THE IMPLICATIONS OF CHINA'S MILITARY AND CIVIL SPACE PROGRAM

HEARING

BEFORE THE

U.S.-CHINA ECONOMIC AND SECURITY

REVIEW COMMISSION

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

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MAY 11, 2011

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UNITED STATES-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

WASHINGTON : 2011

U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

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The Commission's full charter is available at www.uscc.gov.

June 2, 2011

The Honorable Daniel Inouye
President Pro Tempore of the Senate, Washington, D.C. 20510
The Honorable John A. Boehner
Speaker of the House of Representatives, Washington, D.C. 20515

DEAR SENATOR INOUYE AND SPEAKER BOEHNER:

We are pleased to notify you of the Commission's May 11, 2011 public hearing on *"The Implications of China's Military and Civil Space Programs."* The Floyd D. Spence National Defense Authorization Act (amended by Pub. L. No. 109-108, section 635(a)) provides the basis for this hearing.

At the hearing, the Commissioners heard from the following witnesses: Bruce MacDonald of the U.S. Institute of Peace; Barry Watts of the Center for Strategic and Budgetary Assessments; Mark Stokes of the Project 2049 Institute; Dean Cheng of the Heritage Foundation; Alanna Krolikowski and Dr. Scott Pace of the George Washington University Space Policy Institute; and Dr. Clay Moltz of the Naval Postgraduate School. The subjects covered included China's military space and counterspace activities and developments in China's commercial and civil space capabilities. The hearing reviewed these issues in the context of their implications for the United States.

We note that prepared statements for the hearing and supporting documents submitted by the witnesses are available on the Commission's website at www.uscc.gov. The hearing transcript will also be available soon and will be posted to the Commission's website. Members and the staff of the Commission are available to provide more detailed briefings. We hope these materials will be helpful to the Congress as it continues its assessment of U.S.-China relations and their impact on U.S. security.

The Commission will examine in greater depth these issues, and the other issues enumerated in its statutory mandate, in its 2011 Annual Report that will be submitted to Congress in November 2011. Should you have any questions regarding this hearing or any other issue related to China, please do not hesitate to have your staff contact our Congressional Liaison, Jonathan Weston, 202-624-1487 or via email at jweston@uscc.gov.

Sincerely yours,

William A. Reinsch
Chairman

Daniel M. Slane
Vice Chairman

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THE IMPLICATIONS OF CHINA'S MILITARY AND CIVIL SPACE PROGRAMS

WEDNESDAY, May 11, 2011

U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

The Commission met in Room H-309, The Capitol Building, Washington, D.C. at 9:00 a.m., Chairman William A. Reinsch and Commissioners Daniel A. Blumenthal and Michael R. Wessel (Hearing Co-Chairs), presiding.

OPENING STATEMENT OF COMMISSONER DANIEL A. BLUMENTAL HEARING CO-CHAIR

HEARING CO-CHAIR BLUMENTHAL: Our hearing will come to order. I am Commissioner Dan Blumenthal, and I'm co-chairing this with my colleague, Commissioner Michael Wessel.

I'd like to welcome everybody to the seventh hearing of the U.S.-China Economic and Security Review Commission for our 2011 Annual Report cycle. We're going to examine China's military and civil space programs and the implications for the United States.

We've assembled excellent panelists to evaluate these issues, and I'd like to thank Ambassador Schulte first for being here.

The United States has friends and allies throughout the Asia-Pacific. Some of our most important bilateral relations are in the Pacific, including Japan, South Korea, Taiwan, Australia and others. Our ties with these nations are based on shared economic interests, often shared values, as well, but each has important military and security dimensions.

Each military aspect of these relationships has maintained regional peace and stability over the past several decades and also helped promote economic and political development in the region.

China's rapid and comprehensive military modernization challenges, I think, affect this very stable status quo. If nations come to doubt the U.S. abilities to fulfill its various treaty and legal obligations, regional actors could increasingly turn their intentions inward or engage in a kind of arms race that we don't really want to see. Some evidence suggests that the latter is actually underway.

Fundamentally, this does relate to space, which is what we're going to talk about here today. The U.S. relies so heavily on space assets to carry out all of its military missions, particularly in distant theaters like the Pacific. Communications, reconnaissance and a host of other types of capabilities require satellite platforms and other types of space inputs.

Defense planners view space itself increasingly as another domain of warfare just as they do land, air, sea and cyberspace. Satellites are now facing a range of potentially devastating threats, mostly from China's very sophisticated anti-satellite weapons programs and other means of interfering with space assets. They present the first-ever real challenge to the U.S. ability to use space since the Soviet Union.

China is also beginning to effectively leverage its own space assets to enhance their own military capabilities, including precision strike weapons and other types of weaponry and capabilities that the U.S. has always had dominance in.

I look forward to hearing more details about these developments today, and I'm confident that the witnesses can help the Commission inform Congress about how we can meet these challenges.

So I thank the witnesses, and Ambassador Schulte, and I yield over to my co-Chair, Commissioner Wessel, for his opening statement.

OPENING STATEMENT OF COMMISSONER MICHAEL R. WESSEL
HEARING COCHAIR

HEARING CO-CHAIR WESSEL: I thank you, Commissioner Blumenthal, and I want to first thank our staff for putting together what I think is a very wide-ranging and important hearing here today.

Today's topic on China's space programs and capabilities is both timely and relevant given recent developments in both the U.S. and Chinese space programs.

China has made some notable achievements in its civil space program in recent years. It has successfully conducted a manned space flight not once but three times, a feat only the United States and Russia had previously accomplished. Beijing has launched two lunar probes in preparation for a future unmanned landing.

Additional plans include building and orbiting its own space station and launching an exploration probe to Mars. China should take pride in its

accomplishments.

Unfortunately, there are also several more unsettling aspects to the development of China's space capabilities. China continues to develop its counterspace capabilities. In 2010, China maneuvered two satellites closely to one another in what some analysts surmise was an anti-satellite test. Previously, in 2010, China's military demonstrated that it has the ability to destroy satellites in orbit in an event it outwardly portrayed as a ballistic missile defense test.

Finally, I note that just weeks ago, a piece of debris from China's 2007 anti-satellite test orbited so closely to the International Space Station that its American and Russian occupants almost had to take refuge in an emergency escape capsule.

The opacity of China's space program does little to allay international concerns over China's military intentions in space. For this reason, the United States needs to remain wary of cooperating with China on its space programs. Given the inherently dual-use nature of many space technologies, U.S. efforts to assist China's civil space program, if taken too far, could lead to improved Chinese counterspace capabilities. China needs to adhere to accepted international norms rather than pursue destructive space operations.

A key question I'd like to address today is how these factors affect the U.S. space industrial base. How do China's space-related activities and advancements affect the U.S. firms that design, build, launch, and operate our space assets?

We will be joined today by a number of experts from the administration, academia, and private organizations who we hope will help us address these issues.

We are pleased to welcome Ambassador Greg Schulte from the Department of Defense to present the Obama administration's perspective on these issues. And also, in particular, we'd like to extend our deep appreciation to Congressman Wolf from Virginia who will take time out of his busy schedule to join us later today. And we thank Mr. Wolf and his staff, Tom Culligan and others, for allowing us to use their hearing room.

I turn it back over to my co-chair.

HEARING CO-CHAIR BLUMENTHAL: Thank you, again, Ambassador Schulte, Deputy Assistant Secretary of Defense for Space Policy, increasingly, I think, one of the key positions in the Department of Defense.

Ambassador Schulte has a long and distinguished record in the U.S. government in service to his country, including U.S. Permanent Representative to the International Atomic Energy Agency and three tours in the White House, and I remember him well for being the signatory to all the documents that came from the White House when I served in the Department of Defense myself.

We look forward to hearing him present his views, DoD's views, on

China's space program and how their progress relates to our national security space and other types of national security strategies.

I would note that we anticipate Representative Wolf will join us in the morning. If by chance he arrives ahead of schedule, we may have to conclude or take a brief pause to let him make his remarks. So we appreciate your flexibility on that, and I would like to turn it over to you.

Thank you.

PANEL I: ADMINISTRATION PERSPECTIVES

STATEMENT OF AMBASSADOR GREGORY L. SCHULTE
DEPUTY ASSISTANT SECRETARY OF DEFENSE FOR SPACE POLICY
U.S. DEPARTMENT OF DEFENSE

MR. SCHULTE: Mr. Chairman, distinguished Commissioners, thank you very much for giving me this opportunity to meet with you today. I know witnesses aren't supposed to say this, but I'm hoping to learn as much from you today as I hope to impart to you given the focus that you have had on China, which I think is important, particularly in the space area.

I also want to commend you and your staff for picking a terrific list of follow-on witnesses. People like Scott Pace and Bruce MacDonald and Dean Cheng and Clay Moltz actually provide a lot of the intellectual foundation for what we do in space, and they've actually helped us to think through the strategy that we've issued that I want to talk to you about today, and, in fact, what I'd like to do today is in my opening remarks talk about this strategy and then talk about how it impacts our security relationship with China.

During the past 50 years, U.S. leadership in space has benefited the global economy, has enhanced our national security, has strengthened international relations, has advanced scientific discovery, and improved our way of life.

Space is vital to our national security. Space-based capabilities enable our Armed Forces to see with clarity, to communicate with certainty, to navigate with accuracy, and to operate with assurance.

I think it's safe to say that the recent operation against Osama bin Laden would not have been able to take place had it not been enabled by space-based capabilities.

Maintaining these benefits is not only important to our national security; it's also important to economic growth and prosperity, in China and around the world.

Space is increasingly a shared domain in which we operate with more and more space-faring countries, both close allies and potential adversaries.

The space environment is changing in ways that are fundamental.

Space is increasingly congested with increasing amounts of space debris. Space is increasingly contested by a growing range of foreign counterspace capabilities, and space is increasingly competitive as more and more countries and companies operate in space.

These three "C's"--congested, contested, and competitive--pose new challenges for U.S. security.

In response to these challenges, Secretary Gates and DNI Clapper approved this new National Security Space Strategy, which was delivered to Congress in February.

This strategy builds upon the President's National Space Policy from June of last year and his National Security Strategy, and it's significant in several regards:

First, it's the first-ever National Security Space Strategy issued by an administration.

Secondly, it's not just signed by the Secretary of Defense; it's also signed by the Director of National Intelligence, meaning it covers the whole scope of national security space, encompassing DoD's activities in space and intelligence activities in space. But perhaps most importantly, it's significant because it signals that just as the space environment has changed the way we advance our national security through space must also change.

The strategy establishes three broad objectives. One is obvious and enduring: to maintain and enhance the strategic advantages that we derive from space. The other two objectives are equally important: to strengthen safety, stability and security in space, and to energize our industrial base.

In short, in addition to protecting the advantages we derive from space, we have to protect the domain itself, and we have to protect our industrial base. There was a time when we could take space for granted and when we could take our industrial base for granted. We can't anymore.

To meet these three overarching objectives, this strategy establishes a series of strategic approaches, and this document, which we'll make available to you, spells those out in detail, but I'd like to focus on two elements of the strategy that are particularly relevant to our relationship with China, and that's promoting responsible use and deterring attack.

Promoting the responsible, peaceful and safe use of space is one of the strategy's key approaches. A more cooperative predictable environment enhances our national security and discourages destabilizing behavior.

Here the United States is leading by example. We will soon provide pre-launch notification of DoD space launches, just as we already notify of ballistic missile launches, and already STRATCOM, our Strategic Command, a command first established for the sole purpose of delivering nuclear weapons, is now also delivering warnings of possible collisions in space, including to countries like China.

STRATCOM has signed agreements with over 20 satellite operators across the world to share space data and conjunction analysis.

The United States is also pursuing bilateral and multilateral transparency and confidence-building measures to encourage responsible use of space.

With that in mind, we are currently evaluating the draft international "Code of Conduct for Outer Space Activities" proposed by the European Union.

The administration has not made a final decision on whether the U.S. can subscribe to the proposal, including what, if any, modifications would be necessary, and the Department is assessing the operational impact of the proposed Code of Conduct.

Our preliminary review, however, finds it a positive approach to promoting responsible behavior in space, enhancing our national security in the process.

The new strategy also reflects a new, multi-layered approach to deterring attack on our space assets. This is important as we monitor countries like China developing a wide range of counterspace capabilities.

Do you want me to wrap up shortly or--

HEARING CO-CHAIR BLUMENTHAL: Go ahead. Take your time.

MR. SCHULTE: Good. Thank you.

But our concern is not focused solely on China or solely on one country. The increasingly contested nature of space is most readily seen today in the jamming of commercial communication satellites by several foreign countries. These satellites carry content that is critical for commerce, for democracy in terms of free expression, and U.S. and allied military communications.

The new strategy's approach to deterrence has four layers:

The first layer of deterrence is the establishment of norms of responsible behavior, as I've already mentioned. Such norms can help separate responsible space-faring countries from those who act otherwise.

The second layer of deterrence is the establishment of international partnerships. This forces an adversary to contemplate attacking the capabilities of many countries, not just one.

The third layer of deterrence is increasing our resilience and capacity to operate in a degraded environment. This reduces the incentive to attack our space capabilities.

And the fourth layer of deterrence is a readiness and capability to respond in self-defense and not necessarily in space. This complicates further the calculus of a government considering an attack on our space assets.

Foundational to all four layers of deterrence is improved space situational awareness and an improved intelligence posture to better monitor and attribute activities in the space domain.

Now we shouldn't only think about deterrence in space but also about space in deterrence, including how a robust space posture can help deter

conflict on earth and how vulnerabilities in space, on the other hand, can cause instability in a conflict on earth.

Our new strategy is designed to confront the "three C's"--the space environment that is increasingly congested, contested and competitive.

China has contributed to all three of those "C's." China's 2007 test of a direct-ascent anti-satellite weapon against one of its own weather satellites created some 14 percent of the debris that we currently track.

Over the last year, STRATCOM has issued close to 700 warnings of possible conjunctions with that debris from that now defunct weather satellite--700 warnings over the past year. So China has clearly contributed to the congested nature of space.

China is also contributing to the contested nature of space. It is pursuing a broad range of counterspace capabilities, well beyond that direct-ascent system that they tested in 2007.

The Department of Defense's most recent report to Congress on Military and Security Developments Involving the PRC describes a multidimensional program for China to improve its capabilities to conduct counterspace operations during times of crisis or conflict, capabilities ranging from jammers to direct-ascent ASAT to other capabilities to attack space assets.

China's also getting ready to contribute to the third "C," competitive. Its nascent commercial space ambitions and its increasing outreach to emerging space-faring nations is part of the more competitive nature of the space environment that is one of the challenges we face.

Now while China has contributed to the three "C's," and is contributing to the challenges that we face in space, China also as a major space-faring country shares our interests in the safety, stability, and security of the domain. Indeed, at their January summit, President Obama and President Hu agreed that, quote, "the two countries have common interests in promoting the peaceful use of outer space and agree to take steps to enhance security in outer space."

The United States looks forward to using fora like the Strategic and Economic Dialogue to provide opportunities to discuss space and other strategic security issues with China's senior political and military leaders.

In fact, yesterday, I am informed we and the Chinese agreed to initiate strategic security--a Strategic Security Dialogue--have to get the term right--a Strategic Security Dialogue in the future that would involve defense officials from each side in addition to State and the Ministry of Foreign Affairs, and we have specifically proposed--Secretary Gates has proposed that space and space security be part of that dialogue.

We see such an opportunity, we see such a dialogue as an opportunity to promote safe and responsible space operations and to help avoid mishaps, misperceptions and mistrust, thereby strengthening stability in space.

In summary, we have not only a new National Space Policy but also a new National Security Space Strategy to meet new challenges in space. Both documents clearly state that it is the shared interest of all nations, including the U.S. and China, to act responsibly in space.

We seek to engage China in promoting the responsible use of space. At the same time, we are acting to bolster deterrence, and if deterrence fails, our ability to defend vital U.S. and allied interests in outer space.

Thank you very much, and I look forward to a discussion with you.

[The written statement follows:]

PREPARED STATEMENT OF AMBASSADOR GREGORY L. SCHULTE
DEPUTY ASSISTANT SECRETARY OF DEFENSE FOR SPACE POLICY
U.S. DEPARTMENT OF DEFENSE

Mr. Chairman, distinguished members of the Commission, thank you for the opportunity to testify today. I plan to describe our new National Security Space Strategy and its implications for our security relationship with China.

A New Strategy for New Challenges

During the past fifty years, U.S. leadership in space activities has benefited the global economy, enhanced our national security, strengthened international relations, advanced scientific discovery, and improved our way of life. Space is vital to our national security. Space-based capabilities enable our Armed Forces to see with clarity, communicate with certainty, navigate with accuracy, and operate with assurance. Maintaining the benefits afforded by space is also essential to economic growth and prosperity, not only in the United States, but also in China and around the world.

Space is increasingly a shared domain in which we operate with more and more space-faring countries – both close allies and potential adversaries. The space environment is changing in ways that are fundamental. Space is increasingly congested with increasing amounts of space debris; contested by a growing range of foreign counterspace capabilities; and competitive as more and more countries and companies operate in space. These "three C's" pose new challenges for U.S. security.

In response to these challenges, Secretary of Defense Gates and Director of National Intelligence Clapper approved a new National Security Space Strategy, delivered to Congress in February. This strategy, which builds on the President's National Security Strategy and National Space Policy, is significant in several regards: It is the first-ever National Security Space Strategy; and more importantly, it signals that – just as the space environment has changed –the way we advance our national security through space must also change.

The strategy establishes three broad objectives. One is obvious and enduring – to maintain and enhance the strategic advantages that we derive from space. The other two are equally important: to strengthen safety, stability, and security in space; and to energize our industrial base. In short, in addition to protecting the advantages we derive from space, we must also protect the domain itself and the industry that provides our capabilities.

To meet these three overarching objectives, the strategy establishes a series of strategic approaches. I urge you to read these in detail in the summary available at *http://www.defense.gov/home/features/2011/0111_nsss/*. Allow me to touch on two aspects of the strategy particularly relevant to our relationship with China: promoting responsible use and deterring attack.

Promoting Responsible Use of Space

Promoting the responsible, peaceful, and safe use of space is one of the new strategy's key approaches, building on the President's National Space Policy. A more cooperative, predictable environment enhances our national security and discourages destabilizing behavior. The United States is leading by example. We will soon begin to provide pre-launch notification of DoD space launches, just as we notify ballistic missile launches. And, already, STRATCOM, a command first established for the sole purpose of delivering nuclear weapons, is now delivering warnings of potential collisions in space. It has signed agreements with over twenty satellite operators across the world to share space data and conjunction analysis.

The United States is also pursuing bilateral and multilateral transparency and confidence building measures to encourage responsible actions in, and the peaceful use of, space. With that in mind, we are currently evaluating the draft international "Code of Conduct for Outer Space Activities" proposed by the European Union (EU). The Administration has not made a final determination on whether the United States can subscribe to the proposal, including what, if any, modifications would be necessary to gain our acceptance. The Department is assessing the Code's operational impact. Our preliminary review, however, is that it is a positive approach to promoting responsible behavior in space, enhancing our national security in the process.

Deterring Attack

The new strategy also reflects a new, comprehensive approach to deterring attack on our space systems. This is important as we monitor countries like China developing a wide range of counterspace capabilities. But our concern is not focused on only one country. The increasingly contested nature of space is most readily seen today in the jamming of commercial communications satellites by several foreign countries. These satellites carry content that is critical for commerce, democracy, and U.S. and allied military communications.

The new strategy's approach to deterrence has four layers:

- The first layer of deterrence is the establishment of norms of responsible behavior, as I have described. This helps separate responsible space-faring countries from those who act otherwise.

- The second layer of deterrence is the establishment of international partnerships. This forces an adversary to contemplate attacking the capabilities of many countries, not just one.

- The third layer of deterrence is increasing our resilience and capacity to operate in a degraded environment. This reduces the incentive to attack our space capabilities.

- The fourth layer of deterrence is a readiness and capability to respond in self-defense, and not necessarily in space. This complicates the calculus of a government considering an attack on our space assets.

Foundational to all of these layers is improved space situational awareness and an improved intelligence posture to better monitor and attribute activities in the space domain.

We should not think only about deterrence in space, but also about space in deterrence, including how a robust space posture can help deter terrestrial conflict, and how vulnerabilities in space can cause instability in a terrestrial crisis.

Implications for the U.S.-China Security Relationship

Our new strategy is designed to confront the "three C's" – a space environment that is increasingly congested, contested, and competitive. China has contributed to all three:

- China's 2007 test of a direct-ascent anti-satellite (ASAT) weapon against one of its own weather satellites created some 14 percent of the debris that we currently track. Over the last year, STRATCOM has issued close to seven hundred warnings of possible conjunctions with that debris.

- China is pursuing a broad range of counterspace capabilities in addition to the direct-ascent ASAT. The Department of Defense's most recent report to Congress on *Military and Security Developments Involving the People's Republic of China* describes China's multidimensional program to improve its capabilities to limit or prevent the use of space-based assets by potential adversaries during times of crisis or conflict.

- China's nascent commercial space ambitions and increasing outreach to emerging spacefaring nations is a part of the more competitive nature of space.

While China has contributed to the new challenges in space, it also shares our interest in the safety, stability, and security of the domain. Indeed, at their January summit, President Obama and President Hu agreed that "the two countries have common interests in promoting the peaceful use of outer space and agree to take steps to enhance security in outer space."
The United States looks forward to fora like the Strategic and Economic Dialogue to provide opportunities to discuss space and other strategic security issues with China's senior political and military leaders. We see such dialogue as an opportunity to promote safe and responsible space operations and to help avoid mishaps, misperceptions, and mistrust, thereby strengthening stability in space.

