space-based assets in a variety of orbits. As China develops its own capabilities, it may one day match the size of our space-based infrastructure. Does China recognize the importance of keeping space clean and free of debris?**

Beijing's statements affirm that it seeks to keep space clean and free of debris. China's 2011 Space White Paper (its most recent) stated that "China will continue to strengthen its work on space debris monitoring and mitigation and its work on spacecraft protection" and cites actions taken specifically to mitigate debris.⁶⁵ After its 2010 and 2013 ASAT tests, China pointed out that "they did not generate space debris."⁶⁶ Some PLA analysts have expressed a preference for soft over hard kills in order to avoid the diplomatic repercussions of creating debris.⁶⁷ While it is not possible to conclusively determine whether China's leaders truly recognize the importance of keeping space free of debris, and these statements do not speak to the potential activities of the PLA in wartime, the absence of kinetic tests since 2007 is an encouraging sign.

- 21. Over the past 10-15 years, there have been dozens of reports, studies, audits, investigations and recommendations related to China, U.S. national security, cyber espionage, weaknesses in export compliance, and International Traffic in Arms Regulations (ITAR) violations.**

More recently, there have been a number of specific reports that have strongly detailed weakness and failures in enforcement of current policies.

Despite ITAR, EAR and OFAC regulations that exist to protect U.S. data and technologies, significant problems still exist and violations occur. It is documented in several reports and other publications that a significant part of the Chinese strategy for gaining access to U.S. data and technology is by exploiting the weaknesses in regulations related to science and technology research through university and non-profit partnerships, as well as special provisions in the law(s) excluding fundamental research (FRE). Further, engagement isn't always via formal university and non-profit partnerships, access is often through seemingly benign events such as conferences, "think-tank" or annual industry meetings, hosted facility tours and exchange programs; these are just a few key avenues used strategically for access by thousands of Chinese researchers and students.

The book, *Chinese Industrial Espionage: Technology Acquisition and Military Modernization*, details various strategies the Chinese have used and continue to evolve in order to infiltrate and access U.S. data and technology.

In 2011, P.L. 112-55, Sec. 539 of the U.S. spending bill prohibits NASA and the White House OSTP from utilizing any funds to engage or coordinate in any way bilaterally with China.

Despite all current regulations, violations continue to occur due to multiple levels of weaknesses in foreign access management programs, IT systems, and lack of consistency, training and enforcement of ITAR, export compliance and in some cases, blatant disregard for the law(s).

- a. Do you believe these weaknesses at NASA are being strategically exploited by the Chinese government?

- b. Do you see the same type of issues/relationships in other government agencies – DoD, DoE, etc.?
- c. What do you believe is the crux of the problem? Enforcement, training or international disregard/indifference to regulations, or subjective interpretation of the regulations allowing individuals to “operate in the gray area”?
- d. What do you believe are the top areas the U.S. government space industry community needs to strengthen related to protecting our national security, intellectual property, adherence to export compliance regulations, etc.?
 - i. Are there additional legislative actions that can or should be taken OR is it a matter of better enforcing the current laws and regulations?
- e. Do you believe the appropriations law restricting bilateral engagement with China should remain in place?
 - i. Do you believe it’s having any real affect curtailing export control issues and inappropriate foreign national access management?
 - ii. Should it be expanded?
 - iii. Given the tight NASA budget and the strong desire and current planning for the U.S. to explore deep space and send humans to Mars, do you believe it’s in our best interests to partner with China in order to bring in additional funding to enable such mission(s)?

China indeed employs a host of methods to access U.S. data and technology. The Commission included a section covering China’s intelligence services and espionage threats to the United States in its 2016 Annual Report to Congress, noting China’s human, technical, and cyber intelligence gathering capabilities. The report notes that Chinese intelligence services target a broad range of U.S. national security actors, including government organizations.⁶⁸ China has targeted DoD entities as well as actors within the space sector.⁶⁹ We should expect China’s efforts in these areas to continue.

U.S. prosecutions of alleged Chinese commercial espionage activities have risen sharply over the past several years, accounting for a large portion of the 53 percent rise in commercial espionage cases investigated by the FBI from 2014-2015, as noted in the Commission’s 2016 report. The report notes that the U.S. counterintelligence response to Chinese espionage has suffered from a lack of coordination within the U.S. Intelligence Community, however. According to the *National Counterintelligence Strategy of the United States of America 2016*, “the current and emerging [counterintelligence] challenges facing the United States require an integrated, whole-of-government response.”⁷⁰ The document outlines priorities for achieving this objective, such as “strengthen[ing] secure collaboration, responsible information sharing and safeguarding, and effective partnerships” among counterintelligence entities.⁷¹ However, ODNI’s Office of the National Counterintelligence Executive, which is statutorily responsible for developing the U.S. government National Counterintelligence Strategy, does not appear to have practical authority to make structural changes within the U.S. intelligence community toward this goal.⁷² Michelle Van Cleave, former national counterintelligence executive, testified to the Commission that “instead of looking at the strategic implications of China’s intelligence operations, the U.S. government for the most part has adopted a case-by-case approach to dealing with the threat they represent.”⁷³ This

approach has—at least publicly—largely manifested as a series of isolated commercial espionage prosecutions, rather than a coordinated counterintelligence effort across the Federal Government.⁷⁴

In addition to the above observation, the Commission has put forward several recommendations related to this topic:

- *Congress direct the U.S. Department of State to develop educational materials to alert U.S. citizens living and traveling abroad about recruitment efforts by Chinese intelligence agents, and to make these materials available to U.S. universities and other institutions sending U.S. students abroad. Congress should also direct the U.S. Department of Defense to develop and implement a program to prepare U.S. students studying in China through Department of Defense National Security Education Programs to recognize and protect themselves against recruitment efforts by Chinese intelligence agents.*
- *Congress direct the Federal Bureau of Investigation to provide a classified report to Congress on what risks and concerns have been identified as associated with information systems acquired by the U.S. government, and how those risks are being mitigated. This report should identify information systems or components that were produced, manufactured, or assembled by Chinese-owned or controlled entities.*
- *Congress should direct appropriate jurisdictional entities to undertake a review of (1) the classification of satellites and related articles on the U.S. Munitions List under the International Trafficking in Arms Regulations and (2) the prohibitions on exports of Commerce Control List satellites and related technologies to China under the Export Administration Regulations, in order to determine which systems and technologies China is likely to be able to obtain on the open market regardless of U.S. restrictions and which are critical technologies that merit continued U.S. protection.*

Whether the U.S. appropriations law restricting bilateral engagement with China should remain in place and whether U.S. laws are being adequately enforced are two separate questions. The United States would incur costs as a result of any cooperative efforts with China in space. Even knowledge gained by China on ostensibly civilian projects, such as human spaceflight, should be expected to directly support the development of PLA space, counterspace, and conventional capabilities.⁷⁵ Further, advancements in space technology will benefit China's efforts to compete with the United States in a range of military, commercial, and diplomatic areas. However, if the United States decides not to prioritize leadership in multilateral space efforts (in order to pursue the Journey to Mars, for example), it must be prepared to see its partners gravitate towards China, or alternatively seek to allow some cooperation with China and manage the fall-out. Weighing the cost of assisting China's military space capabilities against the cost of the United States potentially being shut out from major international projects is a strategic decision for top U.S. leadership.