Conclusion
In summary, we have not only a new National Space Policy, but also a new National Security Space Strategy to meet new challenges in space. Both documents state clearly that it is the shared interest of all nations to act responsibly in space. We seek to engage China in promoting its responsible use. At the same time, we are acting to bolster deterrence and, if deterrence fails, our ability to defend vital U.S. and allied interests in outer space.

PANEL I: Discussion, Questions and Answers

HEARING CO-CHAIR BLUMENTHAL: Thank you very much, Ambassador Schulte, for a very comprehensive overview of the administration's space strategy, and I'm very pleased to hear so much thinking through these issues and the way you've structured them.

We have a lot of questions, but I'll take the first one, and I want to mesh together the National Defense Strategy that the Department of Defense has put forward and the Quadrennial Defense Review with the space strategy, particularly when it comes to international partnerships.

So we have a stated strategy of building partnership capacity, and oftentimes this is thought of at the very low end, building up the Afghan National Forces and so forth, but obviously we have some high-end partners and allies in Asia, Japan South Korea, Australia and others who are as interested as we are in what's going on in space and terrestrially, in terms of what the Chinese are doing.

So can you say something about how we're building military partnerships, sharing the kinds of capabilities we get from space, to reconnaissance and surveillance that really enhances our allies' and partnerships' capabilities to see what's going on around them on the sea and other places the Chinese are increasingly operating?

MR. SCHULTE: Thank you.

Well, this new strategy, like the QDR, like the President's National Security Strategy, talks a lot about partnership, and frankly that's kind of a new concept in space. Space is an area where in the past we tended to operate alone, and we tended to operate alone in part because during the Cold War, at least, we were sort of the only folks up there except for the Soviet Union. We weren't in a position to operate in partnership with them.

But increasingly we have close allies and other partners who have capabilities to offer in space, and so increasingly we are thinking about how do you operate in space in a coalition, much as the way we operate in coalition in other domains. We have a long history of operating in coalition at sea, on land, and air. Increasingly we need to think about how do we operate in coalition in space.

And operating in coalition means we need to think about who are the allies and partners who have the most to offer? The Secretary of Defense has recently signed statements on sharing of space situational awareness with Canada, Australia and France. Those are allies who are close to us who have capabilities to offer, and occasionally in the case of a country like Australia have geography to offer that's very important as we develop our space situational awareness.

But we're also looking at going beyond the traditional partners and thinking about who are other allies who we could bring into our coalition approach to space? Japan is a country that we are talking with actually as we speak. My office is in Colorado Springs now having discussions with the Japanese about partnerships.

One of the initiatives that we're taking under this new National Security Space Strategy is to take something that we have at Vandenberg Air Force Base in Colorado called the JSpOC, the Joint Space Operations Center, and make it into a CSpOC, a Combined Space Operations Center. So again it's not just us operating alone.

HEARING CO-CHAIR BLUMENTHAL: At Vandenberg?

MR. SCHULTE: At Vandenberg. The JSpOC today has some liaison officers, but the idea is actually go to allies and say, okay, we're ready to share more data with you, but at the same time we need you to commit some of your assets to us, and we are looking at how do we start conducting coalition operations in space the same way we do on land.

Partnership is important for a couple of reasons. First off, there are countries that are developing real capabilities that can augment our own capabilities.

Secondly, to the extent we can augment our capabilities with allied capabilities, it can add some resilience; it can make it that much harder for our space assets to be attacked.

Third, it can contribute to deterrence. I told you that I mentioned that the second layer of deterrence was to create international partnerships which an adversary would need to attack. To the extent that we can bring other countries into our partnerships and operate in coalition, it just complicates a little bit more the decisions of an adversary. I think one very good example is a communications satellite system that we have today called WGS, the Wideband Global SATCOM system.

This initially was a U.S. only satellite system, and then Australia bought one of the satellites, bought Satellite 6, and so now they have a share across the constellation. For Satellite Number 9, the Air Force is now talking to a number of other allies; would they like to contribute and buy into this system?

Now, at a time of budget constraints, obviously, cost-sharing is a good thing, but from a deterrence standpoint, it also means that if a potential adversary were thinking about attacking WGS, they wouldn't just be attacking the U.S., they would be attacking a coalition. Again, that might not be enough to stop them from attacking us, but it would be just another complicating factor for them in their decision.

HEARING CO-CHAIR BLUMENTHAL: Just as my time is running out, in Asia, the most promising capabilities are resident in Australia and Japan?

MR. SCHULTE: Well, certainly Australia. We work very closely with the Australians. Japan is a new area, and they're very interested in space, and we're talking to them about how we can cooperate in building their capacity and augmenting our own at the same time.

HEARING CO-CHAIR BLUMENTHAL: Great. Thank you very much.

Commissioner Shea.

COMMISSIONER SHEA: Thank you, Mr. Ambassador, for being here.

You mentioned in your testimony about, and I think I'm paraphrasing here, the importance of preserving our industrial base with respect to our U.S. space program and civil and military space program.

First of all, are there Chinese source components in U.S. military satellites? Is that something that we take a look at? Is that something that we have a handle on?

MR. SCHULTE: We have a handle on it. I can't give you the definitive answer. I would have to come back to you on that if that's okay for your staff. The Department is very worried about the supply chain for defense procurement across the board, and my colleague Bob Butler, who works on cyber, spends a lot of time thinking about how do we prevent incursions into our supply chain that put our capabilities at risk, particularly from a cyber perspective?

COMMISSIONER SHEA: I've got three-and-a-half more minutes. I'll ask

you another question. Thank you.

I think a lot of people were surprised in 2007 with the ASAT test. People have been surprised about the DF-21, the antiship ballistic missile. People have been surprised by the J-20 stealth fighter.

What do you expect to be surprised about? Are there things that you think are coming down the pike in the Chinese space program that maybe people aren't talking about but might appear in the near future?

MR. SCHULTE: I'll answer your question, but I'll start off by saying that I was among those surprised about what they did in 2007. I think it wasn't surprising they were developing the capability, but it was surprising they would test it the way that would create so much debris.

I was in Vienna at the time. I was mostly worried about Iran and Mohamed ElBaradei, but that's a separate story. We also had the Committee on the Peaceful Uses of Outer Space there, and everyone was just stunned that the Chinese would do something like that, and my Chinese counterpart, the Chinese ambassador, who I worked very closely with on a wide range of issues, wasn't even authorized to acknowledge that the test had taken place for days.

So they were clearly stunned by that, but the Chinese learn, and sometimes they maybe learn better than we do --I'm subject to being surprised--but I think they're going to be very careful in the future not to create such debris in tests.

Where I think we have to watch for surprise in a way, and it shouldn't be a surprise for you or for those of us watching it, but is just the amount of investment that they're putting in counterspace. I came from Vienna and I started work in space policy, and one of the first things I did is I said I want the full intel briefing on what they're doing in space, and it was eye-watering.

The amount of investment that they're putting into counterspace capabilities, again, not just that direct attack ASAT capability, but jammers that they've developed and deploy, work they're doing on directed energy ASAT, other work they're doing. We obviously watched very carefully last year when they maneuvered that one satellite in very close proximity to another satellite.

By the way, the way the world knew about that because it was data that was made available by STRATCOM as part of our information sharing on space. So I think we need to watch this very carefully. Maybe they won't do something as dramatic and as embarrassing as the 2007 ASAT test, but they're clearly looking to exploit what they perceive as a weakness, and part of the strategy is meant to address that and to bolster our deterrence and our capability to operate even in a degraded environment.

COMMISSIONER SHEA: Thank you very much.

HEARING CO-CHAIR BLUMENTHAL: Okay. Commissioner Fiedler.

COMMISSIONER FIEDLER: Thank you.

A couple of factual questions. You mentioned that there were 700 warnings issued by STRATCOM. I infer from your testimony that we're warning the Chinese as well. We're providing those warnings to the Chinese. So just curiously, what percentage of those things that we're warning the Chinese about involve the debris they created?

MR. SCHULTE: Sir, I'd have to come back to you on the percentage. But let me say, though, if I remember correctly, over the past year, we've issued--Ashley, what was the number that we've issued over the past year--we've issued I want to say something like 1,700--and I'll correct that if it's wrong [Note: 1,983 conjunction warnings were sent in 2010]--1,700 conjunction warnings, and of that a fully--what did I say--700 were about collisions with the Chinese satellite.

And we have arrangements with 23 companies to notify them, owner-operators, of potential conjunctions, and we also have emergency arrangements whereby we will notify a country if there's a conjunction, and we on a regular basis find ourselves notifying, STRATCOM notifies through the State Department the Chinese that you are about to collide potentially with a piece of debris from your satellite.

Now I have to say, you could imagine, it's very tempting not to tell them.

[Laughter.]

COMMISSIONER FIEDLER: Yes.

MR. SCHULTE: Don't tell them.

COMMISSIONER FIEDLER: It would be something I could not resist myself.

MR. SCHULTE: But then we pull back and we say no, no, no, let's think about our strategy, and one of our objectives is to protect the domain, and neither we nor the Chinese nor anyone else have an interest in more collisions that would create more debris.

COMMISSIONER FIEDLER: Well, it would create more debris; right.

MR. SCHULTE: And so we provide the warning to them.

COMMISSIONER FIEDLER: Thank you very much.

A couple other short questions. The Chinese have monopoly on rare earths and what impact is that having on our space program, military space program? Not necessarily short-term but longer term; are we worried about that?

MR. SCHULTE: Can I come back to you on that?

COMMISSIONER FIEDLER: Yes, certainly.

MR. SCHULTE: To give you a good answer. I'm sorry.

COMMISSIONER FIEDLER: Absolutely.

MR. SCHULTE: Okay.

COMMISSIONER FIEDLER: And the other is a general question. We much discuss Chinese technology in our hearings, and it strikes me that their own space technology is more highly developed than a lot of the

manufacturing technology, which I think goes to the point that you were making about the heavy investment.

Do you find their original technology is up to par or exceeding par frankly?

MR. SCHULTE: I think what we've found is that China has invested for a sustained period in a very methodical fashion in developing their capabilities. They tend not to look for particular successes. I mean obviously some of what they're doing is aimed at prestige.

But even their efforts to put humans into space are oriented not just to prestige but also in their view to developing economic capabilities that benefit them. So there's been a very methodical approach they've taken.

My sense is they'd like to do all of this indigenously. They aren't in that position yet, and so they have, by hook or crook, acquired a lot of technology from elsewhere. They've cooperated with Russia. They've cooperated with the Ukraine. They use joint ventures very effectively in this area and in other areas to acquire technologies so they can develop their base. So I think in many ways there are areas where their technology base isn't up to ours, but they're working very hard and very methodically to prefect those capabilities.

COMMISSIONER FIEDLER: Thank you.

One final question. We also focus a great deal on their anti-access strategy militarily, just generally speaking.

MR. SCHULTE: Right.

COMMISSIONER FIEDLER: In your view, in their investments, are they investing more in counterspace capability, anti-access capability, to deny us access potentially than in developing an offensive capability?

MR. SCHULTE: Well, we talk about, and I'm sure this Commission talks a lot about anti-access area denial efforts by China, and I think it's important to see that their efforts in space are part of that strategy.

COMMISSIONER FIEDLER: Right.

MR. SCHULTE: If you want to make it harder to operate close into China, something they want to do is to make it harder for us to have surveillance, communications and navigation that would support that.

So I think you have to see their counterspace investments in that context, and you have to see our effort to deter and defend in the context of how do we respond to that to maintain our own ability to operate where we need to operate and where we're allowed to operate.

The Chinese are also investing, not just in counterspace capabilities, but in their own space capabilities. As you know, they're working on developing their own navigations, space-based navigation system. They're working on space-based communications. They are becoming more reliant on space.

By the way, that maybe makes it a little bit easier for us to deter them from conducting hostilities in space because they'll be reliant on it, too.

But given geography the way it is, we are probably always going to find ourselves more reliant on space than the Chinese are, and so for the foreseeable future, that's an asymmetry they're going to look to exploit as they pursue an anti-access area denial approach.

So, again, that strengthens the importance of looking to deter attacks on our space systems, but also should deterrence fail, be able to operate through a degraded space domain, and the way you can do that, and the way we need to do that is to think about how do we provide more resiliency in our space constellations. Over time this could mean, for example, instead of having a lot of functions aggregated on one satellite, disaggregating it. It could involve things like hosting military payloads on commercial satellites to provide more diversity.

It can involve working with coalition partners to give you more diversity and deterrence, and it can also involve what we in the department call cross-domain solutions, meaning if you're worried about getting communications through space or ISR through space, you need to have other backups too.

COMMISSIONER FIEDLER: Thank you very much.

HEARING CO-CHAIR BLUMENTHAL: Commissioner Wessel.

HEARING CO-CHAIR WESSEL: Thank you, Ambassador, for great testimony well organized, direct and comprehensive and I also want to thank you and the department for being here today. I think DoD has been a great friend of the Commission in terms of trying to look at the long-term problems and have an open honest assessment of what the challenges and the opportunities are. So I want to thank you and the department for being here.

Let me ask a very direct question if I can because when I hear the three terms, "congested," "contested," and "competitive," I think threat. What is the China threat? How would one assess it today? Is it a here and now threat? Is it a threat in terms of space capabilities, space assets? Is it one that is still in its infancy? How would you rate it after the tests they've done, both ASAT as well as repositioning of satellites?

Should we look at this as a current threat, and if not a current threat, would you rate in terms of one or five, years on the horizon?

MR. SCHULTE: Thank you.

My goal in life in this job is to have everyone on the planet know what the three "C's" are.

[Laughter.]

MR. SCHULTE: So I've just scored one more. Congested, contested and competitive.

HEARING CO-CHAIR BLUMENTHAL: Sounds like my drive to work.

[Laughter.]

MR. SCHULTE: But I wouldn't cast the three "C's" as a threat. I would cast them as a challenge because congested, for example, is a challenge to

every space-faring nation, including the Chinese, and we want to engage the Chinese. We're seeking to engage the Chinese on how do we mitigate that debris? How do we avoid that in the future? How do we create norms, that sort of say you shouldn't create long-lasting debris?

And, for example, we have encouraged the Chinese to look at the EU Code of Conduct. Again, we haven't made a decision on it, but we've said you ought to look at that, too. They're a little bit challenged on that because they think we're trying to undercut their PPWT Arms Control Agreement they put forward, which is not the intent.

We don't support that, but we're looking at rules of the road, and we encourage them to do it, too.

Contested is a problem, but in a way contested should be a concern for China, too. This strategy says very clearly that no country has an interest in hostilities in space. We don't think China does either, and that's why, as part of our strategic dialogue with them, we'll want to talk to them about that.

And we'll want to make it clear to them the risks of initiating hostilities in space, the fact that an attack on our space assets, which we consider a vital national interest, would be provocative and escalatory so they don't think somehow it would be de-escalatory.

Competitive, well, there are opportunities there, too, and those opportunities, maybe they don't apply to China, but they certainly apply to other countries, close allies, and so forth where, yes, there's more competition, but there are also opportunities to develop coalitions, to leverage foreign capabilities, to leverage commercial capabilities.

But clearly China has contributed all three "C's," and clearly we worry about what they're doing in the contested piece of this. Chinese diplomats like to say that they oppose weaponization of space, but you look at their program, and apparently the Chinese diplomats haven't looked at what the PLA has been doing over the last however many years.

HEARING CO-CHAIR WESSEL: How would you rate their capabilities against all nations other than the U.S. in terms of concerns or challenges to space assets. How do they compare to Russia or any other nation that is looking at ASATs or any other type of capabilities, kinetic or otherwise?

MR. SCHULTE: It's clear. China is ahead of anyone else in terms of counterspace investments and deployments. They've invested a lot of money against this. Look at the number of jammers they have. It's quite impressive. You look at their investments, they're quite impressive. Other countries are investing in counterspace capabilities, but not to the extent here.

You would actually be surprised at some of the countries investing in counterspace. Iran, on a regular basis, jams space assets. Libya was doing it. I think we've taken care of that now.

Ethiopia has jammed commercial space assets. You know, jamming is

not that hard in the end, but China has gone well beyond jamming in terms of capabilities and how they've integrated counterspace into their doctrine, as we understand it, too.

HEARING CO-CHAIR WESSEL: Thank you.

HEARING CO-CHAIR BLUMENTHAL: Commissioner D'Amato.

COMMISSIONER D'AMATO: Thank you very much, Mr. Chairman.

And I want to thank you, Mr. Ambassador, for your very detailed and excellent testimony here this morning. We really appreciate DoD coming up with that kind of specificity.

I have two questions. The first one, to follow up on something you just said. Are you saying, then, that Chinese counterspace capabilities are ahead of those of the Russians?

The second question is in follow-up to what Commissioner Wessel was talking about. I got the three "C's" now. I've got them. The “contested” area, what would be the most provocative and difficult area with the Chinese that you would put in the contested box?

Also, we've got quite a dialogue coming along here with the Chinese in the S&ED and so on. What would be the two or three most important achievements or benchmarks that you think we could achieve to reduce some of the contested areas, jammers and ASATs, and so on. What are two or three things that we would seek to accomplish in the way of cooperative arrangements with the Chinese out of this dialogue that we've engaged them with?

MR. SCHULTE: I think, sir, I think it's safe to say the Chinese have put in more investment than the Russians have. The Russians once had--the Russians during the Cold War had a co-orbital ASAT system, but Russian investment in counterspace went way down. We still watch it very closely. The Chinese are ahead of the Russians. It's fairly clear there.

What would we want to accomplish in our discussions with the Chinese? I think, first, to the extent, when we last talked to the Chinese about this in the Defense Consultative Talks that took place in December, we actually mentioned, I actually mentioned their investment in counterspace capabilities, and we told them that we were worried that--particularly in crisis--a misunderstanding in space could easily lead to an inadvertent escalation that would not be in the interests of either of our countries.

I think what will be important is if we can somehow come to a common understanding of what responsible behavior in space is, and then based upon that, also some type of common understanding or at least a dialogue over what irresponsible behavior might look like and how that could get out of control.

I think there's a tendency in China for them to think that acting early in space could be de-escalatory. We want them to understand that that could have rather unpredictable effects and be quite provocative.

So as we think about contested, but we also think about the

relationship between our countries, we want to promote stability and an element of stability is going to be stability in the space domain, too.

I should end by saying this is a dialogue that may take some time to take place, and it may be a sustained dialogue, but I think it's an important one.

COMMISSIONER D'AMATO: Do we have a pretty good concept as to what we would like to try and expect out of the Chinese in what you're just referring to?

MR. SCHULTE: We've already offered to brief them on this strategy and talk to them about some of our concerns, and so we've sort of laid out internally the way ahead, and actually we've consulted with a number of the witnesses who are going to follow me to get their good advice on how best to do that.

COMMISSIONER D'AMATO: Thank you.

HEARING CO-CHAIR BLUMENTHAL: Commissioner Mulloy.

COMMISSIONER MULLOY: Thank you, Mr. Chairman. Mr. Ambassador, thank you for being here and thank you for your career serving the great Republic over many years. You're the kind of guy that should be out at these top schools recruiting people to come into the federal government. You've had such a rewarding career.

Part of that was when you were Executive Secretary of the National Security Council, and that's an issue that I want to discuss. The report on space worries that the United States seeks to foster a space-industrial base that is robust, competitive, and flexible.

In our work on this Commission, we've held a lot of hearings about what's happening to our industrial base. We've had testimony that we've now outsourced so much manufacturing and the R&D which is now going with it, that we've weakened our ability to innovate. In other words, they called it an industrial commons, and we've weakened the commons so that we're not feeding off it as well as we used to.

I was at a session over at the Chamber of Commerce a week ago, and they did a session on China, and a gentleman from the AmCham came in and talked about China's indigenous innovation program, and it was discussed. This gentleman from the Chamber of Commerce said that we have a national security problem here, that individual companies in order to get sales in China will transfer technology, R&D and other things.

That may be in the interest of an individual company, but he said this may not be in the national interest, and we need to get a handle on this.

Here's the concern I have. You talk about in the report why we have to have a space-industrial base, but when you actually look at what you're doing, it doesn't seem adequate to the task, particularly when the Chinese are incentivizing our companies to deliver our manufacturing and technological base to them.

The underpriced currency is just one part of how they incentivize that

game. Treasury and USTR and Commerce, they answer to different constituencies. You are the ones who are looking out for the national security of the United States. Is this an issue that DoD sees as a big issue, and that we have to rethink some of the ways that we're conducting our international economic policy and international trade policy?

MR. SCHULTE: Sir, we're certainly seized with the space industrial base, and I know Secretary Lynn, the Deputy Secretary, has devoted time to this. The Secretary of the Air Force Mike Donley, who is also the department's Executive Agent for Space and is chairing a new Defense Space Council, is focusing on the industrial base.

And I said the strategy itself says protecting the industrial base is one of the three objectives. We can't take it for granted anymore. If you look at U.S., the U.S. share of satellite manufacturing sales, over the last ten years, it's declined precipitously. Now, that has a lot to do with France, and it has a lot to do with Russia. It's not just--China is not the only player here.

But I think we've recognized that some of our own policies have contributed to that, and Secretary Lynn has said very clearly, for example, that export control has been a self-imposed folly in the space area, part of the strategy, part of what the administration is doing, is looking at how do you reform the export control system. My boss, Jim Miller, is going to be testifying before the House Foreign Affairs Committee later this week to talk about our export control efforts.