Responses to questions submitted by Rep. Donna Edwards, Ranking Member, Subcommittee on Space:

1. **The U.S.-China Economic and Security Review Commission reported that China sees space power as driving that country's economic and technological advancement and providing the Chinese Communist Party with international prestige.**
 - a. **To what extent does the Chinese Communist Party's support inoculate China's space program from disruptive program starts and stops and fluctuating budgets?**

While information on China's space budget is extremely limited, the support of China's top leaders likely reduces such instability significantly. China's space program demonstrates a concentrated effort, marked by high leadership prioritization and steady investment over time.

b. To what extent does it face competition for resources from other domestic Chinese priorities?

Information on China's space budget is scarce, but the high prioritization given to space in China's state directed plans going back decades indicate it has likely not been crowded out from access to resources by competing programs. China, of course, faces resource constraints like any other nation.

2. What do you think the impact of China's projected future capabilities, such as a manned space station and lunar activities, will be on the U.S.'s ability to attract international participation in its Journey to Mars initiative?

The impact will likely be negative. Prospective U.S. international partners have shown interest both in activities involving China's planned space station and in lunar activities in general. More broadly, while European nations have certainly cooperated with NASA in regard to the Journey to Mars initiative thus far, European Space Agency officials have indicated they would prefer to go to the Moon as a stepping stone to going to Mars.⁷⁶

3. NASA and the Chinese Aeronautical Establishment recently signed a memorandum of understanding to cooperate on aeronautics research that will advance air transportation automation for U.S. and Chinese aviation operations in China. Are there similar opportunities available in space operations that could benefit both the U.S. and China?

The United States could continue to explore agreements with China whereby space weather, earth geodesy, and meteorological data that the United States already distributes freely can be exchanged directly between U.S. and Chinese counterparts. Direct cooperation on research involving space technologies is likely to be more dual-use in nature than research involving air transportation.

4. What counsel would you offer to the incoming Administration as it considers how to work with China on space issues?

The Administration should consider the four key characteristics of China's space program outlined in my testimony: a concentrated effort with high prioritization by China's government; a long-term, deliberate approach; no distinction between military and civilian space programs; and a lack of transparency due to military predominance. Even ostensibly civilian projects, such as human spaceflight, should be expected to directly support the development of PLA space, counterspace, and conventional capabilities,⁷⁷ and advancements in space technology will benefit China's efforts to compete with the United States in a range of military, commercial, and diplomatic areas.

The Administration should have a clear expectation of these costs, and only determine to pursue cooperation if it is absolutely necessary for fulfilling its larger foreign policy vision, conferring advantages that outweigh the costs. If some degree of cooperation is pursued, I suggest it be evaluated

on a project-by-project basis to limit the transfer of advanced technologies to the greatest possible extent.

- 5. Much of the U.S. civil space program is tied to scientific goals and objectives; advances in scientific understanding go hand-in-hand with technical and engineering achievements. To what extent is science a priority in China's space activities? How has this changed over time?**

Science plays a role in the security, commercial, and political benefits China hopes to reap from its space program. However, these objectives have taken precedence over the pursuit of scientific understanding for its own sake, and China's efforts have largely duplicated previous scientific achievements. Thus, while China's government is quick to tout the scientific benefits of each of its space missions, the science component is best seen as a goal when it fits the government's larger objectives. This pattern has been consistent over time.

- 6. You indicate in your prepared statement that a visionary U.S. space exploration program can strengthen our national purpose, inspire new generations of leading scientists and engineers, and continue to benefit mankind.**

- a. Are there any lessons learned from your examination of China's space program that would argue for urgency on the part of the White House and Congress in crafting such a visionary space program?**

China's activities in space present a clear argument for the importance of crafting a visionary U.S. space program. As noted in my testimony, the series of high-profile activities China has planned over the next six years will be particularly influential, as it may appear China is reaching major milestones that the United States has already achieved and is thereby gaining ground, during a time in which the United States is readying for longer-term exploration projects, and observers are cognizant of the planned International Space Station deorbit date approaching in 2024. This assessment underscores the importance of U.S. commitment to its objectives in space—specifically, its goals of manned asteroid and Mars missions in the 2020s and 2030s—so that this apparent disparity does not continue after this period.

- b. How is China taking advantage of its space program to inspire its young? Is there a way to gauge the effectiveness of China's STEM efforts?**

China's space program is highly publicized in state media and likely has the effect of inspiring interest in STEM fields, although the primary aim of this publicity is likely to lend prestige and domestic legitimacy to China's Communist Party leadership.

Gauging the effectiveness of China's STEM efforts is highly difficult, but it can be observed that China graduates both a higher raw number and a higher percentage of students in STEM fields than the United States.⁷⁸ In 2008, 31 percent of U.S. bachelor's degrees were awarded in science and engineering fields, compared with 51 percent in China⁷⁹ (importantly, a far lower percentage of China's population has a bachelor's degree, and experts note that definitions of "engineer" in China can vary⁸⁰).

Other potential metrics can be found in China's own 13th Five-Year Science and Technology Innovation Plan, which targets improvement by 2020 in the following areas:

- Global innovation ranking
- Contribution of science and technological advances to economic growth
- R&D as a percentage of GDP
- Number of R&D personnel per 10,000 people employed per year
- Revenue of high-technology enterprises
- Share of value-added knowledge-intensive services industries to GDP
- R&D Intensity
- Global ranking for the number of citations in international science and technology papers
- Patents filed under the Patent Cooperation Treaty per 10,000 patents
- Patents filed per 10,000 people
- National technical contract turnover
- Proportion of the total population possessing scientific degrees (only 6.2 percent in 2015, aiming for 10 percent in 2020)⁸¹

These objectives will be covered in detail in a forthcoming Commission report titled *China's 13th Five-Year Plan*.

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Responses by Mr. Mark Stokes

Copy of document submitted by Mr. Stokes was not tendered.

Responses by Mr. Dean Cheng

**House Committee on Science, Space, and technology
Subcommittee on Space**

Responses from Dean Cheng

Questions from REP Brian Babin

First group of questions

1. How do the two programs compare in funding and relative importance.

At this point in time, we do not have any good open source information on China's space budget, whether on the civilian or military sides. (China's official defense budget is not considered an accurate representation of their defense spending.)

China's space program has long enjoyed highest level political support, including from the top military and political leadership. Chinese military writings make clear that they place a high priority on the ability to establish "space dominance."

2. How does American advantage in deep space exploration translate into tech, political, or security benefits?

The United States is the foremost explorer of the outer solar system. The ability to track objects in deep space provides the United States with significant experience in an essential set of technologies and, as important, scientists and engineers well-versed in its operation and limitations. The conduct of such missions has also ensured that American engineers, mission planners, and others are familiar with the conditions throughout the solar system.

Designing, building, and launching such missions has allowed the US to better exploit technologies for satellite power (essential for operations where solar power are limited), power management, communications with limited bandwidth, as well as systems integration. It has also tested American abilities to track objects with very weak signatures and signals.

Politically, it reflects the ongoing American lead in certain space technologies, and helps contribute to the American and NASA "brands." No other nation has been so associated with deep space exploration at this time, including the former Soviet Union.

3. What can the US learn from China?

More than anything else, China benefits from having a clear strategy, i.e., a means-ends chain, and an ability to sustain support for that strategy. China's manned space program, reflected in the Tiangong-2

and Shenzhou XI crewed mission, was laid out in the late 1980s. The current program reflects some 25 years of sustained support, including likely stable funding.

The contrast with the Augustine report on American manned space efforts is notable.

Similarly, the Chinese Lunar Exploration Program (CLEP) reflects sustained political support, and therefore a stable funding environment.

Finally, China feels it imperative to be largely self-reliant for much of its space technology. Consequently, while China officially welcomes cooperation with other states, it is unlikely to allow itself to depend upon foreign nations for key technologies. The continued outsize reliance on Russian rocket motors for key missions is a situation that the Chinese would be unlikely to ever tolerate.

4. Is there a unified concept for Chinese military and non-military space operations?

It is not clear if there is a Chinese national, non-military strategy for space. Chinese writings on mobilization, however, including “science and technology mobilization” suggest that there is a holistic view of all of China’s space capabilities, military and civilian, in time of conflict. This would likely include mobilization of key civilian personnel, equipment, and facilities, to supplement military assets.

China also clearly views its space program as a diplomatic/political asset in peacetime, and has used it to create diplomatic openings, such as the Asia-Pacific Space Cooperation Organization (APSCO).

5. Yes.

6. How do China’s neighbors view China’s space program?

China’s neighbors are engaged in a comparable, long-term space development effort. Japan and India both keep an eye on China’s space program, but there is not a “space race” comparable to the efforts undertaken by the United States and Soviet Union in the late 1950s and early 1960s. In particular, at this time none of China’s neighbors are making a major effort towards developing national manned space programs.

Japan, however, has clearly shifted its views on national security space, establishing a “basic national security space law,” and developing indigenous earth-observation satellites that can serve a national reconnaissance purpose.

7. One Belt, One Road and Chinese space?

There does not appear to be any direct links between the Chinese space program and the “One Belt, One Road” program.

However, both efforts reflect China’s ability to integrate geostrategic calculations, including foreign policy, with other elements of national power. Thus, the “One Belt, One Road” effort links Chinese economic capacity (such as the Asia Infrastructure Investment Bank and the Silk Road Fund) to China’s efforts to expand its diplomatic ties to Central Asia.

Similarly, China established the Asia-Pacific Space Cooperation Organization (APSCO) to leverage its space program as a means of expanding ties to other East Asian and South Asian states. It has sold satellites to nations that are key sources of raw materials, including Venezuela and Bolivia. And it is using its military capabilities, including space systems, to intimidate its neighbors.

8. Cooperation in civil space?

I believe that there is potential room for cooperation with the PRC in the area of civil space, and specifically in exploring the Moon and other planets. At a minimum, the two states can share the data that their respective probes collect, with minimal risk to either party of inadvertent loss of data or heightened possibility of cyber intrusion.

It would also be helpful for the two states to consider coordinating their respective future space exploration efforts, if only to minimize the potential for redundant data collection. As China and the US send probes to the Moon and Mars, for example, both sides might inform the other of the broad types of information their respective probes will collect, so that they do not overlap. If the US is intent on collecting information on water vapor in the Martian atmosphere, it might be useful to inform Beijing, so that they might focus on nitrogen or carbon dioxide.

Coordination might also provide insight into Chinese space decision-making, including which organizations are stakeholders; how budgetary priorities are set; and the relative importance of various universities and state-owned enterprises.

9. Chinese engagement with space-faring powers, including Europe and Russia?

China has limited cooperation with the European space programs at a national level. During the Shenzhou-VIII mission, for example, a German science payload was included.

China reportedly can access some European nations’ space surveillance networks, but it is unclear how extensive the cooperation is. China has access to the Italian Luigi Broglio space tracking facility at Malindi, Kenya. China has also established a space-tracking facility at Dongara, Australia.

China had a small-satellite payload incorporated into the Russian Phobos-Grunt mission, which was launched in November 2011, but which failed during initial launch.

China has cooperated with Brazil in the development of the China-Brazil Earth Resource Satellite (CBERS), China's first electro-optical imaging satellite.

10. Chinese engagement with non-space-faring powers, including Africa, South America?

China has clearly sought to leverage its space program diplomatically, through the creation of APSCO (Asia-Pacific Space Cooperation Organization). China has also sold satellites to a number of countries, often at very attractive prices, covering not only satellite construction and launch, but design, initial check-out, and insurance. This has included sales to Venezuela, Bolivia, and Nigeria.

Probably not coincidentally, many of these sales have been to countries which sell raw materials China requires for its own economic development, and are also often states with questionable human rights policies (e.g., Venezuela).

11. ESA space cooperation with China? US responses?

At the end of the day, Europe will pursue those policies which it feels are most important or beneficial to Europe. So should the United States. The US should maintain and sustain scientific cooperation with Europe, for a variety of reasons, including mutual scientific benefit. But it should also make clear to Europe the risks inherent in too close a relationship with China, especially in terms of information security.