On space, the department just delivered to Congress a report focused on space export control called the 1248 Report. It was delivered on Friday. I think there will be further briefings this week. It's an interim report that starts looking at how can we take items that are generally available on the global market and allow our companies to export those so they can become competitive again.

The goal with export control reform is to build higher walls around a smaller number of items. So, we both protect the crown jewels, but at the same time recognize that the state of world technology in many areas has caught up, if not in some areas surpassed, ours, and so we should let our companies be out there and competing. So export control reform is critical to the industrial base.

I'm not an acquisition expert, but from an acquisition standpoint, we have also asked Congress to support an initiative called EASE, which is--remember the three "C's." You don't have to remember EASE. It's--EASE--

[Laughter.]

MR. SCHULTE: Evolutionary Acquisition for Space Efficiencies. Thank you. And what we're trying to do is we're trying to, with Congress' approval, is to buy satellites in blocks rather than one at a time, which requires Congress to give us authority for advanced appropriations, but the goal is with some of the satellites we're building to provide more stability to the industrial base so we can protect the second and third tier suppliers by

providing some predictability, and from the savings we get from that reinvest that in technology upgrades because even though we're building satellites now, we're not necessarily keeping the people who are doing the technological development, and so we're trying to think smarter from an acquisition standpoint about how do we protect the industrial base and do it at a time when there's less money to go around.

COMMISSIONER MULLOY: Thank you, Mr. Ambassador.

HEARING CO-CHAIR BLUMENTHAL: Commissioner Slane.

VICE CHAIRMAN SLANE: Thank you very much for your testimony. It was very, very helpful.

My question is, can you comment on the cutbacks at NASA and how it's impacting your mission and your strategies, and whether you think it's further weakening our industrial base?

MR. SCHULTE: I think I'll stay away from talking about what's happening at NASA, being I've survived my government career in part by being prudent at times.

[Laughter.]

MR. SCHULTE: But I will say, though, is we tend in the U.S. government to think in sectors. We think about the commercial sector; we think about the civil sector involving NASA; we think about the national security sector. But industry isn't arranged that way, and one of the things we have to do a better job of is to think cross-sector. And here, as we think about protecting the industrial base, it's the same rockets that we're using across the industrial base.

It's the same solid rocket fuel industry that we're using across the industrial base, and so here Secretary Donley, the Secretary of the Air Force, has actually reached out to NASA, to General Carlson at the National Reconnaissance Office, and said, okay, let's also come up with a block buy approach to EELVs so we can provide some stability to the industrial base on predictability and maybe hold down costs as well.

So we, clearly NASA's program impacts the industrial base, and therefore impacts us, and we're trying to do a better job of working across the sectors to protect the industrial base and create key technologies.

HEARING CO-CHAIR BLUMENTHAL: Thank you.

Commissioner--did you have a follow-up?

VICE CHAIRMAN SLANE: Yes, just one quick question. Our job is to make recommendations to Congress. Is there anything that you want us to consider, and maybe you want to follow it up with a letter or something that might be helpful to us when we get to that point?

MR. SCHULTE: Well, sir, if you're making recommendations on the industrial base, I'd be happy to provide you more information on EASE. Again, that's more of an acquisition issue, but it's important, but we need congressional authority for that, and it's important if we're going to protect the industrial base.

Export control reform also requires congressional authorization. Right now the space arena is the only area where Congress has actually legislated controls. The President can make the decisions in all other areas, and so if we're to conduct export control reform, if we're to purchase some of our satellite systems in a different manner that we think will be better for the industrial base, we'll need congressional authority to do that.

VICE CHAIRMAN SLANE: That would be great. Very helpful. Thank you.

HEARING CO-CHAIR BLUMENTHAL: Commissioner Bartholomew.

COMMISSIONER BARTHOLOMEW: Thanks very much. Thank you for your testimony, and I join Commissioner Mulloy in thanking you for your distinguished service. In these days of vilification of government employees, I think it's important to recognize the significant contributions that people are making. So thank you.

I have three questions. One is you mentioned no country has an interest in hostilities in space, and I'm interested in why you think that that would be a statement that would work with China, particularly given the counterspace investments that they're making?

The second one is why you think we're going to be able to get to some sort of common understanding of responsible behavior? If you think we can get to some sort of common understanding with China, you will be going against the tide in many other areas where responsible behavior is defined quite differently.

And then, third, we have a history in this country, of which we're all proud, of protecting the global commons, protecting the sea lanes, for example, and at the same time, while we have been doing that, it has allowed other countries to build their capacity, their capabilities, and indeed their economies without them having to expend any funds in order to do that.

And I wondered, listening to you, talking about what STRATCOM is doing, are we protecting the space domain, policing the space domain, at our cost, both fiscally, and--I'm searching for the other word--I guess I can best say metaphorically?

MR. SCHULTE: Uh-huh. Uh-huh. So I'm sorry. Global commons--backward--common understanding. What was the first?

COMMISSIONER BARTHOLOMEW: Why you think they have no interest in hostilities?

MR. SCHULTE: Oh, no interest in hostilities. Okay. I guess, ma'am, we would like to convince them that they have no interest in hostilities in space. And we would like to convince them because of, if there are hostilities in space, we're worried about the implications for the domain itself, about making it unusable.

We're worried about the implications economically depending on what happens in the hostilities in space, and the economics are going to hurt China as much as they're going to hurt any other country in all likelihood,

and we also want them to worry from a deterrence standpoint about how we might respond to hostilities in space.

Hostilities in space, we would not confine to space. We have very clearly said, the President has said, this is a national interest for us, and we will respond at a time and place of our own choosing. So our goal is certainly we have no interest in hostilities in space.

The Chinese may be tempted, but I think our goal is to convince them it's not in their interests, and that's why our declaratory policy is important, our strategy is important, but also the type of dialogue that we have with them is important.

Now, will this dialogue lead to a common understanding? That our desired end state, at least have the dialogue, I think, is important.

As I mentioned before, I think the Chinese believe that in a conflict, they would want to employ counterspace capabilities, particularly reversible ones, early and often. We'd like to convince them that could be a dangerous proposition. So we may not come to a common understanding, but maybe we come to a better mutual understanding or maybe we bring our views closer together to avoid mistrust, misperception and mishap in a particular crisis.

On the global commons STRATCOM in a way is doing what the Air Force and STRATCOM have been doing for some time with GPS. The GPS system was set up to help initially our ships navigate at sea, and now we all across the world rely upon GPS, and the economy relies on GPS. It has become a global good that the Department of Defense pays for, but it's a global good.

I think collision warning could become another global good that we could find ourselves providing to the rest of the world as we collaborate with partners in avoiding collisions, in providing data that would help prevent collisions. We're not doing that because we're just nice people and have deep pockets; we're doing that because one of our objectives is to protect the space domain.

Space in many ways is like the global commons. In fact, the President's National Security Strategy talks about space as part of the global commons. And we have an interest, and we would actually argue that China as a major space-faring country also has an interest in protecting those commons and creating some type of norms that would allow the Department of Defense to do its job, but that would also bring just a little bit more order to the domain.

COMMISSIONER BARTHOLOMEW: I'm curious. Thank you for all of those answers.

But, as we look at the cyber world, Facebook, Google, all of these companies charge, and they're profiting. They don't charge. They're profiting off of the information that's out there, and I wonder is it feasible to charge for the services that STRATCOM is providing in this information, this collision prevention information?

We're providing information that has a significant economic benefit to people who are avoiding those collisions.

MR. SCHULTE: Right.

COMMISSIONER BARTHOLOMEW: And I wonder would it even be possible to do some sort of fee-based structure for that?

MR. SCHULTE: Well, Congress in authorizing this sharing actually provided for a fee-based structure. I would have to look into whether we're thinking about implementing that or not.

But in the end this isn't about sort of helping to fund STRATCOM. It's about protecting the domain that we have an interest in as other countries do, too.

COMMISSIONER BARTHOLOMEW: Thank you.

HEARING CO-CHAIR BLUMENTHAL: Thank you very much, Ambassador Schulte. We really appreciate your testimony--

MR. SCHULTE: Thank you.

HEARING CO-CHAIR BLUMENTHAL: --and your candid questions and answers.

MR. SCHULTE: Could I just make one remark at the end or two remarks?

First off, thank you so much for paying attention to this area. I think it's important, and as we think about China, we have to think about how do we deter and defend, but also recognizing that they are a space-faring country, how can we get them to accept some of the responsibilities that should go along with that?

And secondly, thank you for all your comments about public service. It's been my honor. I'm out there talking to young kids, encouraging them to do the same thing. I think it's amazing the taxpayer lets me go on some of the adventures I've had. So thank you very much.

VICE CHAIRMAN SLANE: Great job.

HEARING CO-CHAIR BLUMENTHAL: Thank you.

PANEL II: CONGRESSIONAL PERSPECTIVES

HEARING CO-CHAIR WESSEL: Please, Mr. Wolf. Welcome, Mr. Chairman.

Congressman Frank Wolf is the Representative for Virginia's 10th Congressional District, serving in Congress since 1981. He's also Chairman of the House Appropriations Subcommittee on Commerce, Justice, Science and Related Agencies, and has been gracious enough, and we are deeply appreciative, to let the Commission use his hearing room today.

The Congressman is well-known as a leading advocate for human rights

in China, but also works diligently to ensure American economic prosperity and to protect our national security.

He is the sponsor of the *Bring Jobs Back to America Act*, which would help protect American manufacturing from unfair trade practices in China and other countries.

The Chairman was also the sponsor of legislation that now bans NASA from helping China develop its space capabilities, which is in part the topic of the Commission's hearing today.

Congressman, the Commission is glad to have you as a friend, and the nation is fortunate to have you as a leader in Congress. We are honored by your presence with us today, look forward to your testimony, and I know you have a couple of particular personal friends on the Commission, and we are always happy to have you with us.

Thank you.

STATEMENT OF FRANK WOLF
A U.S. REPRESENTATIVE FROM THE STATE OF VIRGINIA

MR. WOLF: Well, thank you much, and thank you for having the hearing.

I appreciate the Commission's leadership, and I strongly support its work in this area. I believe this review of the Chinese space program is both necessary and long overdue. Before I start, I want to express my sincere disappointment that NASA has chosen not to participate in this important hearing. As the agency responsible for our nation's civil space program, NASA has a unique responsibility to lead in this area and to be sure that the American space program remains preeminent.

NASA's absence is reflective of this administration's abysmal, and very abysmal, absolutely totally and completely abysmal, record on America leadership in space.

Last year, the Congress wisely repudiated an administration proposal to take a, quote, "time out" from NASA's exploration program. Fortunately, Congress rebuked this proposal in the 2010 NASA Authorization Act and has provided funding for a robust exploration program beyond Low Earth Orbit.

Space is the ultimate high ground that has provided the U.S. with countless security and economic advantages over the last 40 years. As the victor of the Cold War space race with the Soviet Union, the U.S. has held an enormous advantage in space technology defense capabilities and advanced sciences.

Our space program has been the envy of the world. Federal investments in NASA have generated entirely new sectors of our economy, created hundreds of thousands of private sector jobs for Americans. It should not be surprising that many countries have taken notice of the

tremendous benefits that the American space program has yielded.

It is clear that we are now entering an era of much greater civil defense and commercial competition in space. Most countries expanding their space programs are strong U.S. allies that are primarily interested in advancing science research or building a commercial space industry. However, the Chinese do not fall into this category.

Over the last decade, China has developed a space program at a surprising pace. In less than ten years, the Chinese have gone from launching their first manned spacecraft to unveiling plans last week for an advanced Chinese space station designed to rival the International Space Station.

However, the Chinese are not focusing only on establishing a significant presence in low earth orbit. In March, the Chinese state news agency announced its plans for, quote, "a powerful carrier rocket for making a manned moon landing and exploring deep space."

This announcement confirms what space experts have long believed: the Chinese have their sights set on the pinnacle of American achievement--landing a man on the moon.

According to this article, the Chinese are planning a heavy-lift rocket capable of carrying up to 130 tons. This would provide the capability to launch the critical component for a lunar landing. The announcement made clear that if the United States does not get serious about its own exploration program, the next flag planted on the moon may very well be a Chinese flag.

What concerns me most about the Chinese space program is that, unlike the U.S., it is being led by the People's Liberation Army. There is no reason to believe that the PLA's space program will be anymore benign than the PLA's recent military posture.

For example, according to the Congressional Research Service, quote, "On March 9, 2009, the Pentagon reported that the PRC ships and aircraft operating in the South China Sea had been acting in an increasingly aggressive way toward two U.S. Navy ocean surveillance ships operating in the area."

China has taken a more assertive posture globally, and their interests rarely intersect with ours. Consider the 2008 Senate testimony of the Director of National Intelligence, quote, "China continues to develop and field conventional theater-range ballistic and cruise missile capabilities that will put U.S. forces and regional bases throughout the Western Pacific and Asia at greater risk. China arms sales in the Middle East are also destabilizing and a threat to U.S. forces, while missile sales to Iran pose a threat to U.S. forces in the Persian Gulf."

U.S. intelligence community notes that China's attempts to penetrate U.S. agencies are the most aggressive of all foreign intelligence organizations. The Chinese regime has launched some of the most

aggressive and widespread espionage and cybersecurity attacks against U.S. agencies and contractors. Several years ago, the Chinese attacked my office computers and those of many other members of Congress and other companies.

China's aerospace industry for decades has provided missile technology and equipment to rogue regimes such as Iran and North Korea. China's aims globally are often directly at odds with those of the U.S.

According to the Pentagon, weapons that PRC entities supplied to Iran were, quote, "found to have been transferred to terrorist organizations in Iraq and Afghanistan."

China has failed to use its influence to bring about a peaceful resolution of the multiple crises in Sudan. It is a major arms supplier and source of economic strength to President Bashir's government in Khartoum. There is a museum on the Mall, the Holocaust Museum, that says "never again."

I was the first member of the House to go to Darfur and see with my own eyes. The Chinese, they have the largest embassy in Khartoum. They're funding the operation, whether it be the weapons that the Janjaweed carry outside the camps, the Antonov bombers that come over, the Soviet Hind helicopters. They are fundamentally propping up the Bashir government and all this situation with Osama bin Laden, who lived in Sudan from '91 to '96, was invited by Turabi and Bashir there, all of this terrorism stuff we're now facing has basically come out of Khartoum and come out of the Bashir government, and fundamentally genocide, today genocide, less genocide today than there was four years ago, but only because the villages that I have seen have been ethnically cleansed.

They're ethnically cleansed. They have already pretty much, and these people, these women, who are raped when they go out in the morning because they go to pick firewood, and the longer they're there, the farther they have to go out. The Chinese have been the number one supporter, the number one supporter, of the Bashir government.

And yet this administration wants to go and have relationships with him. I mean the museum and anyone in this administration who wants to advocate ought to go over there and go through the Holocaust Museum and see, then go to Darfur and see.

There's a Simon and Garfunkel song, "Man hears what he wants to hear and disregards the rest." They're fundamentally disregarding what this Chinese government is doing with regard to genocide in Khartoum, and Bashir, with Bashir in Darfur.

China has been no friend in our engagement with Iran either. U.S. efforts to exert diplomatic pressure against Iran's nuclear weapon program have been thwarted by China's opposition to the U.N. Security Council sanctions against Iran.

In a column last year, Robert Samuelson summed it up this way.

Quote: "China's world view threatens America's geopolitical and economic interests."

Consider our different world views. The U.S. was founded on the premise that liberty is a birthright, that individual human life is sacred, that the freedom to worship according to dictates of your conscience is paramount. The Chinese government operates antithetically to these beliefs.

There is no clearer indication of the gulf that exists between our two countries than the Chinese government's treatment of its own people, and the Chinese people are good people. It is the Chinese government that is fundamentally evil.

According to the Cardinal Kung Foundation, currently every one of the more than 30 underground bishops of the Catholic Church is either in jail, under house arrest, under strict surveillance or in hiding. The Bishop of Hong Kong came in to see me a month ago. The Catholic Church is being persecuted.

The Catholic Church is going through a difficult time in China, and yet this administration, and yet this administration, and quite frankly this Congress and members on both sides of the aisle, are silent on it. It's like it's not even taking place. There are hundreds of house church leaders that are being arrested or are under strict surveillance.

Protestant house church parishes are routinely intimidated and imprisoned. Their congregations worship in secret. An underground house church in Beijing that I visited shortly before the 2008 Olympic Games has come under growing harassment from the government for daring to hold a worship service in public. Dozens have been arrested or detained.

According to the Congressional Executive Commission on China's Political Prisoner Database, as of July 2009, there were 689 Tibetan prisoners of Conscience, 439 of whom were monks or nuns. I went to Tibet in '97. They have turned Lhasa into a dirty Chinese city. Lhasa is no longer this magnificent place. You can still look up and see the Potala, but they have literally decimated that place, bulldozed large areas of Tibetan culture, and the Tibetan people are peaceful people. It is against the law to have a picture of the Dalai Lama.

And keep in mind Hu Jintao was the guy who put the crackdown in place in Tibet, and yet silence. Nobody says a thing. The Uighur Muslims face persecution by the Chinese government.

The Chinese government sent out spies to Fairfax County to spy on Rabiya Kadeer, who's the leader of the Uighur population, whose two boys are in prison, and frankly I asked Secretary Locke when he came before the hearing, would he go--I said you're going to be the only ambassador. Would you worship with? He said I'm not going to tell you who I'm going to worship with.

I said don't go worship. Just attend. Be there. Show up. I go into a

Buddhist, a monastery, and I'm not Buddhist. Just be there, identify with them, as we did with Solidarity and the people in Poland during that period of time. Just be there, and he wouldn't even say that he would go do and go do that and Rabiya Kadeer in Fairfax county.

And we found out because she wrote down the license plate. We had the FBI track it. They were Chinese public security police in Fairfax County, and the Uighurs are going through a heck of a time.

China maintains extensive system of slave labor camps as large as those which have existed in the former Soviet Union. Talk to Harry Wu. Slave labor camps. Slave labor camps. And yet nobody says a thing about it.

This is but a snapshot of what can only be described as grim human rights situation in China, but rather than being a voice for the voiceless, we see U.S. government officials like the President's Science Advisor who spent three weeks in China last year kowtowing to the Chinese government, and he said he took his BlackBerry there. He said he was able to do because then it's the same BlackBerry he still uses, and he took his BlackBerry there. He forgets about Secretary Gutierrez who had his whole system stripped by the Chinese government.

Ronald Reagan once spoke of the U.S. Constitution as a covenant. He said, quote, "we have made not only with ourselves but also with all of mankind." We risk breaking that covenant with the kind of posture that we display today, and quite frankly my criticism goes to both political parties. You very seldom hear people on either side talk about these issues. It's business. They're willing to do anything to get a business deal in China without raising--the Catholic bishops can be in jail, the Protestant pastors can be in jail, the Uighurs can be arrested, and the Buddhist monks can be stripped, and all they care about is getting a deal.

GE signed an avionics package several months ago with China that will literally put Boeing at a disadvantage. It's the deal, what deal you can make for this moment. At the same time, the 2010--think about this--at the same time the 2010 Nobel Prize recipient, Liu Xiabo, was jailed, the 2009 Nobel Prize winner, President Obama, was hosting a State dinner for the Chinese Premier Hu Jintao and committing the U.S. to more cooperation on space, and the Nobel Prize winner couldn't go to Oslo to pick up the award, and his wife couldn't even get out of her apartment to go there and is followed everywhere she goes.

One of the world's worst human rights abusers does not deserve, does not deserve, to be rewarded with greater cooperation with the U.S.

For these reasons, I've been very concerned by this administration, and quite frankly this Congress, and both political parties, their apparent eagerness to work with China on the space program. The U.S. has no business cooperating with the PLA to help develop its space program.

Did anybody ever see the Harry Wu photos where the PLA is selling organs and kidneys for 50 and $55,000? "Man hears what he wants to hear."

Okay. But we're going to disregard the selling of the organs, and so if the Catholic bishops are in jail, we'll work something out. We'll have a trade delegation, and frankly congressional delegations no more--used to take--in the old days they would take lists. Shultz would go, Jim Baker would go, to Moscow with lists of dissidents. Neither go with lists. They go with deals. They want to get a business deal for somebody back in their own district.

Is there something fundamentally immoral with what's taking place, and yet you want to kind of do a deal with these guys who want to eat your lunch? And frankly, there's much more that I could say. But they are spying against us.

The FBI comes before my committee. I've seen what they're doing, not only for finding secrets but industrial espionage, taking jobs from this country. That's why I included language in the fiscal year 2011 Continuing Resolution preventing NASA and the Office of Science and Technology Policy from using federal funds to, quote, "develop, design, plan, promulgate, implement, or execute a bilateral policy, program, order, or contract of any kind to participate, collaborate, or coordinate bilaterally in any way with the Chinese or any Chinese-owned company."

Last week, the President's Science Advisor, Dr. John Holdren, told the committee that the administration does not, does not, does not intend to comply with the statutory prohibition. One day after the hearing, actually he sat here and he said he was going to be looking at this thing, and later the next day before anyone came in, a letter came up saying, and by the way, we're meeting with the Chinese on the 6th, on the 7th, on the 8th, on the 9th, and on the 10th.