This goes to a larger requirement, for the US and Europe to think in a more cooperative, coordinated fashion about key strategic challenges to the international system, including not only China, but Russia and Iran, and the impact of these challenges to the space domain.

12. Long term US space strategy towards China, among containment, coordination, and assimilation?

The United States, to paraphrase John F. Kennedy, should not fear negotiations, but should never negotiate out of fear. There is no need for the two states to have absolutely no contacts regarding space, but neither is it essential that the two engage in close cooperation, especially when the two states are so divergent in view, so differing in transparency, and increasingly at odds.

At the same time, the United States must recognize that it cannot expect to "contain" China, especially regarding space. The PRC is intent on developing its space capabilities, and the United States will have no more than a marginal effect on that desire (although it can complicate Chinese efforts to establish itself as a global space services provider).

13. How does soft power accrue from space, and is it cost-effective?

Soft power ultimately is an example of the “long game.” It is not a substitute for hard power, but it complements hard power. Soft power shapes perceptions and perceptual frameworks; it is the basis for “winning without fighting.” Because space capabilities touch on so many hard power aspects (95% of space is dual use, according to one RAND study), and reflects advances in various key military-relevant technologies (advanced computing, telecommunications, advanced materials, systems engineering), a robust space capability demonstrates aspects of hard power, without having to employ it. It is the epitome of the velvet glove that surrounds the iron fist.

In the long term competition between the US and China, therefore, space plays a comparable role to what it did during the Cold War—it demonstrates the capabilities of the respective systems.

The benefits of space, however, are not solely a matter of soft power. From international trade to military operations to global air travel, space directly contributes to key national activities. Therefore, it would be wrong to judge the soft power gains as somehow obtained at a cost, but rather, is a distinct side benefit to actual economic and military gains.

14. What are China’s plans for its space station, given that it will be smaller?

The smaller size of the Chinese space station does not mean that, somehow, China is obtaining less from it, any more than one should presume that a person with a smaller automobile somehow gets less from it. The Chinese seem to have laid out a methodical approach towards expanding their presence in space, based in part on their launch and production capabilities. The eventual Chinese space station will be about the same size as the American Skylab (which was not, at the time, a stop-gap measure). It will mark an advance over the current Tiangong-1 and Tiangong-2 space labs (which is how the Chinese describe the Tiangong facilities).

15. Space as dual-use. Any legitimate scientific research and analysis?

The Chinese space program should not be seen as a purely military effort, although technological and industrial developments obviously have military benefit. China also recognizes the importance of strengthening its overall scientific and technological base. Therefore, it sees its space program as providing incentives for people to become aerospace engineers, astrophysicists, etc. They recognize that not every person needs to work on developing China’s military capacities in order for China to grow stronger.

China has an interest in space science, but those interests, conversely, also benefit their military. Thus, the ability to deploy satellites to cis-lunar space, in order to support a landing on the far side of the Moon generates both soft power and hard power benefits. It messages the world that China is capable of achieving scientific and technological results that no other nation can; at the same time, China

establishes a foothold at key strategic outer space points such as L-2, which can have scientific but also military benefit.

16. Tiangong-2 in-orbit refueling and repairs?

It is possible that the Tiangong-2 will be directly refueled (and repaired) remotely. Alternatively, Chinese space writings have emphasized the utility of manned missions as complementing robotic and automated activities in space. It is therefore possible that the Chinese will use the Tiangong-2 to monitor, perhaps even to control, robotic systems engaged in refueling and repair activities.

17. Chinese vs US space launch in terms of pricing? Comparison in terms of resilience and operationally responsive space?

I am not familiar with the specifics of Chinese or American space launch pricing. Ironically, it would seem that China's failure to become a major commercial space launch provider is due, in large part, to the International Trade in Arms Regulations (ITAR) rules, which effectively prohibits any satellite containing ANY American items from being launched from a Chinese launch site. Thus, the Cox Commission report and the subsequent legislation has served to limit the ability of China to become a low-cost satellite launch provider.

The United States, however, has not been able to capitalize on this, as the European Space Agency and Russia have, ironically, been better positioned (and better priced).

Meanwhile, in terms of resilience and operationally responsive space, it is not clear which is superior, but China's reliance on state-owned enterprises means that its aerospace industry does not have to be as focused on meeting bottom line profitability. Thus, China can afford to build satellites and keep them in storage—a practice that may be in place for scientific packages. China seems to have built two of each lunar exploration satellite thus far, and will then launch the second, once the first is successfully deployed. Chinese military writings similarly suggest that it may be prudent to keep military satellites in reserve, not deploying them in peacetime.

18. Can China reduce launch costs by 30%? If so, how does that affect SpaceX and private space sector?

Since the Chinese space launch industry (and general space industrial sector) are managed through state-owned enterprises, the Chinese can set launch prices (as well as satellite construction) at almost any price they choose to. There is reason to think that China's sales of satellites (including launch services) to such states as Nigeria and Venezuela do not reflect the true cost of those systems and services. At a minimum, they almost certainly entail significant subsidies. Consequently, if the Chinese wanted to, they could engage in a price war with other space launch businesses.

Given the limitations of ITAR, however, this would not necessarily solve their problems, since satellite launch is only partly based upon pricing. This would suggest that, apart from ITAR, there is a need to keep Chinese behavior under close scrutiny, to watch for subsidies that would create a highly imbalanced playing field.

19. Does the Wolf amendment on NASA actually affect anything? Should it be expanded?

19a. I believe that the limits on bilateral discussions and engagement do restrict some of the ability of the PRC to obtain sensitive information about American space capabilities. In the first place, it limits the interactions and venues where American space scientists and administrators are likely to bring electronics and other devices that the Chinese would exploit. Second, it limits the direct transfer of technology that is likely to result from cooperative agreements. Third, it limits expectations of future cooperation, which is too often used as an excuse for ongoing violations (as is typical of Russian violations of arms control treaties, for example). Fourth, it limits inadvertent release of sensitive information, such as in the course of conversation.

19b. There is a fine line between limiting the release of information, and the ability to obtain information, as well as to engage in international cooperation with other states who might also interact with China. Therefore, in my opinion, this provision is sufficient for the present.

However, reports that Chinese nationals work at some NASA facilities (e.g., Langley) underscores the limits of even current restrictions and prohibitions.