One day after the hearing, Holdren was participating in a major bilateral summit with senior Chinese officials to discuss U.S.-China collaboration. I think it's a blatant disregard for the law, very seriously, and the committee is currently reviewing its options, including frankly maybe the only way you can do this is just zero out his office. Just say you're going to this in violation, we're going to just zero you out because if there's no other way, if they're not going to comply with the law, and Holdren doesn't care about the Catholic bishops, he doesn't care about the Buddhist monks, doesn't care about the Protestant pastors, doesn't care about the slave labor camps, then what else can the Congress do?

The PLA's space program merits serious and thorough review so that Congress and the administration can fully understand the recent developments.

I want thank you. There's more I could say. I thank you for having these hearings and forcing this Congress and this administration to deal with an issue that quite frankly they just don't want to deal with. And with that, I will just end.

[The written statement follows:]

WRITTEN STATEMENT OF FRANK WOLF
A U.S. REPRESENTATIVE FROM THE STATE OF VIRGINIA

Says U.S. 'Has No Business' Helping China Develop Its Space Program

Washington, D.C. – Rep. Frank Wolf (R-VA), chairman of the House Appropriations subcommittee that oversees the budgets of NASA, the National Science Foundation and the White House Office of Science and Technology Policy, today delivered the following remarks at a U.S. - China Economic and Security Review Commission hearing on the implications of China's military and civil space programs:

"I appreciate the commission's leadership and I strongly support its work in this area. I believe that this review of the Chinese space program is both necessary and long overdue.

"Before I start, I want to express my sincere disappointment that NASA has chosen not to participate in this important hearing. As the agency responsible for our nation's civil space program, NASA has a unique responsibility to lead in this area and to ensure that the American space program remains preeminent. NASA's absence is reflective of this administration's abysmal record on American leadership in space.

"Last year, Congress wisely repudiated an administration proposal to take a 'time out' from NASA's Exploration program. Fortunately, Congress rebuked this proposal in the 2010 NASA Authorization Act and has provided funding for a robust Exploration program beyond Low Earth Orbit.

"Space is the ultimate 'high ground' that has provided the U.S. with countless security and economic advantages over the last 40 years. As the victor of the Cold War 'space race' with the Soviet Union, the U.S. has held an enormous advantage in space technology, defense capabilities, and advanced sciences.

"Our space program has been the envy of the world. Federal investments in NASA have generated entirely new sectors of our economy, creating hundreds of thousands of private sector jobs for Americans.

"It should not be surprising that many countries have taken notice of the tremendous benefits that the American space program has yielded. It is clear that we are now entering an era of much greater civil, defense and commercial competition in space.

"Most countries expanding their space programs are strong U.S. allies that are primarily interested in advancing science research or building a commercial space industry. The Chinese, however, do not fall into this category. Over the last decade, China has developed its space program at a surprising pace. In less than 10 years the Chinese have gone from launching their first manned spacecraft to unveiling plans last week for an advanced Chinese space station designed to rival the International Space Station.

"However, the Chinese are not only focusing on establishing a significant presence in Low Earth Orbit. In March, the Chinese state news agency announced its plans for 'a powerful carrier rocket for making a manned moon landing and exploring deep space.' This announcement confirms what space experts have long believed: the Chinese have their sights set on the pinnacle of American achievement – landing a man on the moon.

"According to the article, the Chinese are planning a heavy lift rocket capable of carrying up to 130 tons. This would provide the capacity to launch the critical components for a lunar landing. The announcement made clear that if the United States does not get serious about its own Exploration Program, the next flag planted on the moon may be a Chinese flag.

"What concerns me most about the Chinese space program is that unlike the U.S., it is being led by the People's Liberation Army (PLA). There is no reason to believe that the PLA's space program will be any more

benign than the PLA's recent military posture.

"For example, according to the Congressional Research Service, 'on March 9, 2009, the Pentagon reported that PRC ships and aircraft operating in the South China Sea had been acting in increasingly aggressive ways toward two U.S. Navy ocean surveillance ships operating in the area…'

"China is taking a more assertive posture globally, and their interests rarely intersect with ours. Consider the 2008 Senate testimony of then-director of National Intelligence Michael McConnell: 'China continues to develop and field conventional theater range ballistic and cruise missile capabilities that will put US forces and regional bases throughout the Western Pacific and Asia at greater risk…. China's arms sales in the Middle East are also destabilizing and a threat to US forces, while missile sales to Iran pose a threat to US forces in the Persian Gulf.'

"The U.S. intelligence community notes that China's attempts to penetrate U.S. agencies are the most aggressive of all foreign intelligence organizations. The Chinese regime has launched some of the most aggressive and widespread espionage and cybersecurity attacks against U.S. agencies and contractors. Several years ago, the Chinese attacked my office computers and those of many other members of Congress and committees. China's aerospace industry for decades has provided missile technologies and equipment to rogue regimes such as Iran and North Korea.

"China's aims globally are often directly at odds with those of the U.S. According to the Pentagon, weapons that PRC entities supplied to Iran were 'found to have been transferred to terrorist organizations in Iraq and Afghanistan.'

"China has failed to use its influence to bring about a peaceful resolution to the multiple crises in Sudan. It is a major arms supplier and source of economic strength to President Bashir's government in Khartoum.

"China has been no friend in our engagement with Iran either. U.S. efforts to exert diplomatic pressure against Iran's nuclear weapons program have been thwarted by China's opposition to U.N. Security Council sanctions against Iran.

In a column last year, Robert Samuelson summed it up this way, 'China's worldview threatens America's geopolitical and economic interests.'

"Consider our differing worldviews. The U.S. was founded on the premise that liberty is a birthright, that individual human life is sacred, that the freedom to worship according to the dictates of your conscience is paramount. The Chinese government operates antithetically to these beliefs.

"There is no clearer indication of the gulf that exists between our two countries than the Chinese government's treatment of its own people.

"According to the Cardinal Kung Foundation, currently every one of the more than 30 underground bishops of the Catholic Church is either in jail, under house arrest, under strict surveillance, or in hiding. Protestant house church pastors are routinely intimidated and imprisoned. Their congregations worship in secret.

"An underground house church in Beijing – that I visited shortly before the 2008 Olympic Games – has come under growing harassment from the government for daring to hold a worship service in public. Dozens have been arrested or detained.

"According to the Congressional Executive Commission on China's Political Prisoner Database, as of July 2009, there were 689 Tibetan prisoners of conscience, 439 of whom were monks or nuns. Uyghur Muslims face persecution by the Chinese government as well. China maintains an extensive system of slave labor camps as large

as that which existed in the former Soviet Union.

"This is but a snapshot of what can only be described as a grim human rights situation in China. But rather than being a voice for the voiceless, we see U.S. government officials – like the president's science advisor – who spent three weeks in China last year kowtowing to the Chinese regime.

"Ronald Reagan once spoke of the U.S. constitution as a covenant 'we have made not only with ourselves, but with all of mankind.' We risk breaking that covenant with the kind of posture we display today.

"At the same time that the 2010 Nobel Prize recipient Liu Xiaobo was jailed, the 2009 Nobel Prize winner, President Obama, was hosting a state dinner for Chinese premier Hu Jintao and committing the U.S. to more cooperation on space with China. One of the world's worst human rights abusers does not deserve to be rewarded with greater 'cooperation' with the U.S.

"For these reasons, I have been very concerned by this administration's apparent eagerness to work with China on its space program. The U.S. has no business cooperating with the PLA to help develop its space program.

"That is why I included language in the Fiscal Year 2011 Continuing Resolution preventing NASA and the Office of Science and Technology Policy from using federal funds 'to develop, design, plan, promulgate, implement or execute a bilateral policy, program, order, or contract of any kind to participate, collaborate, or coordinate bilaterally in any way with China or any Chinese-owned company.'

"Last week, President Obama's science adviser, Dr. John Holdren, told the House Commerce-Justice-Science Appropriations Subcommittee that the administration does not intend to comply with this statutory prohibition. One day after the hearing, Holdren was participating in a major bilateral summit with senior Chinese officials to discuss U.S.-China collaboration. I take this blatant disregard for the law very seriously and the committee is currently reviewing its options.

"The PLA's space program merits a serious and thorough review so the Congress and Administration can fully understand the recent developments in this area.

"I want to thank you for holding this hearing today and look forward to the final report on the commission's review."

HEARING CO-CHAIR WESSEL: Thank you, Mr. Chairman, for your leadership, for your long-term activities on all these issues, and also for your passion. It is an inspiration and deeply appreciated.

MR. WOLF: Thank you all. Thanks so much.

VICE CHAIRMAN SLANE: Thank you, Congressman.

HEARING CO-CHAIR WESSEL: We're going to take a short break. Be back in about ten minutes or so to resume operations.

[Whereupon, a short recess was taken.]

PANEL III: CHINA'S MILITARY SPACE PROGRAM

HEARING CO-CHAIR BLUMENTHAL: We are going to get started on our third panel of the morning, China's Military Space Program, and we have

some excellent witnesses today, some of whom are colleagues and friends of mine, some of whom are welcome to be in the future.

[Laughter.]

HEARING CO-CHAIR BLUMENTHAL: I think we're going to have a robust discussion on the military implications of China's space program, both in terms of force enhancement, what China might be doing with regard to its desire for precision strike type weaponry, terrestrially, and how their space programs and space system could support operations on land and sea and in the air, quite like we do, as well as some of their counterspace programs.

So again I think we have an excellent group of witnesses here. We have Mark Stokes, who served many years in the Air Force and dealt with space and other industrial, defense-industrial issues, and is now Executive Director for the Project 2049 Institute.

We have Bruce MacDonald, who is the Senior Director for Nonproliferation and Arms Control at USIP.

And Barry Watts, who also wrote some very definitive assessments of U.S. versus competitors, I think, in a very timely fashion before people were really paying attention to China in space, and he works at the Center for Strategic and Budgetary Assessments and also former Air Force officer himself.

And Dean Cheng from the Heritage Foundation has submitted written testimony that will benefit us greatly, and we will submit that for the record.

So I'd like to start with Mark Stokes and move on down the line. Thank you.

STATEMENT OF MARK STOKES, EXECUTIVE DIRECTOR PROJECT 2049 INSTITUTE, WASHINGTON, DC

MR. STOKES: Mr. Chairman, Commissioners, it's an honor and a privilege to be asked to appear here today to talk about one of my favorite subjects. The force is with me today because I made it right on or at least close to when I was supposed to be here.

And of course, the topic today, space, and my presentation will be on Chinese military space developments, and with that as a preface, what I'd like to start off with is a passing comment that China's military space program has elements of civilian and military considerations.

I tend to focus mostly on the military aspects, but I just want to sort of put that out front, that there's a strong civilian component with a civilian component primarily being at the Party and the State Council, the government level.

But the drivers for China's space program may, in certain aspects, not be that different from other space-faring nations, political prestige, sort of to be with the space program being a metric of a global power. But beyond

the political aspects, there are certain economic benefits that China gains from investing in space technologies.

For example, the technical spinoffs, not too different from what we had in our Strategic Defense Initiative announced in 1983. There are commercial applications, for example, in global positioning systems, in terms of the sales that investments in space systems may generate, as well as, for example, the revenue that's generated from commercial space launches, which is relevant but not necessarily all that significant in the big scheme of things.

And in the final consideration or the final driver, of course, is military, hardcore military, and from this perspective, within the military, what I would like to do is take a little bit more time to address organizational issues within the military, starting with fundamental warfighting interests.

Warfighting interests begin within the People's Liberation Army within the General Staff Department, and there are a diffuse set of organizations within the General Staff Department that generate operational requirements. To give an example, the General Staff Department Second Department, Intelligence Department, has an interest, of course, in imagery systems, both electro-optical and synthetic aperture radar, and they have at least one major organization that's involved in establishing operational requirements, and there's also an operational angle in terms of management of ground-receiving and processing stations, of which there are maybe two, three, if not more, both for electro-optical and synthetic aperture radar satellites.

GSD also manages ground segment of certain aspects of China's navigation satellite programs, specifically the Survey Mapping Department, and there are certain centers underneath here that manage, for example, reference stations, as well as at least one that I've been able to identify, one laser-ranging system that's based out of a department in Xi’an.

But the organization that is most responsible for translating operational requirements into sort of technical services or satisfying the operational requirements from a technical perspective, is the General Armaments Department. Within the General Armaments Department, there are various organizations. For example, the key organization would be a second-tier department known as the Electronics and Information Infrastructure Department.

Underneath this department, there are at least four bureaus, and the key bureau, of course, is the Aerospace Equipment Bureau that conducts, that does acquisition management to include managing, for example, R&D contracts from the space industry.

There's also a Manned Space Program Office that is equal in stature to the Information Infrastructure Department. So this gives you an idea of the general structure within the PLA in terms of satellite management or space management, in general.

On the industrial side, there are two major organizations or corporations or conglomerates: China Aerospace and Science Technology Corporation; China Aerospace Science and Industry Corporation. These would be rough, very, very rough equivalents of perhaps a Boeing or a Lockheed Martin or major U.S. industry. And they have business divisions subordinate to these corporations, focusing on certain core competencies, say, for example, weather satellites, communication satellites, or electronic reconnaissance satellites.

And on the counterspace side, of course, you also have intercept systems, space intercept systems, as well as, for example, microsatellites. There's evidence of increasing competition between the Academies, competition for both contracts with the General Armaments Department, as well as commercial contracts with other parts of the Chinese government.

From an operational perspective, space can be looked at in many ways. I tend to look at where the Chinese appear to be going in their space program from their prospective aerospace power, and it's not just me, but also an increasing number of writings that tend to view the domains of air and space becoming integrated into a single domain. In Chinese, it would be "*kongtian yiti*," basically air and space integration literally.

It's viewed as sort of aspirational concept at this particular point, but the manifest station of aerospace doctrine could be in various, particularly in a strike program, for example, hypersonic cruise vehicle programs that manifest attributes of air-breathing platforms, for example, aircraft, as well as ballistic missiles.

There are some that believe, for example, that China's anti-ship ballistic missile is an example of this type of technology in which it doesn't necessarily adopt a pure ballistic trajectory, and this presents some challenges, for example, when it comes to missile defense and engaging some of these systems.

But, in summary, as China increases its capacity in exploiting the benefits of space systems, as well as at least holding other potential adversaries, space assets at risk, it certainly at a minimum offers the People's Liberation Army greater flexibility, if not greater influence, in resolving disputes around the PRC's periphery in the political leadership's favor.

And so with that, I will reserve any other comments in the question and answer session.

[The statement follows:]

PREPARED STATEMENT OF MARK STOKES, EXECUTIVE DIRECTOR PROJECT 2049 INSTITUTE, WASHINGTON, DC

Mr. Chairman, thank you for the opportunity to participate in today's hearing on a topic 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 apply aerospace power presents a number of challenges for the United

States, allies, and friends in the Asia-Pacific region. In my presentation this morning, I will address the perceived nature and intent of PRC investment into militarily relevant space technologies and potential operational implications.

Drivers

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, there is a military stake. China's motivations for investing significant resources into space programs may differ little from other space-faring nations. From a political perspective, Beijing seeks to elevate its status and prestige internationally. National pride resulting from successes in space may enhance the domestic legitimacy of the Chinese Communist Party. From an economic perspective, China benefits from space technology spin-offs, commercial applications of space systems, and revenue generated by international satellite launch services.

While political and economic considerations contribute to China's ambitions in space, the People's Liberation Army (PLA) plays a prominent if not central role. Aerospace power – the strategic and operational application of military force via or aided by platforms operating in or passing through air and space -- is emerging as a key instrument of Chinese statecraft. The PRC understands the potential role that aerospace power can play in pursuing military goals. Control over the skies over a particular region is a critical enabler for dominance on the surface. Effective application of space-based systems, and denying a potential adversary's effective use of space assets, offers the PLA greater flexibility in conducting operations around the country's periphery and greater confidence in its nuclear deterrent. An ability to hold at risk adversarial space systems also may deter attacks on Chinese space systems, or complicate the ability of regional powers to operate in the Asia-Pacific region should deterrence fail.

Overview of Military Space Organizations

Within a broad and fragmented party and government policy framework, the PLA plays a central role in coordinating, defining, and managing national space requirements. Functional offices within the General Staff Department (GSD) shape operational requirements for militarily relevant space-based sensors, aerospace surveillance systems, and communications satellites. The GSD, as well as the Chinese Air Force, Navy, and Second Artillery Force, also are primary customers of space-based systems. For example, the GSD Operations Department appears to manage reference stations and at least one laser ranging system supporting the country's expanding navigation satellite network. Other GSD departments operate sites for processing and distributing downlinked imagery and electronic reconnaissance information.

The PLA's General Armaments Department (GAD) oversees the development and acquisition of technical solutions to satisfy GSD operational requirements, and manages launch, tracking, and control of civilian and military satellites and other orbital systems. For example, GAD's Electronics and Information Infrastructure Department appears to play a leading role in developing technical requirements for the PLA's space-based maritime surveillance architecture. GAD mans China's National Space Command and Control Center, and coordinates technical aspects of the country's manned space program through its 921 Engineering Office. GAD-managed expert working groups leverage expertise from across China's science and technology community in order to break down institutional and bureaucratic barriers that may inhibit technological progress.

Research and development (R&D) and manufacturing of Chinese space systems is centered upon two state-owned defense industrial establishments: the China Aerospace Science and Technology Corporation (CASC) and China Aerospace Science and Industry Corporation (CASIC). Along with senior academics within the scientific community, CASC and CASIC also function as national proponents for aerospace power. Aided in part by technologies funded by national-level research efforts such as the 863 Program, CASC and CASIC research academies specialize in certain space-related core competencies, such as heavy lift launch vehicles, tactical solid fueled launch vehicles, weather satellites, and communication satellites. CASIC appears to serve as a lead systems integrator for tactical microsatellite and space intercept systems. Increasingly accountable for profit and loss reporting, trends indicate

growing competition between business divisions for R&D and manufacturing contracts managed by GAD and other customers. 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. The State Council's China National Space Administration coordinates and executes international space cooperation agreements.

Emerging Capabilities

The PLA is expanding its ability to project military power vertically into space and horizontally beyond its immediate periphery in order to defend against perceived threats to national sovereignty and territorial integrity. Over time, the PRC's defense establishment may gain a limited ability to conduct "new historic missions" to enforce a broader set of security interests beyond China's immediate periphery. PLA observers view air and space as merging into a single operational medium of the future, with the English term *aerospace* best describing the linkage between the two domains.

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. Authors publishing in authoritative journals have advocated accelerating and expanding China's space-based surveillance system to cover targets operating out to a range of 3000 kilometers from the shoreline.

The GAD boosts payloads into orbit from three fixed launch centers in China, with a fourth for heavier payloads under construction on Hainan Island. A diverse and reliable family of launch vehicles is available depending on mission and payload weight. Cost effectiveness and reliability are key factors shaping design of new generation launch vehicles. Over time, the PLA may acquire 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 threats. 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. While GAD has a well-established space tracking and control network, the PLA appears to be investing R&D resources into ground-based radar systems capable of providing queuing quality data for engaging targets in space. A prototype long range large phased array radar has been used to support missile defense and anti-satellite testing. One space surveillance radar R&D study indicated a requirement for detecting and tracking targets as small as 10 centimeters at an altitude of 500 kilometers. 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.

As its persistent sensor, data fusion, and command and control architecture increases in sophistication and range, the PLA's ability to hold at risk an expanding number of targets throughout the western Pacific Ocean, South China Sea, and elsewhere around its periphery is expected to grow. In line with the PLA's "informationization" goals, precision guidance enjoys a high R&D priority. For high altitude target acquisition of moving targets at sea, China's defense R&D community appears to be investing significant resources into developing a missile-born SAR capability that would be integrated with satellite positioning and inertial navigation systems. Existing and future data relay satellites and other beyond line of sight communications systems could transmit targeting data to and from

theater command elements. Developments underway suggest that the PLA is improving its ability to quickly download, process, and disseminate information obtained from space systems. Space-based assets have been integrated into "Blue Force" ballistic and ground launched cruise missile operational training exercises.

The PLA's ability to conduct operational strike missions is likely to be restricted by the range of its persistent surveillance. While China's militarily-relevant space remote sensing capabilities are expanding, PLA and defense industry writings highlight the potential for "near space" flight vehicles that could augment space-based systems for persistent region-wide surveillance capability during crisis situations. "Near space" is the realm between 20-100 kilometers in altitude. As conceptual studies have noted, coverage from platforms in near space offer similar if not improved resolution as compared to satellites in low earth orbit, and flight duration that may exceed airbreathing unmanned aerial vehicles. Near space flight vehicles are noted for their small radar and thermal cross-sections that make them difficult to track and target. Within the last five years, CASC and CASIC have established design bureaus for near space flight vehicle R&D.

One additional aspect of PRC aerospace modernization is worthy of note. China appears to be investing R&D resources into advanced hypersonic propulsion technologies. Success over the longer term could present opportunities for efficient launch of payloads into space, as well as long range precision strike missions. Hypersonic aerospace flight vehicles exemplify the merging of the air and space domains from both an operational and industrial perspective. Hypersonic aerospace flight vehicles under development in China could be divided into two categories: 1) a boost-glide vehicle that is launched into a sub-orbital trajectory by a ballistic missile; or 2) a horizontal take off and landing strike system that utilizes an airbreathing supersonic combustion ramjet (scramjet) engine to propel a vehicle to hypersonic speeds. Key areas of R&D include high lift-to-drag ratio delivery vehicles, high temperature materials for thermal protection, precision navigation, guidance and control, and ability to maintain external radiofrequency links through plasma in near space.