20. Outcomes of space debris limitation talks? More Chinese ASAT tests?

The Chinese ASAT test generated a massive amount of debris, but it is not clear that the Chinese necessarily view this as being as large a problem as their Western counterparts do. Chinese military writings suggest that the testing of ASAT systems serves to deter (or coerce) potential adversaries, by demonstrating a real capability and implicitly threatening their satellites.

This warning is not only directly aimed at adversaries (e.g., the United States), but may also influence other spacefaring states. It makes clear that their satellites may be at risk, should they cooperate with an adversary. Thus, European and other systems are implicitly held at risk.

It is not clear whether Beijing is likely to stage equally destructive anti-satellite tests in the future. On the one hand, they have not conducted any tests that generated comparable levels of debris since 2007. On the other hand, they have demonstrated an ability to kinetically destroy satellites at geosynchronous orbit, where debris would be even more disruptive and long-lived.

There is no reason to think that the Chinese are intent on generating debris simply in order to generate debris. However, should the generation of debris serve other national interests (e.g., deterring or coercing adversaries or their potential allies), it is not at all clear that Beijing would necessary refrain from doing so.

21. Is the Chinese space program a “military program” like AFSPACECOM?

China’s space program should not be thought of as a “military” or “civilian” space program. Even less should it be compared with AFSPACECOM.

Instead, it should be seen as a *national* program, intended to further national goals, both military and civilian (including commercial). In this regard, then, it is very different from AFSPACECOM, but should be seen as embodying military aspects (including AFSPACECOM, but also the Army Corps of Engineers), civilian (including NASA and NOAA), and commercial (including Boeing, Lockheed-Martin, Raytheon). It also includes some universities (e.g., Beijing University of Aeronautics and Astronautics), and some intelligence gathering aspects (making it also comparable to the Missile and Space Intelligence Center and the National Air and Space Intelligence Center).

22. How does China use legal warfare w/r/t space?

It is not clear if China currently employs “legal warfare” tactics, since there are few ongoing legal cases involving space. The most obvious is the constant effort to overturn or modify the ITAR regulations so as to make it easier to engage in high-technology trade (which in turn would allow China greater access to sensitive technologies).

It is likely, however, that as American entrepreneurs such as Jeff Bezos and Elon Musk assume a greater role in space, that the Chinese will seek to employ regulatory and legal means to constrain them (and therefore the United States). Similarly, we can expect to see the Chinese emphasize the role of the state (versus corporations or individuals) in any international space regulatory framework, much as they have vociferously opposed any non-state actor role in establishing rules for the Internet.

23. ITAR and Chinese circumvention

23a. I believe that the weaknesses in the ITAR system, including its complexity, as well as compliance, are being exploited by the Chinese. I am not sure that NASA is unique in this regard, however. The PRC appears to be pushing high-level academic exchanges with various American universities in aspects of aerospace. And the recent RIMPAC exercises almost certainly provided China with first-hand opportunities to see how the US and its allies employ space for naval activities of various sorts.

23b. Yes, but also with non-government entities such as academia, professional organizations, and NGOs.

23c. I believe that part of the problem is the complexity of ITAR, which even with recent reforms, remains an area that is hard to understand even for corporate lawyers. In some cases, it appears to involve a failure to see the PRC as an espionage threat (e.g., the employment of Chinese nationals at NASA facilities, through contractors).

In other cases, it would appear to be a disregard for the possibility of said threat (as opposed to failure to recognize), grounded in a belief that scientific exchange is paramount, and/or scientists need to dilute policies such as ITAR or the Wolf amendment. Some openly argue that the problem in space security is not China but the United States. This is not necessarily the case with NASA, but is certainly a common view among various arms control groups and academics, including at some of the US military's professional military education establishments.

23d. Awareness of the threat is most important. The more focused on national security, the more there already is awareness. The problem seems to lie more with space policy experts in the NGO realm and academia (including the professional military education establishment) which seem intent on downplaying, if not outright ignoring, the problem.

This is exacerbated by the complexity of the ITAR system, and the need to rationalize the system so that compliance is facilitated, key technologies are protected, while easing the burden of sharing technology with key allies (e.g., UK, Australia, Canada, Japan). The Administration's efforts at ITAR reform are a good step in this direction, and need to be sustained in the new Administration.

What is not done, at this point, is even an attempt to understand how Chinese-manufactured sub-components may incorporate means to bypass ITAR and other technology security measures. Only recently has DOD issued instructions to cease the purchase of Lenovo computers for use at US facilities!

23e. I believe that the appropriate law restricting bilateral engagement with China should remain in place until such time as the conditions which mandated its application, including broad-ranging Chinese espionage, have changed. Any change now would be a concession without a corresponding gain.

It does not have to be expanded, but it should be rigorously enforced.

23eiii. Granting China financial power over a project of interest to the United States strikes me as extraordinarily reckless.

It is highly unlikely that any US-China partnership in manned space will generate positive benefits, and highly likely it will have negative secondary consequences. It is likely to be used as a hostage against other US-China points of friction (creating an interest group that would oppose countering China on, say, Taiwan-related issues or the South China Sea, for fear of jeopardizing the Mars program).

That said, Chinese efforts towards going to Mars will be driven by broader Chinese interests first and foremost, and those broader interests necessarily align with our own. Nor are they likely to provide much funding, without demanding substantial compensation in other arenas (diplomatic, political, military, technology transfer). Indeed, it is difficult to imagine how such cooperation could occur without rescinding much of the ITAR regulations as they apply to the PRC.

Second set of questions

1. CCP support and Chinese space program.

The high level support accorded China's space program by the nation's top leadership, embodied in the Chinese Communist Party, helps inoculate China's space program from disruptive program starts and stops and fluctuating budgets. It also ensures that goals agreed upon by the top leadership will remain in place, even over extended development periods, without changes in the program itself (beyond the funding aspect). That is, goals are determined in advance, and then pursued fairly consistently.

It is likely that the space program does face some competition within China for resources. Some of this competition may well be from other parts of the military, since so much of China's space program is embedded within the military. However, so long as China's economy has been growing, it is a matter of how large a share of an ever-growing pie.

If China's economy slows to the point of entering a recession (two consecutive quarters of negative growth), then the competition for resources is likely to mount. However, at that point, the role of the space program as a contributor to Chinese national security is likely to continue to insulate it. Competition *within* the space program, however, may increase at that point.

2. Chinese lunar capabilities and US Mars initiative

The Chinese ability to mount a lunar exploration program will be complemented by a diplomatic and political campaign to portray itself as a cooperative, equal partner in space. This will likely garner some partners, including Europe.