Summary

In short, PRC space-related ambitions are driven by political, economic, and military considerations. With a broad mandate granted by Chinese Communist Party and government leadership, the PLA plays a leading role in developing operational requirements for militarily-relevant space systems, overseeing technology development that could satisfy operational requirements, and managing the national space launch, tracking, and control system.

The PLA is investing in aerospace capabilities that may offset shortcomings in the face of a more technologically advanced adversary. Long range precision strike assets could offer the PLA a decisive advantage in resolving conflicts on terms favorable to PRC interests. Extended range conventional precision strike assets, supported by sensor architecture that is inclusive of space-based surveillance assets, could facilitate attainment of air superiority in the event of disputes over territorial or sovereignty claims around China's periphery. In a future contingency requiring U.S. intervention, space-enabled long range precision strike assets could seek to suppress U.S. operations from forward bases in Japan, from U.S. aircraft battle groups operating in the Western Pacific, and perhaps over the next five to 10 years from U.S. bases on Guam. PRC interests may expand beyond its immediate periphery. Space-based capabilities also could enhance China's ability to conduct other missions, such as peacekeeping or humanitarian relief.

HEARING CO-CHAIR BLUMENTHAL: Thank you, Mr. Stokes, and I will say to my fellow Commissioners, it is true that Mark being on time is a special privilege for us and shows how seriously he takes us.

With that, Mr. MacDonald.

STATEMENT OF BRUCE W. MacDONALD, SENIOR DIRECTOR
U.S. INSTITUTE OF PEACE, WASHINGTON, DC

MR. MacDONALD: Thank you very much, Mr. Chairman, members of the Commission. I see a number of old friends here as well. Thank you for inviting me to discuss the important issues of China's military space policy and programs and their implications.

I'm speaking in a private capacity, and my comments do not represent the views of the United States Institute of Peace.

This hearing is timely, and it's one of rising urgency. Since China destroyed an aging weather satellite with its new anti-satellite, or ASAT, capability in 2007, it has developed more advanced military space capabilities, as Ambassador Schulte has mentioned to you.

This should not surprise us, nor should we be stricken with fear, but we would be quite unwise to ignore these developments. The PLA recognizes that U.S. space assets, coupled with our advances in absolutely brilliant weaponry, have provided us with unprecedented global conventional military superiority.

China is not our enemy, but their growing economic and military power coupled with many friction points in our relationship, most notably over Taiwan, mean we can't rule out a future conflict. The PLA and U.S. Armed Forces both would be derelict in their duties if they had no contingency plans for this.

As the current inferior military power, the PLA has every incentive to develop options for offensive operations against weak points in the U.S. military posture like space, just as our military establishment should develop options against Chinese weak points, and I'm sure they have.

The PLA has just seen how U.S. Special Forces, using satellite photography, space-derived weather and electronic intelligence, along with GPS and other space-enabled information and data, executed a brilliantly successful strike against Osama bin Laden half a world away from the U.S. This operation was built on a firm foundation of information in which space played a vital role, and I'm sure the PLA noticed.

Is it any wonder that the PLA would want to be able to interrupt these rivers of information that enable our military superiority and are provided by space assets?

This space-enabled information allows our decision-making, our weapons, and especially our warfighters to be far more effective than in the past--vital advantages across the spectrum of potential conflict. The PLA certainly wants to be able to greatly weaken U.S. military power in wartime, and I believe the PLA could do so within a decade using its kinetic kill and other ASAT weapons if it chose to deploy them in large numbers, and that certainly bears watching.

Based largely on China's ASAT test, in fact, other nations are now

interested in ASAT as well, such as India and Russia.

This strategic space situation is troubling. Though we are ahead in space, and our capabilities will grow over time, the margin of our advantage seems likely to diminish as China increases its space capabilities, and these PLA efforts are funded by a vigorous, fast-growing economy and supported with full appreciation for the roles that space-enabled information and information warfare play in modern conflict.

Beyond their ASAT test, China demonstrated their growing hit-to-kill technology when they demonstrated a ballistic missile intercept last year. This successful test has serious strategic implications for U.S. security interests that I believe have been largely ignored to date.

Senior Chinese military and political leadership clearly appreciates the significance of space. 18 months ago, the PLA Air Force Chief of Staff spoke of the inevitability of space conflict, followed one week later by Hu Jintao's statement about the PLA Air Force requirement of developing both offensive and defensive space capabilities.

China's most recent Defense White Paper also states once again that space plays a prominent role in its security thinking. The Web Site of the daily newspaper of the Central Military Commission recently criticized Deputy Assistant, and this morning's witness, Secretary of Defense for Space Policy Greg Schulte's citing of China's anti-space weaponry development.

But something very significant happened, I note here, and that is although China retorted that, well, some countries are worried about U.S. anti-space capabilities, they did not deny the accuracy of Ambassador Schulte's statement, whereas, in previous years, they have denied. This is quite a noteworthy change, I think, given its origin.

Last year, the PLA said that our new space policy is "seeking space hegemony" as a "core U.S. objective," and that we are developing and deploying space-based weapons, and that's our established strategy.

I think that these and other distorted PLA accounts must be called out and refuted, lest more junior PLA officers and others who read PLA publications and hear their statements accept them uncritically. And there's a tendency, as we all know, particularly among third-world countries, to tend to want to accept what China says about the big bad United States, more than what we say.

Time and again the United States has been rebuffed in seeking greater openness and transparency in space and China’s larger defense strategy.

But the PLA has been publishing an increasing number of papers on these issues that have not received enough attention. The problem, I'm told, is primarily a resource constraint on our side, that we're not devoting enough resources to intelligence and analysis.

One thing is clear: China overall is quite opaque. Despite all these writings, they are very opaque on their military space policy and doctrine. Clearly, we need more clarity on PLA and Chinese government thinking on

space deterrence doctrine, stability and related issues. If there is any aspect of space security that needs more attention and resources, space intelligence and analysis is it. It's hard to fight what you don't understand.

Now, it would be easy to fall into the assumption that, well, China has the most at stake, and they're just looking for war. China sees the United States as militarily superior to them, and so they would be unlikely to consciously provoke any military conflict in the near to midterm. I don't believe China is spoiling for a fight with the United States. They've come too far to want to place their substantial economic achievements at risk unless they face an extraordinary threat to their national security.

Plus, as you know better than I, China faces serious demographic realities over the next couple of decades which further underscores China's need for stability and continued economic growth for years to come.

One particular thing on the PLA, though, I would call out, and that is while China's civilian leadership has become more sophisticated in dealings with the rest of the world, the same can't be said for the PLA senior officer corps.

They travel a lot less, interact with the outside world a lot less than their civilizan counterparts, and so the PLA overall views world events from a less knowledgeable perspective, and I think that can be very dangerous in a likely crisis situation. They also have no equivalent to our National Security Council so there is not this kind of a body available. I think the United States should remain preeminent in space, and we can, but there are a lot of space deterrence issues that need to be examined and really haven't been very well. I made an attempt in my Council on Foreign Relations study, and also in terms of space stability, I would also give a plug for the America Strategic Posture, which spoke to the space issue. This was the report of the Perry-Schlesinger Commission, the Congressional Commission on the Strategic Posture of the United States.

So I see that my time is up so let me just say that, in conclusion, I think the United States should put greater effort and resources into understanding the PLA space program and larger military intentions in space, including space intelligence, put more emphasis on understanding how space deterrence works, continue to seek to engage China on key space stability issues, and ensure at least that others understand why U.S. diplomatic initiatives are superior to the Chinese-Russian proposal, and enhance our space situational awareness and space intelligence, and we should challenge the PLA on some of its space statements and set the record straight.

Thank you, and I look forward to your questions.

[The written statement follows:]

PREPARED STATEMENT OF BRUCE W. MacDONALD, SENIOR DIRECTOR U.S. INSTITUTE OF PEACE, WASHINGTON, DC

Mr. Chairman and Members of the Commission, it is a pleasure to appear before you today, and I thank you for extending to me this invitation to discuss the important issue of China's military space policy and programs and their implications for the security of the United States and its allies and friends. I am speaking purely in a private capacity, and my comments do not represent the views of the United States Institute of Peace (USIP), which provides analysis, training and tools to help prevent, manage and end violent international conflicts, promote stability, and professionalize the field of peacebuilding. Prior to USIP, I led the Council on Foreign Relations study of China, Space Weapons, and U.S. Security, which built upon my years of national security policy work in and out of government, travel to China, and training as an aerospace engineer.

The Chinese Challenge

This hearing is timely, and one of rising urgency. In the more than four years since China destroyed an aging weather satellite, demonstrating not only an anti-satellite (ASAT) capability but the potential for strategic ballistic missile defense capability as well, it has proceeded to deploy more, and more advanced, military space capabilities as well. We should not be surprised by this, nor should we be stricken with fear. We would, however, be unwise to ignore both these developments, which are public knowledge, and other developments that are of a classified nature.

The Peoples' Liberation Army (PLA) appears to recognize what most thoughtful observers of national security also recognize, that U.S. space assets, coupled with our advances in brilliant weaponry, have provided the United States with unprecedented and unequaled global conventional military capabilities. Both China and the United States are fortunate that neither country is the enemy of the other. However, China's growing economic and military power, coupled with friction points in the relationship, most notably over Taiwan, suggest that a future U.S.-China conflict, though unlikely, cannot be ruled out. The PLA and U.S. armed forces both would be derelict in their duties if they did not have contingency plans for such a conflict. As the current inferior military power, the PLA has every incentive to develop options for offensive operations against weak points in U.S. military posture, just as our military establishment should develop options against weak points in Chinese defenses.

PLA officers have noted the great U.S. dependence upon space assets and capabilities and the way they multiply U.S. force effectiveness. Just recently, they saw how U.S. special forces, and the military and civilian leadership that commanded them, heavily depended upon satellite photographs, space-derived weather and electronic intelligence, GPS, other space-enabled information, and satellite communications in executing the strike against Osama bin Laden's compound in Pakistan. This brilliantly successful operation was built on a firm foundation of information in which space played a vital role in creating..

Is it any wonder that the PLA would want the capability to interrupt these rivers of information and services that our space assets provide? This information allows our military decision-making, our weapons, and especially our warfighters to be far more effective than in the past, vital advantages across the spectrum of potential conflict. These "space-enabled information services" lie at the heart of U.S. military superiority. The PLA certainly wants to be able to greatly weaken U.S. military power in wartime, and I believe the PLA could do so within a decade using its kinetic kill and other ASAT weapons if it chose to deploy them in large numbers, and thus pose a serious threat to U.S. space assets. China is also pursuing other programs that have important ASAT implications, and other nations are interested in ASAT as well, such as India and Russia.

This strategic space situation is troubling. Though absolute U.S. advantages in space should increase over time, the margin of U.S. advantage seems likely to diminish as China increases its space capabilities and space exploitation, and the PLA will reap both the military advantages and vulnerabilities of greater space capabilities. These PLA efforts are funded by a vigorous, quickly growing economy and supported by a government with full appreciation for the roles that space-enabled information and information warfare play in modern conflict. U.S. and Chinese strategic interests in East Asia are not foreordained to lead to conflict; each has much to lose if this happens, and each appreciates the other's military capabilities.

China's demonstration of an anti-satellite (ASAT) capability through the downing of an old Chinese satellite in 2007, demonstrated at least basic hit-to-kill (HTK) technology capability. They further demonstrated their HTK prowess in January 2010 when they performed a successful ballistic missile intercept test. This shows growing mastery of HTK technology, as hitting a longer range ballistic missile or warhead is a more challenging HTK task than hitting an orbiting satellite. This successful missile defense test has important strategic implications for U.S. security interests that have to date been largely ignored. One Chinese source me that Chinese scientists had been actively pursuing HTK technology development ever since the United States first demonstrated HTK technology in the homing overlay experiment (HOE) in 1984. This source said that Chinese scientists saw at that time the strategic significance of HTK technology and the importance of China mastering it – which they now appear to have done. Besides the kinetic ASAT the PLA tested in 2007, China reportedly has other offensive space programs under development, including lasers, microwave- and cyber-weapons. We also face the twin realities that defending space assets is more difficult than attacking them; and while advancing technology will help both defense and offense, the offense is likely to benefit more.

Senior Chinese military and political leadership also appears to appreciate the national security significance of space. 18 months ago, the PLA Air Force chief of staff, Gen. Xu Qiliang, spoke of the inevitability of space conflict, followed one week later by Hu Jintao's statement about the PLA-AF "requirement of [developing] both offensive and defensive space capabilities." Writings in authoritative Chinese military journals also show a clear awareness of the growing military role that space assets play in advanced conventional military capabilities. A recent article in China reporting on the launch of the latest Chinese Beidou (GPS-type) satellite cited one Chinese military expert as noting that 90% of advanced weapons currently depend upon GPS for their operation. China's 2008 Defense white paper also notes the major role of "informationized warfare" in future conflicts and devotes an entire section to "promoting the informationization of China's national defense and armed forces in the paper. China seeks to have a significant capability in this area by 2020 and to be able to prevail in such warfare by 2050, according to their white paper. China's most recent defense white paper, released two months ago, acknowledges once again that space plays a prominent role in its security thinking. The paper notes, among other national defense taskings, to maintain China's "security interests in space, electromagnetic space and cyber space."

The website of the daily newspaper of the Central Military Commission recently criticized Deputy Assistant Secretary of Defense for Space Policy Greg Schulte's citing of China's "anti-space weaponry." I am particularly struck by the fact that the CMC newspaper, though it countered that some countries are worried about U.S. "anti-space" capabilities, did not deny the accuracy of Ambassador Schulte's statement, as China usually does. This is quite a change, one I believe is noteworthy given its origin.

The PLA views last year's revised U.S. space policy as "seeking space hegemony" as a "core U.S. objective," and claims that "developing and deploying space-based weapons is America's established strategy," according to published accounts. These and other distorted PLA views must be called out and refuted, lest more junior PLA officers, and others who read PLA publications accept them uncritically.

The key questions are what Chinese intentions are for these capabilities, and what the implications are for the United States.

Chinese Military Space Intentions

A fundamental problem we face is that China says little at an official level about its military space policy and

doctrine. Chinese counterspace capabilities may be intended purely for deterrence purposes, to be used in warfare at a time of their choosing, or some combination of the two. PLA leaders have informally told U.S. officials and others that it is in the interest of an inferior power to keep secret information about its weaknesses and strengths, and they appear to be following this advice quite strictly. Time and again the U.S. has been rebuffed in seeking greater openness and transparency in Chinese space and larger defense strategy. That said, the PLA publishes an increasing number of papers on these issues that have not received enough attention, the problem, I am told, being a resource constraint.

There is a sizable PLA literature on space conflict, but it is unclear how well this reflects Chinese government thinking, any more than U.S. military journals reflect official U.S. policy. However, China's ASAT and missile defense tests and this literature demonstrate a PLA awareness of the importance of offensive counterspace (OCS) capabilities and strongly suggest that such capabilities are part of China's larger plans for the future – and perhaps missile defense capabilities as well. It is also unclear whether this reflects PLA interest in OCS for warfighting or just for deterrence, though I suspect it is likely a mixture of both.

Should China choose to deploy its demonstrated ASAT system, or more advanced versions of it, U.S. space assets and the military and economic infrastructures they support would be put at risk. One thing is certain – more clarity on PLA and Chinese government thinking on space deterrence, doctrine, space stability, and related issues – and Russian thinking, too -- are urgently needed and are important to U.S. security. If there is any aspect of space security that needs more resources, space intelligence and analysis is it.

In the face of this growing Chinese military space challenge, it is easy to assume the worst about Chinese intentions. China seeks to be able to prevail militarily at some point in the future should conflict come, but they see the United States as militarily superior to them and thus would be unlikely to consciously provoke any military conflict. While we should guard against a worst case, we should not treat it as a given. I do not believe China or the PLA is spoiling for a fight with the United States – China has come too far to want to place their substantial economic achievements at risk unless they faced an extraordinary threat to their national security. In addition, China faces serious demographic realities over the next couple of decades, where their ratio of workers to retirees will shrink substantially (the result of their one-child policy), which further underscores China's need for stability and continued economic growth for years to come. China also has additional needs, and vulnerabilities:

- Growing environmental problems and water shortages with no obvious solutions that are growing irritants to the public;
- A relentless search for new sources of manufacturing inputs;
- An increasingly restive working class that is making new demands for higher wages and political freedoms;
- A non-democratic one-party system that leaves its senior leadership constantly looking over its shoulder at possible challenges to its authority, especially in the aftermath of the "Arab Spring";
- Growing citizen anger against corruption and cronyism that seems impossible for the CCP to root out; and many more.

These factors are reasons why China is probably not looking for war with the United States, though they also could inadvertently become factors in China's stumbling into a conflict they would ordinarily not want, through miscalculation or distraction.

One characteristic of too many wars in the last century is that they are the result of miscalculation that ignites the tinder of fundamental geopolitical tensions. Averting major power conflict requires skillful management of tensions by senior leaders of the major powers. China has become much more internationally sophisticated, though with important exceptions, in its dealings with the rest of the world than has been true in the past, and this is reflected in its civilian leadership. Unfortunately, the PLA's senior officer corps trails its civilian counterparts in this respect. They have much less interaction with foreign official and travel abroad much less frequently than their U.S. counterparts. This means that the PLA overall views world events from a less knowledgeable and sophisticated perspective, a danger in this increasingly complex world, and could explain, for example, the political "tone-deafness" of the PLA in the manner they conducted their 2007 ASAT test.

This PLA problem becomes more serious when one realizes that the PLA is organizationally separate from the rest of the Chinese government, and reports only to the Central Military Commission, currently chaired by President Hu Jintao. President Hu, and his likely successors, have no significant military background, and the majority of the CMC's members are top PLA officers, suggesting that civilian oversight of major military decisions and consideration of their larger implications are not as carefully reviewed as in the U.S. government. Normally this would not be too great a concern, but in a crisis this could be dangerous. Add to this the fact that China has no equivalent of our National Security Council, a critically important body for coordinating our security decision-making, and one comes away concerned about the relative insularity of the PLA in the Chinese power structure. In a crisis, the PLA probably cannot be counted on to show as sophisticated a sense of judgment as one would hope any country's military leaders, even an enemy's, to show. All these problems and many more pose potential threats to internal political stability and Communist Party control, providing ample opportunity for crisis and conflict in the years ahead.

Overview of The Strategic Landscape of Space

Space assets, and the communications and cyber links that enable them to function, are the means by which essential national security information is either generated, transmitted, or both. This information is the lifeblood of U.S. conventional military superiority and plays a key role in U.S. strategic nuclear posture as well. As such, these space related assets represent extraordinarily appealing targets in any future conflict, and their relative vulnerability can provide dangerously attractive incentives in a crisis to pre-empt, escalating to war. Resisting this temptation to attack may be morally virtuous but could be strategically unwise: going first in a space conflict with a near-peer space adversary appears to offer many advantages, while absorbing such a strike, with all its attendant destruction of military capabilities, and then responding to the attack against an opponent fully expecting such a response, appears to be militarily and strategically quite undesirable.

As technology advances, the ways of interfering with, disrupting, or destroying information streams in space or supporting space systems will likely increase, as will U.S. and others' dependence upon such systems. Providing defensive options for U.S. space assets should be pursued where appropriate, but most space observers believe that offense has the advantage in space over defense, as General Cartwright observed last May. Cartwright also noted that the challenging issues that space poses has made the Space Posture Review "the most difficult of all the defense reviews" the Obama Administration has undertaken.

The overall U.S. goal in space should be to shape the space domain to the advantage of the United States and its allies, and to do so in ways that are stabilizing and enhance U.S. and allied security. The United States has an overriding interest in maintaining the safety, survival, and function of its space assets so that the profound military, civilian, and commercial benefits they enable can continue to be available to the United States and its allies. This need not mean that China and others must perforce be disadvantaged by such an arrangement – there should be ample opportunity for many countries to benefit and prosper from a properly crafted system of space management.

There is an inherent risk of strategic instability when relatively modest defense efforts create disproportionate danger to an adversary, as with space offense. And there is a serious risk of crisis instability in space when "going first" pays off – destroying an adversary's satellites before he destroys yours. We don't know what would happen in a crisis, but the potential for space instability seems high and likely to grow.

The United States can and should remain pre-eminent in space, but many issues are begging to be addressed, including:

- How does deterrence function in space? Could limited counterspace attacks remain limited, or would they inevitably escalate into all-out space conflict?
- How can countries with less to lose in space than we be deterred? Are there asymmetric means available to us for deterrence?
- Is space deterrence possible without offensive space capabilities? If so, how? If not, what kinds of capabilities are most stabilizing?
- What U.S. space strategy, and resulting acquisition strategy, in that order, would promote U.S. security interests and reduce space instability over the longer term?
- How do China, Russia and others see space stability? How will this shape China's space doctrine, acquisition, strategies, and diplomacy?

Creating a stable space domain requires the United States to respond to space threats in a responsible manner, one that ideally does not prod other nations to greater counterspace efforts than they would otherwise pursue. If not careful, the United States could create a self-fulfilling prophecy as nations like China or Russia would see evidence of U.S. attempted space hegemony, they likely would accelerate their own efforts, just as we would if the roles were reversed. China faces the same challenge as well. We should not seek offensive counterspace capability at the expense of effective steps to protect U.S. space capabilities; both can be accommodated.

China and Space Diplomacy

As significant a role that space diplomacy can play in contributing to space stability and responsible space stewardship, China's activities in space arms control sadly do not provide any basis for optimism on Chinese, or PLA, intentions in space. China and Russia have for years promoted their joint draft "Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects (PPWT)." The PPWT proposes to ban all space weapons but provides no credible means for verification. When I approached one Chinese space specialist about verification a few years ago, he acknowledged that verification would be difficult but told me that "You Americans are so technologically clever – you'll figure out a way"!