Foreign space policy makers will have to judge whether the gains from cooperating with China outweigh cooperating with the US on a more distant, long-term (and less financially stable) project such as a *Journey to Mars*, in allocating scarce space-related dollars/euros/pounds. It is not clear that they will necessarily favor cooperating with the United States.

3. US-China air transportation cooperation as basis for space operations cooperation.

It strikes me that, given concerns about infrastructure security in the United States, open cooperation with the PRC in this realm is problematic, rather than serving as a potential model. Given the potential for disruption should someone interfere with the American air traffic control system, creating comparable vulnerabilities in our space surveillance networks would seem foolish.

4. Advice on space cooperation?

There is a belief in some quarters that, if only the United States would engage the PRC in space, especially manned space, there would be spillover effects that would somehow lead to a change in US-China relations. Some analysts even argue that the model would be the Apollo-Soyuz mission, which is somehow seen as catalyzing détente.

Such views belie the reality that, in the first place, China's opaque space-policy-making makes it difficult to know whom we are dealing with. What we do know, however, is that China's space program has a very large military component, and therefore, even scientific cooperation, especially with the manned space and lunar exploration programs, will entail cooperating with the PLA.

As important, however, is the reality that the United States and the PRC do not have a history of interaction, not only in space, but in the broader arena of strategic issues. Despite several years' worth of the Strategic and Economic Dialogue (S&ED), the Chinese and ourselves have not engaged in anything approaching the complexity and extent of the US-Soviet (or US-Russian) strategic nuclear weapons talks. Given the dual-role nature of space, and the high level political attention space, especially manned space, garners, jumping into manned space cooperation with the PRC is premature at best.

I believe that there can be a place for US-China space cooperation, but that we must learn to crawl before we can walk, much less run. Therefore, the US and China should be prepared to share scientific data, perhaps agree upon common formats, before thinking about cooperating in *unmanned* space probes.

This relates to space science and space exploration. With regards to those aspects of space that directly affect national security (e.g., space situational awareness), the focus should be on preserving and improving American security, and cooperation with the PRC is problematic in this regard.

5. Science in Chinese space efforts?

China is interested in improving space science, not only for the engineering and applied aspects, and the associated economic and military benefits, but also because it recognizes the importance of basic research and "pure science" in promoting Chinese "comprehensive national power." Therefore, China has interest in the scientific benefits that accrue from an extensive space program, including furthering understanding of Earth, the Moon, etc.

But those same scientific achievements, in turn, can facilitate broader, non-space related goals, ranging from promoting STEM education and careers among students to fostering its space industries to military benefits.

6. Chinese space innovation?

It would be a mistake to believe that China's space program is largely derivative or dependent upon foreign technologies. China is seeking to promote innovation, and the history of indigenous development in its space capabilities gives it a basis for that.

China is going to deploy a communications satellite to the L-2 LaGrange point. No other country has deployed a communications satellite there (only scientific survey satellites). This is the first time that someone is going to deploy a communications system to that location.

China has also deployed a quantum computer aboard a satellite. Again, something that no other nation has done.

Finally, China has developed a direct ascent anti-satellite system targeting the geosynchronous belt. There is no open source indication that any other nation has done this.

Separately, it is noteworthy that China has organizationally innovated with its PLA Strategic Support Force (PLASSF), which combines space with network and electronic warfare forces to field the first "information warfare" force.

7. Private sector and space

The presence of a vibrant private sector is a benefit for the US, since it fosters innovation, and is more likely to reduce costs.

The Chinese recognize this, and are likely, on the one hand, to try and exploit foreign commercial providers and technology (including through espionage). At the same time, they are concerned that those private companies may prove superior technologically and in terms of flexibility.

China may promote the development of non-state-owned space companies, but as with non-state-owned telecommunications firms, they will obey directives from the central government.

Responses by Dr. James Lewis

Committee on Science, Space, and Technology Committee

Subcommittee on Space

“Are We Losing the Space Race to China?”

Question for the Record

James A. Lewis, Center for Strategic and International Studies

1. How do the two space programs compare in terms of relative funding and relative national importance?

China is developing a full range of space capabilities. China’s interest and investment in space goes back to the late 1950s and some Chinese space activities were even protected during the turmoil of the Cultural Revolution. China sees its space programs as a strategic activity to gain political and military advantage. Its manned program serves both domestic and international purposes. China gains political benefit from orbiting a human and space activities have greater political resonance in China. China’s leaders attend launches and ceremonies – especially for manned spaceflight efforts. In contrast, manned flight is not a political priority for the U.S.

According to Chinese officials, China’s total investments in space program is 13% of U.S. spending, at \$4.3 billion in 2015. The latest public figure for U.S. overall space program budget was \$42.956 billion in 2014, split among 11 agencies. While the breakdown for 2015 is not available, the following table compares U.S. and China space expenditure for 2012, the last year for which we could find complete data for China.

	China Space Program Funding ¹		US Space Program Funding ²	
	2012	% of Total	2012	% of total
Manned Spaceflight	790	23.02%	1606	6.44%
Earth Observation	769	22.41%	1904	7.64%
Launcher	620	18.07%	3327	13.34%
Science & Exploration	479	13.96%	8781	35.22%
Satellite Navigation	416	12.12%	1543.4	6.19%
Satellite Communications	132	3.85%	2192.7	8.79%
Space Security	10	0.29%	1455	5.84%
Other	216	6.29%	4125	16.54%
Total	3432	100.00%	24934.1	100.00%

NB: All funding amounts are reported in millions USD. NASA and DOD appropriations are combined. Within NASA appropriations, "Manned Spaceflight" refers to the combined costs of the Orion Multi-Purpose Crew Vehicle and the Commercial Crew Program. Similarly,

¹ "When China Goes to the Moon." *Springer International*, 2015. Print. Chapter 2: [China's Space Programme: An Overview](#).

² Daniel Morgan, "NASA Appropriations and Authorizations: A Fact Sheet." Congressional Research Service, September 16, 2016; "US Defense Space Programs," Aeroweb.

"Launcher" refers to funding for the Space Launch System. Figure for China may not take into account indirect subsidies to the space program

2. The US still maintains a significant edge in space exploration beyond the Moon, particularly in the outer solar system. Aside from the scientific benefits, what kind of comparative technological, political, or security benefits does the US enjoy from its relative dominance in this area?

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3. Although we are neither fully competing nor fully cooperating with the Chinese, we can still benefit from observing how another space program operates. Based upon your studies, what Chinese activities or practices, if any, could the U.S. adopt?

The only Chinese practice the U.S. could usefully adopt for its program would be consistent funding for attainable objectives and senior political interest.

4. You asserted in your testimony that the current state of the U.S. human space exploration reflects the absence of a strategic vision. Does a strategic vision necessarily imply creating a concrete finish line for a potential space race?

Strategic vision means linking space exploration to U.S. political interests. It does not serve our interests to appear to be sitting on our hands for a decade or two.

5. What kind of reaction are we seeing from its neighbors? Does China's space program encourage or intimidate those in the region?

China's space programs reinforce its claims to regional dominance by demonstrating that it is the most advanced among Asian nations, with the technology and resources that others cannot match. It should be seen as part of a larger effort by China to assert regional dominance and China's neighbors have tried, somewhat fitfully, to match it. India is China's strongest regional competitor and if there is a space race in Asia, it is between India and China. In 2014, India placed a lightweight satellite in the Martian orbit, as the first Asian country to reach Mars. In 2016, India conducted advanced twin-orbit launch that carried eight satellites. India is currently planning a manned spaceflight scheduled for 2016-2018, its lunar rover by early 2018, and its Mars orbiter by 2018-2020. Indian Space Research Organization (ISRO) frequently partners with NASA to launch earth-observing satellites and Mars exploration.

Japan has also reemphasized space programs in response to China. In 2008, Japan's parliament passed the Basic Space Law, ending its non-military space policy. The basic law proposed launching multiple satellites in ten years to upgrade its surveillance system and monitor Chinese ship movements near the Senkaku islands. Japan also plans on launching three medium-sized

scientific satellites and five small satellites. Moreover, Japan proposed to land a lunar rover by 2018 and is now exploring the possibility of human spaceflight missions.

6. A July article in the *Wall Street Journal* reported that the director general of the European Space Agency was open to the idea of cooperating with China onboard the International Space Station. China's long-term lunar plans are not inconsistent with Europe's "lunar village" concept. How should we as a nation respond when our international partners who decide to cooperate with China in matters related to civil space?

If we not doing anything on the Moon, we can't complain when our partners turn to others.

7. What are some ways that the US can formulate a strategy for engaging China that appropriately balances cooperation, assimilation, and containment in space? What should be the long term aim of such a strategy?

China's leaders are pragmatic. They have long term objectives that can put them in conflict with the U.S., but as part of a comprehensive strategy to deal with China's emergence, space cooperation could play a useful part. The question to ask is what would we want in exchange? China benefits more than we do from cooperation, so cooperation and cooperating for its own sake would be naive. A quid pro quo from China would not necessarily have to be space-related, but without a quid, there is no sense in trying to cooperate in space.

8. Our nation's space program pays significant soft power dividends. But this power does not come for free. How useful is this soft power and can it justify the cost? Because the US has already completed many of the space goals that China is pursuing, does soft power and prestige through space necessarily cost more?

Our nation's space program used to pay a significant soft power dividend. It doesn't pay as well now and our first priority should be changing this. Soft power is derived from accomplishments. We've rested on our laurels too long and this damages our global influence.

9. In April, 2011, article featuring an interview with Lei Fanpei, vice president of the China Aerospace Science and Technology Corporation, an unnamed Chinese official expressed skepticism at SpaceX launch prices. More recently, ChinaRocket, a newly formed subsidiary of the China Academy of Launch Vehicle Technology, announced that it intends to "reduce launch costs by 30 percent" and intends to pursue suborbital space tourism in 5 to 10 years. How realistic are these goals? How would the private sector view this company given its direct connection to the Chinese government? How does that involvement impact how private sector entities can engage with such a company?

Chinese satellite launches currently cost around \$50 to 70 million dollars. Reduction in cost are possible if there, but a 30% reduction is unlikely.

The China Academy of Launch Vehicle Technology (CALT), ChinaRocket's parent, showcased its two suborbital tourist vehicle models in September 2016. The models are respectively

designed to carry 3-5 and 6-29 passengers 50 miles of the ground- on par with Blue Origin's 60-mile altitude with a cost close to Virgin Galactic's 85-mile, \$220,000 per trip goal. The models have passed ground tests and are waiting for manned test flights by 2019 and unmanned ones between 2020 and 2021. One Chinese space startup founder reported that European customers rejected Chinese launch vehicles because of the Chinese State's involvement in space technologies.

10. Do you believe the appropriations law prohibiting NASA to use any appropriated funding to engage in bilateral discussions/engagement with China should remain in place?

Given the current state of relations, there is no reason to change the law barring NASA from cooperating with China. Cooperation is not in our interest. The question that is usually not asked about cooperate is what do we get in return, and a warm fuzzy feeling of brotherhood among scientists is not enough. There is no need to expand the law's provisions.

11. The US has many valuable space-based assets in a variety of orbits. As China develops its own capabilities, it may one day match the size of our space-based infrastructure. Does China recognize the importance of keeping space clean and free of debris?

China's anti-satellite test in 2007 created 3400 pieces of space debris, half of which are expected to remain in the orbit until 2027. So far, China has launched 4.5 percent of total spacecraft, but have generated 27.5 percent of the total pieces of space debris, 95 percent of which were created by the 2007 test. International reaction to the 2007 test surprised the Chinese and they have taken efforts to avoid similar debris-creating incidents, channeling their ASAT activities into less overt channels.

12. Over the past 10-15 years, there have been dozens of reports, studies, audits, investigations and recommendations related to China, U.S. national security, cyber espionage, weaknesses in export compliance, and International Traffic in Arms Regulations (ITAR) violations....

12. Any assessment of technology transfers to China that is more than five years old is of limited value. China, unsurprisingly, has greatly increased its own technological capabilities and U.S. export restrictions related to space have probably hurt U.S. industry more than China. This has been true for twenty years. China does seek to acquire U.S. technology licitly or illicitly, but the U.S. has rarely confronted the Chinese over their espionage and attempting to restrict China's access to technology through export controls is both ineffective and not sufficient by itself as a strategy to maintain U.S. technological leadership.

The crux of the problem is that since the late 1980s, China has a large scale espionage campaign aimed at catching up the West and the U.S. has been, with one exception, unwilling to confront them on this. America companies have for two decades and under three administrations been reluctant to see the U.S. pick a fight with China on espionage, arguing that market access outweighed espionage risk. This is not a black or white question, of course, but the U.S. needs to engage at senior levels if it is to do a better job in challenging Chinese strategies for illicit

technology acquisition. The 2015 Obama-Xi agreement to curtail commercial espionage was a useful step forward but cyber espionage is only part of the Chinese activities that need to be constrained

1. The U.S.-China Economic and Security Review Commission reported that China sees space power as driving that country's economic and technological advancement and providing the Chinese Communist Party with international prestige. To what extent does the Chinese Communist Party's support inoculate China's space program from disruptive program starts and stops and fluctuating budgets? To what extent does it face competition for resources from other domestic Chinese priorities?