The PPWT likely serves primarily as a way for China to buy time to enable them to attain a stronger military position, perhaps even catch up to the U.S., in a field where they were far behind us. With the previous U.S. opposition to international agreements on space, it also left a diplomatic vacuum that China and Russia skillfully filled with the PPWT, portraying an image of peaceful intentions in space. It is intriguing to note that with the EU and U.S. in recent months speaking favorably of a draft code of conduct that is a vastly more realistic step than the PPWT, the PLA is now attacking it as an attempt to impose Western regulations on China. This code of conduct provides an excellent vehicle to challenge China to support realistic and useful "rules of the road" for space, and

other steps which I hope the U.S. will pursue. In my conversations with Russian and Chinese counterparts, I find serious Russian interest in this approach but sadly only intransigence from China.

Current U.S. space policy and strategy walks back the U.S. aversion to space diplomacy and strikes the right notes on responsible space stewardship and addressing the issues of a space frontier that, at least in the vicinity of earth, is becoming more of a settled environment that requires some form of management and rules of the road. This realistic direction for space diplomacy, and U.S. and allied support for such approaches, is both a sensible step and also diplomatically turns the tables on China

Meeting the Chinese Challenge

Space is of major and growing national security importance, which introduces a potentially destabilizing element to U.S. and international security. In addition to responsible behavior, the U.S. ability to fully realize the national security and other benefits of space depends on space remaining a stable and peaceful environment, even in crisis situations if at all possible. Given the heavy and growing U.S. reliance upon space for communications, sensor information, and a host of other benefits, it is no wonder that the space policies of both the previous and current administrations have declared space to be a vital national interest of the United States. Where vital national interests are concerned, stability in space that enables the continuation of substantial U.S. conventional superiority should be a top priority. The primacy of space stability as a key U.S. strategic interest was recognized by the Congressional Commission on the Strategic Posture of the United States when it recommended in 2009 that the United States should

"develop and pursue options for U.S. interest in stability in outer space, includ[ing] the possibility of negotiated measures."

Measures or actions that would threaten to upset the stability of space could thus be dangerous to our national security, and U.S. policy should seek to avoid such steps. This is why as long as the United States continues to derive more benefits from space than its adversaries, it should be very careful about initiating significant space hostilities with a near-peer space power such as China. Against non-peer space powers, we should be able to rely upon our overwhelming conventional superiority to achieve victory. Against a near-peer space power, we must weigh the cost of losing some significant fraction of our space-derived or-transmitted information against the incremental benefit of offensive counter space (OCS) steps versus other means to achieve comparable objectives. Most often, the use of OCS would be too costly to U.S. security interests, although some scenarios, such as the threat to U.S. aircraft carriers from ballistic missiles, would completely change this calculus. This entire area requires further study, tabletop exercises not just of space war games, but also "crisis games," where more attention can be paid to crisis behavior in space, to understand whether certain actions are stabilizing or destabilizing.

While the Obama space policy, as did the Bush space policy before it, recognizes that space is a vital U.S. national interest, it seems to overlook the implications of this important reality. In this context, offensive space capabilities cannot be considered just one more weapon in the U.S. arsenal, to be used when tactical circumstances beckon to field commanders. When vital national interests are at stake, great caution must be exercised. As a general rule, where threats to vital national interests are involved, a doctrine of deterrence should be developed and embraced as U.S. policy. We would credibly threaten to use such a capability but not actually seek to do so unless the stakes were extraordinarily high. To do otherwise against a near-peer space power adversary such as China would put our vital national interests at risk.

Recommendations

The United States should:

- Put greater effort and resources into understanding the PLA's space program and larger Chinese military intentions in space.

- Put more emphasis on understanding how space deterrence works, especially through simulation efforts that specifically target the crisis situation itself, in addition to conflict simulations.

- Continue seeking to engage China on key space stability issues and ensure that others understand why U.S. and Western diplomatic initiatives and the approach they embody are superior to the Chinese-Russian PPWT.

- Enhance U.S. space situational awareness and space intelligence capabilities

- Diversify how we provide space information and services to the warfighter and senior national security leaders to reduce dependence on any single link.

HEARING CO-CHAIR BLUMENTHAL: Thank you.

Mr. Watts.

STATEMENT OF BARRY WATTS, SENIOR FELLOW, CENTER FOR STRATEGIC AND BUDGETARY ASSESSMENTS, WASHINGTON, DC

MR. WATTS: I appreciate the Commission giving me an opportunity to talk to you all today. I'm going to focus on net assessment issues because that's really my expertise as opposed to being a China scholar or a specialist on space.

What I want to suggest to you is that back in 2000, when I was working on a space assessment for CSBA, it was a lot easier at an unclassified level to assess what seemed to me at that point to be the fundamental change in the military use of space since the 1960s, when the first KH-1 Corona satellite film-return capsule was recovered. During the Cold War—aside from the fact that the United States and the Soviet Union largely dominated space because of the difficulties of launch and the sheer costs—the military use of space was primarily to track the evolution of strategic nuclear forces on both sides. That focus certainly after the Cuban missile crisis in 1962, increasingly lent stability to the U.S.-Soviet strategic nuclear relationship and the relatively benign way in which the Cold War ended.

That view of how the United States and the Soviet Union primarily utilized space during the Cold War was fairly straightforward from an

assessment standpoint. Today, I think the situation is a lot more complicated because, as you know, starting with TENCAP (Tactical Exploitation of National Capabilities), which Congress imposed on the Pentagon starting in 1977, we began to try to make national technical means—the use of the satellites, real-time access to what they produced, etc.—increasingly available to theater commanders in wartime. And the first time when this new use of space for enhancing outgoing theater operations really became clear was the Gulf War in 1991.

General Norman Schwarzkopf, who was the theater commander during Operation Desert Storm, certainly had access to both radar imagery from space as well as electro-optical imagery. An awful lot of communications in and out of the theater and around the theater went through commercial communications satellites. And Desert Storm was also the first time we really saw the military utility of the global positioning system (GPS). It was especially useful for helping ground forces know where they were in the trackless desert.

GPS was not used in '91 very much for weapons guidance. The 35 conventional air-launch cruise missiles that the B-52s employed the first night of the war were the only GPS-aided munitions that were used during Desert Storm. Most of the effective precision weapons in the air campaign were over 9,200 laser-guided bombs (LGBs).

If you scroll forward to Operation Iraqi Freedom in March-April 2003, about 30 percent of the precision weapons expended were GPS-aided, mostly Joint Direct Attach Munitions. The other big contributor was, of course the LGB, which accounted for another 30 percent of the expenditure of guided munitions.

This shift towards increasing use of space to support ongoing conventional operations was a dramatic change from the Cold War focus on preconflict strategic reconnaissance. During the Cold War, everyone assumed that if a nuclear exchange occurred—which was the thing we feared most—then space was basically going to go away if, for no other reason, because the ground stations were going to be nuked very early in the conflict.

Now, today, we are increasingly using space assets to conduct conventional operations on a day-to-day basis. That, of course, as Mr. MacDonald has pointed out, creates a huge vulnerability for the United States military. The Chinese are fully aware of this dependence. They have been writing for years about our dependence on space systems as an exploitable vulnerability. They are very interested in finding every way they can think of to exploit that vulnerability should there be a U.S.-PRC conflict at a conventional level.

Why do I think it's much harder to assess what the role Chinese space assets, particularly their counterspace capabilities, might have on a conventional war if we actually got into one in 2012 or 2020? Here I'll just

say in passing that I agree with my fellow panelists that I really don't see much likelihood of such a conflict occurring, at least within this decade.

Commissioner Dan Blumenthal and I went to Taiwan back in 2003 and realized—at least one of the impressions that I carried away from that trip—was the degree to which there was the growing economic entanglement of Taiwan and mainland China as the island's technology and production capabilities moved to the mainland. As long as that's going in a reasonably successful way, I don't believe China's leaders are going to be tempted to try to take Taiwan with military force.

But having said that, if you try to look at the sort of conflict that the panel asked us to focus on today, one of the huge complications that we run into is that we now have a cyberspace domain that goes hand-in-glove with the space domain. And to be honest, my sense is that we've encountered real difficulties in our efforts to assess how workspace and cyberspace would play together in a conventional conflict over Taiwan. In fact, in the last game I participated in cyber was actually off the table and didn't even play because it's so complicated and leads in so many different directions.

So net assessments are growing much more difficult today than they were in 2001, and I think you need a lot more detailed information on both sides' systems if you're really going to do a good job of assessing the role of space in a U.S.-China conflict in this decade.

I'll just note in passing, if you look at the DF-21D against a U.S. aircraft carrier in the Western Pacific, the Chinese haven't had an end-to-end test of this anti-ship ballistic missile system against a moving target at sea, which raises another fundamental issue about the difficulties of doing a net assessment.

The U.S. military is extremely proficient at this point in time. It has an enormous amount of recent combat experience compared to, say, the Vietnam period, and our operators are very adaptive and innovative.

How you balance or compare that against a Chinese military, which actually hasn't fought a war in a very long time, with U.S. combat experience and training programs like Red Flag and the National Training Center, which stress realism? So my sense is that we have very little insight into how effective Chinese counterspace operations might really be against a more experienced and better trained U.S. military, and this, adds other complications to trying to assess how space systems might influence the outcome of a conflict in 2012 or 2020.

I will just say, in closing, the Rumsfeld Commission back before 9/11 warned about the possibility of a "Space Pearl Harbor." I don't think we're to that point, at least in this decade. If you look beyond 2020 it becomes more likely that the People's Liberation Army would be able to interfere with U.S. space assets and present the U.S. military with some serious problems in space.

Let me add one other comment. I think the weaponization of space in

a de facto sense is on the way, as I told Commissioner Blumenthal in between this panel and the last. VivaSAT and MDA, whose anchor customer is going to be Intelsat, are developing on-orbit servicing satellites that will extend the service lives of geosynchronous communication satellites. These systems will be able to either take control of a satellite or even refuel it.

These are, in effect, space systems that can be used for military purposes. So I think we're moving into a very different era as we look past 2020.

Thank you.

[The written statement follows:]

PREPARED STATEMENT OF BARRY WATTS, SENIOR FELLOW, CENTER FOR STRATEGIC AND BUDGETARY ASSESSMENTS, WASHINGTON, DC

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

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

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

Throughout the Cold War, accessing the orbit using updated German rocket technology was costly, technically difficult and failure-prone. Excluding Corona launches without a camera, the initial KH-1 success was preceded by eight missions failures. Recall, also, the loss of two American space shuttles: *Challenger* during liftoff in 1986 and *Columbia* during reentry in 2003. As a result, the use of space for military missions such as strategic reconnaissance or attack warning was heavily dominated by the United States and the USSR well into the 1980s. Indeed, American and Russian quantitative dominance of near-Earth space persists even today in terms of on-orbit payloads. Counting civilian and military satellites, in 2010 the United States and Russia had over 80 percent of the more than 3,100 payloads on orbit, while China's had only 3.3 percent (102 payloads). Moreover, although the number of nations and organizations with indigenous capabilities to build and launch satellites has only grown by two since the Cold War ended—Ukraine (capabilities inherited from the USSR after its collapse) and Iran—there are some thirty other nations whose satellites have been launched into orbit by other countries.[1] So, having a satellite, even if put into orbit by another country's launch provider, is rapidly becoming a commodity available in peacetime to most any nation with the necessary funding.

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

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

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

From a U.S. perspective, therefore, the military use of space has changed fundamentally since the early 1960s. During most of the Cold War space systems were used mainly by the United States and USSR for strategic reconnaissance inside the other's sovereign territory prior to the outbreak of general nuclear war. Starting with Desert Storm, however, U.S. space systems have been used increasingly for near-real-time surveillance and targeting of enemy forces during ongoing conventional operations. An added wrinkle is that GPS, which first demonstrated its military value in 1991, subsequently evolved into a universal source of precision location and timing data for individuals, financial institutions, commercial firms, numerous other organizations, and militaries around the globe. Though funded through the U.S. Air Force's budget, GPS is now a service that the U.S. government provides to everyone else on the planet free of charge.

Precision-Strike as a Revolution in Military Affairs

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

Currently, the U.S. military is the only country to have demonstrated a global, end-to-end capability for precision strike in actual combat operations. With the collapse of the Soviet economy at the Cold War's end, the Russians,

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

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

contrary to what Marshall and others expected in the 1990s, failed to field long-range precision-strike capabilities comparable to those of the United States. Instead, nearly two decades after ONA's first assessment of the "military-technical revolution" (or RMA), the country that appears to be making the greatest strides toward fielding regional RUKs is China.

So far, China's precision-strike capabilities are regional in the sense of being focused on limiting the U.S. power projection in the western Pacific, especially in the waters near Taiwan. One element of the PRC's emerging A2/AD capabilities is the development of a variant of the DongFeng (DF) 21 (CSS-5) medium-range ballistic missile capable of targeting U.S. naval surface combatants—notably aircraft carriers—at distances of up to 1,500 kilometers (810 nautical miles) from the Chinese mainland.[4] To provide accurate, real-time target information for the DF-21D anti-ship ballistic missile (ASBM), the Chinese have been considering the integration of data from a variety of space-based sensors, including electro-optical (EO), synthetic-aperture radar *(*SAR), electronic reconnaissance, and ocean surveillance satellites.[5] In 2010 China made three launches of its Yaogan series, which are believed to be military reconnaissance satellites. Most likely, Yaogan 10 carried a SAR sensor, Yaogan 11 an EO sensor, and Yaogan 9 was evidently a triplet of satellites designed for ocean reconnaissance.[6] Robert Willard, commander of U.S. Pacific Command, indicated in December 2010 that China's 2nd Artillery Corps had reached "initial operational capability" with the DF-21D ASBM system, although he added that the Chinese had not yet tested the entire system against a moving ship at sea.[7] Nonetheless, China's development of ASBM and its supporting sensors reflect a strong aspiration—now approaching realization—to be able to hold at risk U.S. carrier battle groups should they try to operate in and around Taiwan as occurred during the crisis of 1995-1996. Indeed, in the near term the People's Liberation Army (PLA) seems intent on establishing a virtual keep-out zone for U.S. power-projection forces extending from the Chinese mainland out to the first island chain running from southern Japan, through Okinawa and Taiwan, to the Philippines and Malaysia.

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

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

Chinese appreciation of the vital role information will play in future hi-tech local wars has two main ramifications. The first is that, from a modernization perspective, the PLA has no choice but to invest in the capability to get information for its forces from space. It is not unreasonable to suspect that, without some in-flight target updates, a DF-21D reentry vehicle, even with terminal guidance, might be hard-pressed to hit a U.S. aircraft carrier operating hundreds of miles off the Chinese coast. After all, during a notional five-minute DF-21D time of flight, a

[4] Andrew S. Erickson and David D. Yang, "On the Verge of a Game-Changer," *Proceedings*, May 2009.
[5] Ian Easton and Mark A. Stokes, "China's Electronic Intelligence (ELINT) Satellite Developments: Implication for U.S. Air and Naval Operations," Project 2049 Institute, February 2011, p. 7.
[6] Yaogan details can be found on Gunter Kreb's Space Page at http://space.skyrocket.de/.
[7] Andrew Erickson and Gabe Collins, "China Deploys World's First Long-Range, Land-Based 'Carrier Killer': DF021D Anti-Ship Ballistic Missile (ASBM) Reaches "Initial Operational Capability" (IOC)," China SignPost," December 26, 2010, Issue 14, p. 1, accessed May 4, 2001, at http://www.chinasignpost.com/2010/12/china-deploys-world's-first-long-range-land-based-'carrier-killer'-df-21d-anti-ship-ballistic-missile-asbm-reaches-"initial-operational-capability"-ioc/, accessed May 6, 2011.
[8] Peng Guanqian Yao Youzhi (chief editor), *Science of Strategy* (Beijing: Military Science Press, 2001), pp. 359-361.
[99] Peng, *Science of Strategy*, pp. 369-370.

U.S. carrier moving at 25 knots could change its position by some two nautical miles, and radio-frequency aerosol obscurants could defeat the warhead's radar terminal guidance. China's emerging ASBM capability, therefore, is likely to require in-flight target updates, and Chinese writings indicate that these updates will come from satellites.

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

The other ramification of the vital role that satellites have increasingly played in U.S. military operations is that the Chinese cannot help but appreciate just how dependent American precision warfare is on the use of space. Precision munitions are only useful if they can be supplied with precision targeting information such as the GPS coordinates of an aim point. To get that information to shooters in time to deal with time-sensitive targets, the United States has invested heavily in developing global battle networks as well as intelligence, surveillance and reconnaissance (ISR) systems such as EO and radar satellites as well as unmanned air vehicles (UAVs) like the RQ-4 Global Hawk and MQ-1 Predator. An advantage of UAVs over LEO satellites is that they can dwell over a target area and provide staring surveillance rather than periodic looks. The UAVs, however, are critically dependent on communications satellites (COMSATs). Currently, a single Predator orbit requires data rates of up to 6.4 million bits/second (Mbps); and the electro-optical, infrared and synthetic aperture radar feeds from a single Global Hawk can potentially consume as much as 274 Mbps. These bandwidth requirements have been met by military and commercial COMSATs in geostationary orbits. In addition, the UAVs themselves depend on GPS for precise geo-location of whatever their sensors are "seeing." Thus, the targeting and battle-management networks integral to current U.S. strike operations contain vulnerabilities to attacks ranging from jamming C2 links to the covert insertion of false data into U.S. networks. During the major combat phase of Operation Iraqi Freedom (OIF) in March-April 2003, the Combined Air Operations Center (CAOC) in Saudi Arabia used 31 military and 27 commercial COMSAT terminals with a capacity of nearly 210 Mbps.[11] Overall, the total information flow in and out of theater during OIF's major combat phase is estimated to have peaked around three billion bits per second while some 84 percent of all military communications in and out of the theater went through commercial COMSATs.[12] As for the dependence of precision strike operations on space, nearly 44 percent of the guided munitions expended in the OIF air campaign used inertial/GPS-aided guidance to home in on their aim points.

There is extensive evidence that the PLA understands these U.S. dependencies and is making every effort to find ways to be able to exploit them in any future conflict with the United States. The Chinese are investing in everything from jamming to counter-network attack (the offensive form of cyber warfare), anti-satellite (ASAT) systems, and directed-energy weapons. Retired Vice Admiral Mike McConnell argued in February 2010 that the United States is already engaged in a cyber-war with various competitors, adding that the United States was losing

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

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

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

this "war," particularly against China.[13] As for traditional "kinetic" approaches to undermining U.S. access to space, in January 2007 China demonstrated a direct-ascent ASAT capability by destroying one of its own aging LEO weather satellites with a kinetic-kill vehicle launched by a mobile missile at the Xichang space facility in Sichuan province.[14] Suffice it to say that even if the PLA would hesitate to disarm its own precision-strike capabilities by taking out both sides space systems in a future conflict, the Chinese will certainly do what they can to degrade and interfere with unimpeded U.S. access to space.

The Chinese Space Program and Comprehensive National Power

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

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

So far, I have focused almost exclusively on the military use of space. Since the 1980s, however, Chinese scholars have developed the concept of Comprehensive National Power (CNP) to quantify the relative power relationships between nations and even to predict the outcome of future local wars under high-tech conditions. While different versions of CNP can be found in Chinese writings, the gist is that CNP involves more than economic and military strength. Political power and influence, science and technology, natural resources as reflected in a country's population and territory, and social development (literacy, education levels, etc.) also contribute to CNP. The obvious point to be made is that the PRC's space program contributes to the country's CNP over and above its contributions to China's military power. China is among the three countries—the other two being the United States and Russia—that have put humans in space on their own. China's current efforts to explore the moon, as well as its longer-term aspirations to land humans there again (starting in 2030) and begin construction of a lunar base, contribute to the PRC's science and technology as well as the country's international prestige. While it is anyone's guess what impact the establishment of a Chinese lunar base might have on power relationships on Earth, the contributions of China's space program to the country's CNP is not limited to the military sphere. As General Ding Henggao has quoted Deng Xiaoping as saying, if China had not had nuclear weapons and launched satellites in the 1960s, "then China would not be called an important, influential country and would not enjoy the international status that it does today."[16]

Table 1 shows CNP estimates for the PRC and the United States from 1980 to 1998 by the Chinese scholars Hu Angang and Men Honghua from the Center for Chinese Studies at Tsinghua University in Beijing. The figure depicts the PRC as a rising power, but still, at the beginning of the twenty-first century, one substantially inferior to the United States. China's economy has, of course, continued to grow much faster than the United States' since the turn of the century. Hu and Men's 2004 paper also contains gross domestic product (GDP) projections that show China's economy being greater than that of the United States by 2020.[17] These projections are consistent with the International Monetary Fund's recent announcement that China's GDP will surpass America's in real terms in 2016. Nevertheless, just as CNP is composed of more than military power, it also reflects more than GDP. Consequently,

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

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

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

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

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

surpassing the United States in GDP does not mean surpassing the United States in Comprehensive National Power.