China's manned spaceflight program, \$790 million a year, is shielded from budget fluctuation. China's state-owned aerospace companies have autonomy over program funding with little public scrutiny and take direct orders from the senior Chinese leadership. In contrast, China's space science projects are subject to large fluctuations. They are managed by the government-backed Chinese Academy of Science, and have to be negotiated on a project-by-project basis. *China has rapidly advanced its space program in the last decade, largely by leveraging heritage technologies from other countries, including the U.S.*

2. What do you think the impact of China's projected future capabilities, such as a manned space station and lunar activities, will be on the U.S.'s ability to attract international participation in its Journey to Mars initiative?

China has difficulty recruiting partners given its political peculiarities, but some international partners are questioning the level of funding that goes to U.S. led projects. Much will depend on what we do with the International Space Station, and crashing into the Pacific Ocean may dampen the enthusiasm of international partners for future projects.

3. NASA and the Chinese Aeronautical Establishment recently signed a memorandum of understanding to cooperate on aeronautics research that will advance air transportation automation for U.S. and Chinese aviation operations in China. Are there similar opportunities available in space operations that could benefit both the U.S. and China?

Safety of flight and space exploration are different issues. The U.S. has a long-standing relationship with China to improve air traffic control and safety of flight. This effort is beneficial to both countries. The two programs really cannot be compared.

4. What counsel would you offer to the incoming Administration as it considers how to work with China on space issues?

To postpone increased cooperation and refocus the manned exploration program onto achievable, near term goals, and to make a permanent human presence on the Moon our primary exploration

objective. Mars isn't going anywhere; it will wait for our technology to catch up, but there are important missions, like a lunar presence, that would better serve our strategic interest and that could be undertaken now.

5. Much of the U.S. civil space program is tied to scientific goals and objectives; advances in scientific understanding go hand-in-hand with technical and engineering achievements. To what extent is science a priority in China's space activities? How has this changed over time?

Science is not the primary motivation for China's space activities. Like the successful U.S. space program of the Space Race era, its primary goals are political and strategic. It is interesting to note that as a percentage of total space budgets, U.S. spending on science is two and half times greater than China's.

6. How important is it for a country to be able to innovate independently of other nations? How would you characterize China's capacity to innovate in the space domain? What are some notable innovations the Chinese have put forth? Have these innovations given rise to new economic markets in China?

China has a long-standing and relatively advanced national space program, with an indigenously developed family of liquid-fueled space launch vehicles that are competitive with American and European launchers. China's broad-sweeping "mass entrepreneurship, mass innovation" initiative, unveiled in 2013, aims to better harness entrepreneurship, bolster indigenous innovation, cut red tape, and extend tax benefits for startups and platforms. Within a year, several Chinese service providers for commercial satellite launches appeared.

Since then, China's space industry reportedly formed 300 startups, and unveiled a \$1.48 billion investment fund. In 2014, the Chinese government issued two reform directives to commercialize its state-funded research institutes into companies or commercial R&D centers, attract private capital, incentivize talented managers, and help merge private companies. private companies such as Alibaba have announced partnerships with CALT to launch commercial satellites in 2017. Chinese companies have announced plans to build satellite constellations, some as large as 1000 satellites. While such announcements should always be received with a degree of skepticism, there is an effort in China to duplicate the U.S. experience with entrepreneurial space activities. China is also trying to break into the commercial market by launching satellites for EU companies and exporting communications satellites to Nigeria, Venezuela, and Pakistan.

Is the presence of a vibrant commercial space industry a marked U.S. advantage?

The U.S. is the only spacefaring country to subsidize independent commercial ventures to put cargo and humans into orbit. A 2010 White House Statement called the entrepreneurial approach "a new era in space exploration" intended to "harness our nation's entrepreneurial energies." Private space activities build on the accumulated knowledge and technology of government experience and investment in space, and the U.S. hopes to see its commercial human spaceflight companies become profitable and self-sustaining. Ultimately, the success of these

entrepreneurial ventures will depend on technological progress that could come from either government or private investment. If the cost of access to space can be lowered, the U.S. investment could produce a broad range of new commercial space activities and give it an advantage in low earth orbit activities

Appendix I

ADDITIONAL MATERIAL FOR THE RECORD

STATEMENT SUBMITTED BY FULL COMMITTEE
RANKING MEMBER EDDIE BERNICE JOHNSON

OPENING STATEMENT

Ranking Member Eddie Bernice Johnson (D-TX)

House Committee on Science, Space, and Technology
Subcommittee on Space

"Are We Losing the Space Race to China"

September 27, 2016

Good morning and welcome to our witnesses.

This morning's hearing poses an interesting question, "Are We Losing the Space Race with China?" This question presupposes that we are in a space race with China, and I look forward to hearing from our witnesses on whether they agree with that premise.

In any event, the reality is that China is an emerging power in space, and is advancing in both its civil and military space capabilities. As a result, I think that the most pertinent questions are, what does China's progress in space mean for the United States and, in particular, for the U.S. space program—and how should we respond to that progress?

The National Academies in its 2014 report, "*Pathways to Exploration*" recommended that NASA should "*Vigorously pursue opportunities for international and commercial collaboration in order to leverage financial resources and capabilities of other nations and commercial entities. International collaboration would be open to the inclusion of China...*"

The experts assembled by the National Academies suggest that collaboration with China and other nations will be important in pursuing our goal of sending humans to Mars. Their conclusion requires careful consideration and so I'm glad, Mr. Chairman, that we have the opportunity this morning to begin to discuss China's space activities. The question of what, if anything, Congress needs to do with respect to China's advances in space, and the implications of any potential decisions to cooperate or not cooperate with China in space are not easy questions to address. I welcome the perspectives and insights of our witnesses on this topic, and I look forward to their testimony.

Mr. Chairman, our nation's international cooperation in space has been a hallmark of America's approach to space exploration since the beginning of the Space Age. I hope our discussion today is just the beginning of what will be further conversations on how our space cooperation may need to evolve to help serve our nation's goals in space and promote the global good.

Thank you, and I yield back.