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

The most common scenarios for a conflict between the United States and the PRC are built around a Chinese attempt to take Taiwan by military force. The first point to be made about the likelihood of such an attempt is that China has been fairly successful in pursuing the economic entanglement of Taiwan. In 2003 I participated in discussions of net assessment with senior Taiwanese national security officials held in Taipei. What struck me during that trip was the growing migration of Taiwan's advanced technologies and businesses to mainland China, lured by such incentives as lower labor costs. Since then, the indications are that the gradual economic entanglement of Taiwan has continued, and that it is leading—in the long run—to Taiwan's eventual economic "capture" by the PRC. If this assessment is correct, then the chances of the PRC initiating a military takeover of Taiwan in 2012 or even 2020 appear to be quite low. Why use military force if economic entanglement leading to economic capture is succeeding? Note, too, that this approach embodies Sun Tzu's dictum that the acme of strategy is to subdue the enemy without fighting.

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

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

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[18] Jacqueline Newmyer, "Oil, Arms, and Influence: The Indirect Strategy Behind Chinese Military Modernization," *Orbis*, Spring 2009, p. 207.
[19] Newmyer, "Oil, Arms, and Influence," p. 207.
[20] Angang and Men, "The Rising of Modern China," p. 30.
[21] "Report of the Commission to Asses United States National Security Space Management and Organization," January 11, 2001, pp. 8-9.
[22] Forden, "How China Loses the Coming Space War (Pt. 3)," *Wired*, at http://blog.wired.com/defense/2008/01/inside-the-ch-2.html. Forden assumed that a DF-21 was used to launch the Chinese kinetic-kill vehicle in January 2007. He also speculated that the kill vehicle used an optical sensor to intercept and destroy the *Feng Yun* 1-C weather satellite.

My inclination is to think that Forden's assessment better reflects actual PRC ASAT capabilities between now and 2020 than did the 2001 space commission's warning of a looming Space Pearl Harbor. Ashley Tellis, whose assessment of China's military space strategy in the autumn 2007 issue of *Survival* sparked a strident debate over China's counterspace capabilities and strategic goals in early 2008,[23] mentions several other options—directed-energy weapons, electronic attacks including jamming, and terrestrial attacks against the ground segments of U.S. space systems—that provide alternatives to direct-ascent, kinetic attacks against U.S. satellites. To these alternatives I would add cyber attacks aimed at disrupting U.S. computer networks. There are other ways, then, to try to turn U.S. dependence on space into vulnerabilities in addition to kinetic attacks on satellites, and some ways are certainly easier than others.

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

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

PANEL III: Discussion, Questions and Answers

HEARING CO-CHAIR BLUMENTHAL: Thank you all very much for an interesting testimony.

I understand the increasing difficulties of assessing where we are versus where China is both in counterspace as well as in the use of space for its enhancement purposes.

I am looking at what I think is a seminal article by Barry Posen on

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

Command of the Commons, and when he discussed space, he argues that we are, in effect, still in command of space as a common. And he points out that in 2003, in the conflict you mentioned in Iraq, by his assessment, we had more than 50 satellites in use to support our land, sea and air operations in every aspect of the campaign.

He also goes on to point out that actually building a new GPS system could, if China were to go all the way forward with this kind of targeting capability, cost up to $4.2 billion. While he points out other vulnerabilities, he basically says that if China is going forward with these kinds of force-enhancement capabilities, particularly things like precision-strike or the DF-21D, as you mentioned, that would hit an aircraft carrier, it could be a very difficult thing to do.

So I have a twofold question. One is, are we coming to a point where that kind of command that he's talking about, which is you can use 50 satellites for an operation--and no one has done the assessment yet of how many satellites or how much space was used for operations such as the capture of bin Laden or the operations ongoing in Afghanistan or other operations, but I'm sure it's pretty close to that kind of space capability--I'm wondering if those days are coming to an end, not just in the Pacific theater, but if China chose to use their counterspace capabilities, that we would be in a much more difficult situation in terms of force enhancement, those kinds of operations we want to do?

The second question is do you believe China is getting to a point where they can use space for the kinds of operations, at least close by to China, that we are used to doing now or using space to enhance our forces on the ground, sea and the air, and if so, how close are they to being able to conduct those kinds of operations?

MR. WATTS: Well, if you go back and look at a lot of the wargaming that's gone on, there has been a pattern in a lot of them where the China team says let's just pull down the house in a Samson-like way, whether it's a high altitude nuclear weapon up at 100 kilometers or you just go after enough, say, LEO satellites to create enough debris that everything begins to deteriorate there.

You raise the issue of them looking downstream in time and wanting to use intelligence information from space. If you look at the illustration on page 17 of the Project 2049 Institute's February report on China's ELINT, it reproduces a Chinese diagram showing the DF-21D receiving two trajectory corrections from a satellite sensor. One of the unknowns in this—one of the uncertainties—is whether the Chinese begin to use space systems increasingly for their own precision-strike forces.

You would think that would constrain how destructive they're going to be able to be in a broad sense in space. But, again, as I say, I think how that plays out beyond 2020—or maybe even in the next five to ten years—is very difficult to assess.

HEARING CO-CHAIR BLUMENTHAL: Mr. Stokes or Mr. MacDonald?

MR. MacDONALD: I would be concerned about that problem, but I think that it's going to take longer than we might think before they would become proficient at it. They clearly are going to have more technical capabilities.

HEARING CO-CHAIR BLUMENTHAL: Are you talking about using space to enhance their forces on the ground--

MR. MacDONALD: Yes. Using space to enhance their forces on the ground. I would--

HEARING CO-CHAIR BLUMENTHAL: --or at sea?

MR. MacDONALD: To better enable them to do what they would like to do. The analogy I would use is in the United States, they even observed it in productivity statistics, that the personal computer brought a huge bump in capabilities, but as somebody observed, and it was noticed in the statistics, that it took America about ten years just to figure out how to use the darned things efficiently, and I think China is going to have somewhat the same problem.

They're not going to have the capability one day and put it in full use the next. I think that there's going to be a learning curve that they're going to be on. I think it is safe to say, and it's very important, and I'm glad that the Defense Department has been addressing these problems--some of us have been calling it out for years--that as we transition into a more contested space environment, we're not going to have the easily available resources that we can just count on, assuming the laws of physics still work, that they'll always be there.

And that's why I think that we're going to need to have more interconnectivity and backups so that our capabilities, if they degrade, will degrade in conflict, gracefully rather than catastrophically.

HEARING CO-CHAIR BLUMENTHAL: Mr. Stokes.

MR. STOKES: I'd offer a few thoughts, the first being that the idea of military competition, operational competition involving space assets, both in terms of active measures to interrupt another and adversary space assets as well as defending one's own, is not new. As a matter of fact, it goes back to the Cold War days with the United States against the former Soviet Union in terms of concerns over the integrity of our own space assets and similar sort of concerns on the Soviet side.

Second point is one area, in particular, that I think is particularly interesting, and that's in electronic countermeasures. It's an area that I don't think has gotten a lot of attention. The kinetic-kill aspects of counterspace tend to absorb a lot of attention, but the Chinese are, at least appear to be, sort of taking a page out of the former Soviet book and placing significant importance upon use of electronic countermeasures as a means of at least degrading a potential adversary's use of space, whether it's communication satellite jammers, or whether it's jamming synthetic

aperture radar satellites, or whether it's using, for example, laser systems to dazzle U.S. electro-optical systems or other assets.

So to me this is one important aspect, and the third point is in terms of the difficulties of assessing, it's just not knowing, for example, what our own capabilities are, for example, our own electronic countermeasure capabilities are in our satellite systems, and what are the Chinese doing along these regards, because what the Chinese are doing, I mean we could do as well on electronic countermeasures. And I don't have a good feel for how much we're investing in systems, and these tend to be black programs anyway.

HEARING CO-CHAIR BLUMENTHAL: Thank you.

Commissioner Wortzel.

COMMISSIONER WORTZEL: I have two questions, one for Mr. MacDonald and one for the whole panel. Mr. MacDonald, in your testimony, you discuss the conceptual problems of deterrence in space. Ambassador Schulte suggests a code of conduct, international partnerships, and resilience in self-defense. Chinese writings suggest demonstrating a satellite kill capability to deter other countries, which they've done.

What are your ideas on how deterrence in space might be achieved?

And then for the whole panel, are any of you aware of ground station components of a Chinese space tracking and situational awareness system, outside China? Mr. MacDonald.

MR. MacDONALD: Yes, thank you.

Very good question, and it goes to the issue that in both the previous administration and this administration, I think that there's been a sad shortage of real thoughtful exploration about how deterrence in space works.

I think that what Ambassador Schulte described is fine for peacetime, and I think it's good. And the more interconnected we can be with other countries, I mean I think really isn't it wonderful that Luxembourg, although hardly capable of launching satellites from its own country, is very much a space player because they fund a lot of things and they are involved, and that's the way they have skin in the game, as do a lot of other countries, and I think that's all to the good.

I would argue that that's necessary, but it's not sufficient, because we want to have something that is not only effective in peacetime, but particularly in wartime, and also in a crisis situation so that we can, the ideal thing, as long as we derive more benefit from, more military benefit from space than anybody else, it should be in our interest not to want to initiate space hostilities, but we need to also be able to deter the other guy, perhaps China, from being tempted to make that leap as well.

And, frankly, that needs a lot more work. I don't think that's well understood. I think that there are a number of ways that you can deter, and you don't have to remain just within the space boundary. If you think about

it, really, my argument is that space warfare would actually just be one dimension of information warfare because what's valuable in space--I mean, yes, there are a few space tourists who go up there and have fun in their short ride, and NASA has shown us some magnificent, wonderful, beautiful pictures, but space really delivers value for the information that is either generated up there or as the medium through which it passes to affect things on earth.

I'm glad that Mark mentioned that there's electronic warfare approaches, but we want to think very hard and careful, and I think we need to lay out red lines to China about what would provoke a very significant U.S. response.

But, again, these are only off-the-cuff thoughts, and this needs a whole lot more work. Unlike in the nuclear era where the Air Force and the Defense Department funded a lot of work on thinking through how these things work, it's been very disappointing that they haven't done this on space, and I think that's one of my most important conclusions, right there.

COMMISSIONER WORTZEL: The second part.

MR. MacDONALD: I'll let my colleagues speak.

MR. STOKES: I'll give it a shot. Commissioner Wortzel, the short answer is yes, they do have elements of their satellite launch tracking and control system deployed in a number of countries.

Let me get to the specifics. There have become so many that I've lost track of them. There used to be a small handful, maybe two or three. It has grown to a much more significant number today.

COMMISSIONER WORTZEL: In the Western Hemisphere, in Latin America?

MR. STOKES: My impression, all over the world. To start off, the trend began in the South Pacific, primarily related to the direction of the launch of their satellites, the supports and the satellite launch systems, part of China Launch and Tracking Control General, CLTC, G80 CLTC. The fixed sites that they have positioned in other countries are augmented by a small handful of ship systems as well, the Yuanwang tracking systems.

The key question here, though, and what I need to do is put together also in a little bit more detail on what exactly are, what types of technologies are at these ground sites. My impression, the ground sites, at least at this point, are primarily related to, for example, tracking and controlling cooperative--targets is a bad word--but cooperative systems, for example, in terms of making their own, ensuring the positions, integrity of their own satellite systems.

And it will become increasingly important, of course, with the Beidou, increasing numbers of the Beidou system.

But distinguishing between systems that would support their space launch tracking and control, and actual systems that would support engagement, for example, downlink of military relevant intelligence data,

for example, for near real-time tracking of events around the world, we'd need to take a closer look at exactly what they have at these sites, but I can offer I can look at that, specifics, and provide that.

HEARING CO-CHAIR BLUMENTHAL: Thank you.

Commissioner Wessel.

HEARING CO-CHAIR WESSEL: Thank you, gentlemen. Thank you, Mr. Stokes, for coming back, and thank you, gentlemen, for appearing here today.

In the earlier panel with Ambassador Schulte, he schooled us on the three "C's," congested, contested and competitive, as he talked about space. As a novice in the defense area, what I hear from those three terms is threat.

Mr. Watts, you referred to a recent wargame, I believe, where you said cyber security was off the table because it was too complex. Over the years, we've become increasingly aware of informationalized warfare, and the importance of ground and space-based assets was mentioned about bin Laden before.

Can you assess the threat for me? The discussion of whether it's a current threat, whether it's a threat in three years, understanding at some point China may have enough skin in the game that might be enough to deter them, but where are we now? We are so reliant on informationalized warfare, if China were to see some reason to address U.S. assets, how great is that threat?

Mr. Watts, do you want to start?

MR. WATTS: Well, again, there's a lot of detailed data that one would have to gather to really give a firm answer to that. My overall sense is that we are, on the one hand, the most vulnerable to having our space assets and our access to space denied, complicated, eroded, but we are also the most capable.

The point was made earlier about how many satellites we typically have in orbit. If the Chinese begin attacking U.S. low-altitude reconnaissance satellites with direct ascent, kinetic-kill ASATs, the eight or nine of those satellites plus some of the others they might want to eliminate generate quite a difficult operational task. It's probably well beyond what they could put together and bring off at the present time.

And to go back to the issue of how far up the learning curve they may or may not be, that's the other real variable in this. Because just being able to go out and start bringing down satellites first bat out of the box, there is very little historical evidence that most militaries can do that successfully.

Much of American military experience in the opening stages of conflicts prior to 9/11 has really been on-the-job-training—trying to figure out how to operate effectively and get our act together.

So I think a serious Chinese threat to the U.S. military's dependence on space is probably beyond this decade. That would be my short answer.

HEARING CO-CHAIR WESSEL: Okay. Mr. MacDonald.

MR. MacDONALD: I would say that, as I mentioned in my testimony, it all depends on what China chooses to do. I think if they were to start up a major deployment even of their current generation system, and particularly if they did a few more tests, it is not impossible to conceive that there would be a very serious threat to U.S. satellites.

I'd be surprised if China did that, but they could, and, of course, we wouldn't just sit there idly by. We would be taking countermeasures as well, but once again, I think it emphasizes the importance of not putting all our satellite eggs in one basket here, but China clearly has resources to do something like that, and there's additional information that's available on a classified basis, but, of course, we can't speak to that here.

HEARING CO-CHAIR WESSEL: Mr. Stokes.

MR. STOKES: Bearing in mind that, of course, the threat consists of two components, capabilities and intentions, I'll focus mostly on the capabilities side. Beyond, in terms of intentions, beyond Taiwan, I think it's hard to gauge at least some of their longer-term intentions, and, of course, the Senkakus and Japan and other territorial disputes they have.

But in terms of capabilities, my impression is that China is making significant advances that could pose challenges for the United States' ability to enforce both alliance treaty obligations as well as obligations on the Taiwan Relations Act.

There are significant challenges. Are these challenges surmountable? Yes, I think they are given sufficient investment on the United States side to make sure, for example, that our satellite communications remain able to operate in a jamming environment, for example, to ensure that if the Chinese start plinking our own satellites, that we have a rapid replenishment capability, for example, launch on demand, be able to get, as well as, assuming we're investing in, for example, reduced cross-sections of satellite systems that would make them much harder, more difficult to track.

So assuming that we're making the right investments in space, there's reason for confidence that we would be able to fulfill our obligations, but it's something to be watched very, very closely as well as watching the Chinese emerging capabilities as well.

HEARING CO-CHAIR WESSEL: Thank you.

HEARING CO-CHAIR BLUMENTHAL: Commissioner Fiedler.

COMMISSIONER FIEDLER: Ambassador Schulte mentioned at least a dozen times in his testimony this morning a fear of miscalculation on the part of the Chinese to take out--I'm paraphrasing--to take out one of our even minor satellites as a miscalculation. So I take from that that we believe that that is--and Larry mentions that--their deterrence is singularly taking out part of it.

Mr. Watts, I'll disagree with you only to the extent that I believe that their intentions on Taiwan could change on a dime. And I believe further

that his unexpressed concern for bringing that out and repeating it so many times, a man of few words and precise words, is because of a fear that in any Taiwan confrontation that one of their first moves would be, as part of their anti-access denial strategy, to take out some of our satellite capabilities so we can't see quickly and make decisions to react.

Am I right about that? Am I reading too much into this, that that's what the concern of the United States government is? Because he didn't actually say it the way I just said it. He just kept bringing it up, and I'm putting it into context. Am I wrong? Am I off base here? Is it an immediate concern of ours, a front of the mind concern of ours?

MR. WATTS: My personal view is it probably shouldn't be. It's entirely possible that there are places in the government where it is. That's sort of my bottom line assessment on where they are right now.

COMMISSIONER FIEDLER: Well, I can't think of any other situations where we're worried about them taking out any of our satellites any time soon other than in Taiwan. I don't think they will for, say--oil--in the South China Sea.

MR. WATTS: It might well be more useful to them if they had the capability to take Kadena off the table, for example, by exploiting growing anti-access/area-denial capabilities and really had the sensors, whether it's over-the-horizon radars or satellites to actually make the DF-21D work as you see in the diagrams in their published writings.

There was some RAND work a while back that assumed the U.S. forces had to operate from Guam. The scenario based the entire force of F-22s on Guam, and the assessment in the analysis was that the F-22s continued shooting down PLA fighters over Taiwan until they ran out of missiles. But then they needed to find their tankers and get back to Guam, and the thing that happened next was there were a lot of PLA fighters still lurking around that were able to go after the tankers and the AWACs. So you ended up with F-22 pilots with a whole bunch of kills that they could paint on their airplanes jumping out over the Philippine Sea because they couldn’t find tankers to get the fuel to make it back to Guam.

That's a very detailed, specific scenario in which, without even touching our space assets, they presented us with real problems in an anti-access/area-denial context in the Western Pacific.

COMMISSIONER FIEDLER: Either of--

MR. MacDONALD: You touch on, in a way, Commissioner Wortzel's excellent question about deterrence and how it might work. It's significant that the fact that we don't have a good feel for how that might work speaks to the fact that, like I said, I think we need more not so much war games but crisis games and maybe early stage war games. What's the dynamic here? We don't have a good feel for it.

I thought the Bush administration space policy did an excellent job in identifying for the first time our space assets are a vital national interest,

and I was very happy to see the Obama administration continue that view. I was worried that maybe they wouldn't.

But that has implications. When you declare something a vital national interest, that means, in extremis, you'd even consider retaliating with nuclear weapons. I mean vital is vital. It's not a designation you hand out like party favors to certain issues, and I think we need to make sure that the rest of the world understands that we consider that a vital national interest so that when you decide to breach that threshold, that space threshold, you are taking a step not to which we would necessarily respond with nuclear weapons, of course, but that you're crossing a major threshold and you can count on potentially a very significant U.S. response.

And that, which was also my biggest concern with the earlier policy, was that I would hate for it be like in the early days of the Cold War where some field commanders considered nuclear weapons just as one more weapon in the arsenal with a little bit bigger boom.

Not only China needs to understand, but we need to understand that crossing that space threshold has huge implications. I also suspect, but I don't want to go on too long, that once that threshold is breached, it strikes me that even more so than nuclear weapons, there's not a lot of virtue for holding back, and that it could escalate very quickly from there.

If you decide to take out two or three satellites, it's like I say, if you decide you want to kill the king, don't miss, and if you do miss, keep on firing. So I'm worried about those whole dimensions. What are escalation dynamics in space? I don't think that's well understood either.

COMMISSIONER FIEDLER: Mr. Stokes.

MR. STOKES: First of all, on the Taiwan issue, I would hope that the Department of Defense is concerned about emerging PRC capabilities, to be able to enforce what they perceive to be their territorial interests/sovereignty interests on Taiwan, because it actually is the law. Taiwan Relations Act actually requires the United States to maintain capacity to resist use of force to resolve political differences with regards to Taiwan. So I would hope that people are giving this issue some very serious thinking.

But a broader perspective, though--I'm not sure if this is relevant or not--but when you think about this concept that at least the Chinese Air Force comes up with, which is the integration of air and space, or aerospace, what they call air and space integration, it may have certain political implications because when you look at the sovereignty issues, for example, you have air sovereignty, and then what the Chinese believe to be the right to be able to maintain sovereignty of their own aerospace, how do they define aerospace that emerges, the goal that extends up into space?

My understanding is that international law does have certain definitions of space and access to space. However, is this definition shared by the People's Republic of China, the policy leaders? And so, therefore,

that's another element that you could potentially see sort of aircraft that could be violating what they perceive to be their aerospace, space sovereignty and satellite sort of in the same manifest, and reserve the right to able to engage either passively or actively, particularly in a crisis situation.

HEARING CO-CHAIR BLUMENTHAL: Thank you.

Commissioner Shea.

COMMISSIONER SHEA: Thank you all for your testimony. Maybe I know enough just to be a little bit dangerous, but I thought I heard a disagreement about 15 minutes ago between Mr. Stokes and Mr. Watts, and help me understand.

Mr. Watts, in your testimony, you say that China's own growing use of space may constrain their counterspace options in the long run to a greater extent than some of our wargaming has suggested, and then you go on and say how multiple kinetic-kills on U.S. reconnaissance satellites or detonating a nuclear weapon above the mesosphere are essentially Samson options, and you basically understate the ability of--you say: "my inclination is to suggest that evolving Chinese efforts to exploit U.S. 'informational' vulnerabilities in space would be unlikely to produce a decisive advantage over the U.S."

You say that by engaging in counterspace operations, China is likely to hurt itself, because they would destroy their own assets. That's what I take from your testimony.

But then you, Mr. Stokes, say, well, there are counterspace operations that don't destroy the neighborhood, for example, electric jamming and lasering. Is there a disagreement here? Are the U.S. and China looking at ways to disable the other country's satellites in ways that don't destroy the neighborhood?

MR. WATTS: Mark Stokes is exactly right. There are a lot of other ways of skinning the cat, so to speak here, in terms of degrading our space capabilities than those kinds of Samson options, and I would think that those would be more natural paths for them to go down in the event of an actual conflict than tearing down the entire neighborhood.

That's particularly likely to be the case over time if they become more dependent on ocean reconnaissance satellites and radar, SAR, and electro-optical satellites themselves for their own operations. So I don't really sense a contradiction between the two of us.

When you point to jamming and that sort of thing, my understanding is the Chinese have really emphasized that area significantly. Now some may disagree, but the destructive ASAT test in January 2007 was sort of a nice announcement of a growing capability to worry the United States, the world hegemon. But making us worry is one thing. Whether the PLA would actually go down that destructive path at the outset in 2020 or 2025 is another.

Mark?

MR. STOKES: I think one way to look at it would be sort of step

through a scenario, say, for example, a Taiwan scenario, and start with the basic question of if all bets were off and space assets were fair game, who would emerge--would China be seriously affected by the loss of their space, of assets that are in orbit? And would the United States be at a loss by the assets in space orbit directly supporting a Taiwan contingency in the Western Pacific?

I think the short answer is I think China is, because of the fact that a conflict would be primarily off, in the near seas or off their shore, that they are better prepared to be able to conduct military operations in the absence of space assets.

And there is one trend, and one of the reasons why I put it in my statement, is I find it particularly interesting and relevant to this question, and that's that what appears to be significant interest in the application of what are called near-space assets.

Space can be roughly divided, for example, there's not a clear line, but I believe in international space organizations, the dividing line between sort of the--space begins about 100 kilometer, about 100 kilometers in altitude.

The area between 20 to 100 kilometers is usually an area that you want to get through fast to be able to maintain your communications and to resist heating, for example, in the area of ballistic missiles or in a manned space program. But with China, they appear to be investing significant resources into utilizing this aspect. For example, an SR-71 flies about 70,000 feet, maybe roughly--what--18 kilometers, something like that, but what they're looking at is about 30 kilometers, in an area generally above some of our conventional air defense assets.

But below that, for example, that level in which one could use, for example, mid-course interceptors, slow moving vehicles that use different types of propulsion systems that aren't air-breathing, normal engines, but don't have enough velocity to be able to get into an orbital trajectory. Very slow moving, sometimes difficult to detect and difficult to engage. They can be launched in a contingency, and they are as good, if not better, than, for example, imaging systems in low earth orbit.

They have two dedicated research institutes, design bureaus, that have been established in the last five years dedicated to nothing but exploitation of this particular domain.

HEARING CO-CHAIR BLUMENTHAL: Are you talking about airships and--

MR. STOKES: Airships.

HEARING CO-CHAIR BLUMENTHAL: Yes. And aerostats.

MR. STOKES: That's one type of that. Airships are one type, and then, of course, hypersonic vehicles that can also sort of fly within that domain, but airships, yes, that certainly is one thing that is touted as a major option, and resources appear to be invested into flight vehicles that can operate in this domain.

HEARING CO-CHAIR BLUMENTHAL: Thank you.

Commissioner Mulloy.

COMMISSIONER MULLOY: Thank you, Mr. Chairman.

Bruce, good to see you again.

MR. MacDONALD: Likewise.

COMMISSIONER MULLOY: You said earlier something like our space capabilities are a vital national security interest. Now, in this document that our witness from DoD referred to--it's called National Security Space Strategy—and on page seven of that, they discuss the space industrial base, and it seems to me that there are concerns about our space industrial base and whether it can maintain the capabilities and the lead that we presently have.

I'm wondering is that view widespread in the space community that something bad is happening to our space industrial base, and that we need to take some actions to deal with, and if so, what are those kinds of actions? I would ask you and then I would ask the other two to comment.

MR. MacDONALD: Thank you, Commissioner.

I miss working in government a lot, but one of the pleasures of not working in government is a person has a little more leeway to speak one's mind. In fact, early in the Obama administration, when they hadn't got their space act together, and there was an important conference in Geneva, they actually pleaded with me to go to it because they knew I could speak my mind and they couldn't.

I share your concern about the space industrial base. I think there is a pretty widespread recognition in the community that this is a problem. And specifically I would cite that this is mentioned in the Strategic Posture Review Commission Report. All 12 commissioners, six Republicans and six Democrats, not an ounce of disagreement among the commissioners that this was important, and that, of course, they were worried back then, but now with the cancellation of the Constellation Program within NASA, it means it's a classic situation any businessman would recognize. When your business suddenly goes down, you've got to spread your overhead more heavily on the remaining business you have.

And this really is a problem. A vexing dimension of it, of course, is that a lot of the approaches to it are not cheap, and, as everybody recognizes, we're in a bad budgetary situation. This isn't real good, of course. We have unparalleled capabilities, and I'm thinking particularly in space propulsion, which is I think one of the areas of most critical concern. We fortunately still produce a small number of Trident II missiles which maintains that base.

But the short answer is, yes, there is widespread recognition. It is a serious problem, and unfortunately nobody has come up with any inexpensive answers to it unless somehow our space business gets booming big, and then the commercial sector can carry it.

I'll leave it at that. There's an interesting analogy with electronics,

but I'll resist the temptation for the time being.

COMMISSIONER MULLOY: Mr. Stokes or Mr. Watts, do you have any additional comments?

MR. WATTS: If you talk to people who are in commercial space in this country or even in places like Canada, the ITAR [International Traffic in Arms Regulations] barriers that have been administrated by the State Department, everybody seems to agree, have really hurt our ability to continue to compete with foreign suppliers, the French and so on and so forth, and that doesn't encourage you to stay up in the forefront of developing space systems. If you're a French satellite company trying to build a satellite, going through the hoops and red tape to get even components from U.S. sources is very, very difficult and the components are often late. It's just a pain in the neck. So foreign companies have been increasingly inclined to go and develop their own components and satellite systems. That's where overseas space industries have been going for a long time.

MR. STOKES: I don't have a good enough feel for in terms of U.S. domestic demand for space assets, for example, satellites, whether military, civilian, or launch services in terms of U.S.-based launch services.

But I would imagine that if there is insufficient demand within the United States, and companies are naturally going to look for overseas markets, and that gets into issues of, for example, of licensing, for example, the sale of satellites or the granting permission, for example, for foreign, for example, Chinese launch service providers to be able to boost U.S. manufactured satellites on their launch vehicles.

But just as a general thought, that obviously would be relevant in terms of U.S. aerospace industrial base.

COMMISSIONER MULLOY: Thank you very much.

HEARING CO-CHAIR BLUMENTHAL: Commissioner Cleveland.

COMMISSIONER CLEVELAND: I think it was Dr. Wortzel who asked about the presence of tracking. Did you ask about tracking?

COMMISSIONER WORTZEL: Yes.

COMMISSIONER CLEVELAND: I'm reading a CNA document that says the manned program is the basis for establishing telemetry sites in Kiribati and Namibia and Kenya. Mr. Stokes, what's in it for these countries to allow China to establish these bases on their territory?

I'm particularly interested in the Namibia one. How does it come about?

MR. STOKES: In terms of the specifics of how these agreements came about, I'm not exactly sure, but certainly revenue for the host would be a major factor. Kiribati, I believe, of course, political recognition, of course, and the competition between China and Taiwan, of course, as well, and I think Kiribati is one of the countries that went back and forth quite a few times, but revenue certainly is one consideration, and there could also be political motivations as well.

MR. MacDONALD: I would only add one additional thought or dimension to it, Madam Commissioner, and that is that there is a desire on the part of smaller countries to be involved somehow in the game, and China is willing to subsidize, offer below market rates if need be, and say like, oh, we'll build a receiving station for you, buy our satellite, buy one/get one free sort of a thing, and to offer more favorable--to offer more favorable terms which, of course, serves China's interests, not the least of which is they might say, and oh, by the way, you wouldn't mind if we occasionally download some information from our satellites as well.

So there's a dimension there that China is willing to go out and be, I think, fairly aggressive to generate this kind of business for them, and I think the countries are only too willing to do it when they see it as being in their interest.

COMMISSIONER CLEVELAND: I have two more questions, please. We've talked a lot about the dynamic between the United States and China, but you all have not talked much about India. How does India factor into Chinese space ambitions?

MR. MacDONALD: I've looked a little bit at that if I can say. One thing that scared the death out of, scared India to death was China's ASAT test, and India has been not exactly shy about saying we're going to develop an ASAT, too, and it's very clear that it's a reaction to China's growing space power.

India is trying to boost their aerospace sector. They're developing longer-range missiles. They feel threatened by China, and they know that they want to produce, put up satellites for their own military purposes, as well as commercial, and they are worried by the threat. Of course, India and China have had problems over decades, and I wouldn't quite call them enemies, but there's clearly a lot of hostility.

An additional dimension that I think hasn't gotten enough attention at all is India is also interested in developing missile defenses to defend against Chinese threats, and because India is developing their own missiles, it would not surprise me in the least to see China at some point develop their own missile defenses to guard against an Indian threat.

In fact, they did it early last year. They conducted a test, which some people think also was, it helped their ASAT program as well as showing missile defense. But I did a review of the literature about China and missile defense, and there are a zillion studies about how China might react to U.S. missile defense. I have not found one study that looks about what the implications are for India, especially for the United States, if China decides to deploy missile defense, and I was stunned by this.

It's almost a plug. I'm going to be submitting a proposal about this, but I was just stunned that there was nothing at all, and I looked with Googling, and I talked to people, and there's been no study of what happens if China decides to deploy their own missile defense, which frankly they

would have every reason to want to deploy to guard against a threat from India. What would be the implications of such a deployment for the U.S.?

COMMISSIONER CLEVELAND: Mr. Stokes, do you have anything?

MR. STOKES: Just one quick comment. I think certainly what China develops for use in space as well as their counterspace capabilities is certainly relevant to the regional security situation around its borders, both politically and militarily, if not economically.

To cite one example, when China conducted its anti-satellite intercept test in January of 2007, I was in Taiwan, and somewhat familiar with Taiwan's programs in space, and when I first heard about this, my first reaction was, oh, finally did it. They'd been working on this for quite awhile.

But at the time, in Taiwan, it was a critical period for debates within their legislature on procurement of a follow-on remote sensing satellite, at the time, for ROCSAT or FORMOSAT-2. It was a major issue, and they were just at a critical period in the debates in the legislature when that ASAT test hit. And the first thought that came to my mind was--and then they killed it.

You don't see that being discussed anymore. They just killed that. Maybe it's still on life support, but that, the ASAT test had, I would say, had a major influence or major impact within the legislative debate in Taiwan of procuring a satellite that would have had a major military application and something, to me, very much that Taiwan, a much needed requirement.

But that's just one example of what China does. It's just not relevant to the United States, but certainly with others in the region.

One final comment is that despite appearances on the surface, I somehow have this feeling down deep below, there's some residual mistrust between China and Russia, and so that's one other dynamic I think that's at a minimum worth considering in terms of motivations within China and Russia perhaps.

COMMISSIONER CLEVELAND: Thank you.

HEARING CO-CHAIR BLUMENTHAL: Thank you.

Commissioner Bartholomew.

COMMISSIONER BARTHOLOMEW: Thanks very much, and thank you, gentlemen. This is very interesting.

I'm going to ask you to step a little bit outside of the box that you've been talking, and there is a troubling pattern in the way the U.S. handles a lot of issues vis-a-vis China, where we somehow believe that all we need to do is talk, and we'll be able to come to some common understanding, and everything will be okay. Meanwhile, the Chinese government is continuing whatever the practice is. The talks don't necessarily come to any conclusion that will be helpful, and by the time we look up, it's too late.

It was interesting that Ambassador Schulte talked about the need to try to come to some common understanding of responsible behaviors in

space, and at the same time, just as we have by protecting the sea lanes around the world and creating a security umbrella where countries have been able to build their economy sometimes at the expense of the United States, it sounds like we're doing the same thing in space.

And I just wonder (a) are you concerned about this kind of pattern, particularly in the context that we're talking about; and (b) what could we do differently?

MR. STOKES: I'll take an initial stab at this. In terms of talking, I've been watching very closely the most recent S&ED, Security and Economic Dialogue, ongoing with China. It's amazing the amount of programs that--bilateral programs between the U.S. government and the government of the People's Republic of China. It's amazing. Talking is great. Nothing wrong with it.

We got Chen Bing-de, I think, coming over here next week, senior PLA military officer. Great.

However, what's not so great though--I mean it's great for bureaucracies and keeping people employed and for growing more work and stuff like that--however, it's not great whenever you invest resources. It's expensive actually to maintain all these dialogues. Whenever four-star generals fly over to Beijing, it is expensive. I used to manage the airplane. The gas, by itself, it is pretty expensive, every one of these visits that goes over.

And the other expense incurred by increasing the level of engagement is what about our allies? What do we have going on with Taiwan? Do we have anything on the scale going on with Taiwan, which actually we have, it's a de facto, I mean the Taiwan Relations Act. Do we have anything on the scale going on with Taiwan or Japan?

South Korea? Do we have anything on this scale? But again, talking with China, engagement is important, but I haven't really seen a lot of evidence of exactly what we're trying to do, and particularly in the defense dialogue, defense relationship, what's our goal besides understanding and making everybody feel good?

MR. WATTS: I'll get myself in trouble talking about this issue. If you will bear with me, I'll read you a passage from page 251 Christopher Ford's *Mind of Empire*, which you may have recently read:

"Chinese history provides essentially no precedent for the stable, long-term coexistence of coequal sovereigns, and the country's traditional ideas of moral governments and statecraft cannot comfortably even admit such a possibility. The modern world may be understandable through the prism of the Warring States period but is only intelligent as a way-station along the road to hierarchical order." In other words, to China eventually becoming the world hegemon.

Now if you read the caveats at the end of Ford's book he essentially says there is a major debate about China, whether they will be socialized

eventually to accept or embrace the Westphalian model of international relations among coequal sovereign states going forward indefinitely or not. His bottom line is that we really don't know the answer to that question yet, unfortunately. It would be nice if we did.

But it is fairly clear that the history and the traditional statecraft that they keep appealing to doesn't give you a warm feeling about where they're going in the long term. I just find our dialogue within this country completely--no, I shouldn't say that--

[Laughter.]

HEARING CO-CHAIR BLUMENTHAL: You can curse in here if you want.

[Laughter.]

MR. WATTS: --just not very helpful. We just don't seem to address these kinds of questions in a serious way.

HEARING CO-CHAIR BLUMENTHAL: Larry is going to.

Okay. Second round. Beyond Assessment, I'd like to move to some prescription because we do have to make recommendations to the Congress.

I was intrigued by Ambassador Schulte's mentioning of increasing coalition partnership and cooperation with countries like Japan and Australia and actually setting up a Joint Space Operation center at Vandenberg Air Force Base, something I didn't know about beforehand.

But I'd like to get from each one of you, if you had some sway over whether we should invest our funds both in terms of enhancing allied cooperation--and by that I mean force enhancement, ISR, targeting, and all the rest of the things our allies might want and need to protect themselves in Asia-Pacific, and here I mean Japan, Australia, India, and some of the other treaty allies also--who are the most promising partners in this regard?

And, second, what would you invest in terms of families of systems and capabilities for the actual protection of satellites as, Mr. Watts, you said China is inexorably moving to weaponizing space.

MR. WATTS: Well, so is our commercial space industry.

HEARING CO-CHAIR BLUMENTHAL: But in terms of where you would put our unilateral, diplomatic and other types of investments to build out partnership capacity on issues of space protection, spare awareness, ISR, and our own ability to conduct operations.

MR. STOKES: I'd add one thought. With a focus on security partners, security partners, yes, I guess roughly a metric would be, for example, security assistance partners or treaty allies or ones that we have legal commitment within our own legal system, in terms of defense obligations, I mean the things, without necessarily being in your face in terms of being directly military, there are all kinds of cooperative programs.

For example, formation of simply a common operational picture, working to a common operational picture that looks at, for example, maritime security, for example, common operational picture looking at maritime environment, looking at the space, the global commons, the space

environment, sharing information, again with partners like Japan.

Taiwan is in that definition. Taiwan has, in terms of a contribution, Taiwan has a great radar system that they paid significant sums of money for, about $100 million for one radar, that as far as I know has significant potential for space tracking, for looking, for example, at space debris, that can play a useful role in terms of our own systems.

And so I'll just throw this out. Undersea, for example, looking at, watching whales in terms of monitoring undersea environment, fishing patterns, but again with an emphasis on those with which we have security partner arrangements or obligations.

HEARING CO-CHAIR BLUMENTHAL: On the space side, particularly, do you have thoughts?

MR. WATTS: Well, historically, certainly the commercial space industry has been very reluctant to harden satellites or even equip them with small sensors, like the little video camera that's in your laptop that could be used so you'd have a better sense of what's actually going on around your satellite. That's something going forward that would be very simple which would really greatly enhance space situation awareness and understanding what really is or is not going on with our own satellites. That would be useful.

I don't know what to say about the hardening issue. I've been listening to discussions of this issue between industry and the government for about a decade-and-a-half. I mean I can remember one conference about a decade ago where the people from the Defense Department said "Why don't you guys harden your satellites and make them more resilient against this kind of attack and that kind of threat?" And the answer was that if the government would pay for hardening, —industry would happily comply. But otherwise it's simply a monetary and insurance issue for industry.

If a commercial satellite gets taken out due to a lack of hardening, then the insurance will pay for the company to put up another one, and they'll continue to make money. From a commercial standpoint, there is just no incentive for them to pay for hardening on their own unless they're operating in an area where they really think they need it.

HEARING CO-CHAIR BLUMENTHAL: I'm going to have to stick with the time because we have two questions left. So Commissioner Wortzel and Commissioner Reinsch with the last.

COMMISSIONER WORTZEL: Thank you very much.

Chinese strategists argue that because they would fight from internal lines of communication, in any conflict with the United States, because of extended external lines of communication, the U.S. would suffer more from degradation of space than they would.

So they have, they argue, other information or data exchange alternatives from internal lines of communication. What's your view of this assertion by China's military strategists? Anyone on the panel?

MR. MacDONALD: I'll take a shot at that. First of all, I think it's fundamentally a good point, and if the roles were reversed, we would probably be saying the same things as well.

A couple of caveats, though. First of all, that's true as long as they can maintain internal lines of communication. If they start wanting to fight farther and farther off their shore, their capabilities go down. Maybe in the long run, they'll be much more capable, but their capabilities, it seems to me, would drop off a lot, and they'd become a lot more vulnerable.

If you're talking about fighting on Chinese soil or very, very close, I think that's absolutely a valid point, and sort of related to Taiwan, that that's true.

That's why I think that, and the point has been made, and I think in the space strategy, about we need to have alternative means, using--there's an old phrase in arms control, but I think it's relevant here--"other physical principles." In other words, it wouldn't do us a lot of good to have a backup that was exactly the same as what the Chinese could easily shoot down.

And, indeed, there are some thoughts, for example, about high endurance drones that could be deployed, which the Chinese ASAT would be almost irrelevant to. But it's a valid concern. We are a world, a global power, and China is not, which means the closer you fight to China, the more they're going to have at least a local advantage in that respect.

I think it speaks, though, to American abilities that we can wage war so effectively, even at great distances, and I think we have to have alternative means to assure that connectivity.

MR. MacDONALD: I'll just add one point that I think you've heard before, which is as precision weapons of various sorts, conventional, become more widely available to everybody, traditional U.S. approaches to power projection that we've been using since World War II, possibilities that will just become increasingly difficult and costly for us to continue to do.

So both space, as well as the proliferation of precision weapons, in the long run, seem to raise challenges to our traditional approaches to overseas power projection, and it is a serious long-term strategic issue, assuming we want to stay in that business.

MR. STOKES: I think the references that you've made in terms of the Chinese believing that their ability to be able to, they are less reliant upon space assets than the U.S. would be simply because the sort of the area which you're talking about.

In terms of what to do about it, I'm not sure if it's really that much of a new problem because, again, going back to the Warsaw Pact-NATO example, there were certain things that the former Soviet Union and Warsaw Pact would be able to do to interrupt U.S. ability to be able to operate on the shores in terms of resupply.

But in the Asia-Pacific context, in terms of our obligations that we have, this seems to me in order to make sure that we're able to maintain

those obligations, a lot more innovative thinking has to go on, both innovation in terms of developing cost effective, low-cost but yet very effective means of being able to maintain our ability to maintain our security commitments.

HEARING CO-CHAIR BLUMENTHAL: Commissioner Reinsch.

CHAIRMAN REINSCH: Thank you.

I was intrigued by Commissioner Bartholomew's question, a little appalled too, but I was intrigued, and I think your comments about the frequent futility of the dialogue are well-taken. I think, Mr. Watts, his quote about their world view, is on target. It's a little more complicated than that, but on target.

However, I think she let you off the hook on the second half of her question, which is what's the alternative? Maybe you could comment on that.

MR. WATTS: Look, trying to engage them, and the long-term hope that they really will buy into Westphalian international order, it seems to me we should make every effort to try to make that future be the one that is realized in the end.

On the other hand, one of the things that my former OSD office and the Office of Net Assessment spent a lot of time doing during the Cold War, over at least a decade, was trying to really get some understanding of Soviet assessments: their calculations, how they viewed the world, their frameworks, their dominant scenarios. And I think in the case of China, we are far, far less capable of beginning to get insight into those things.

That's a worthy long-term research objective, an area to which we really ought to devote more time and energy if for no other reason because when we went back and tried to document, for example, Russian, well, Soviet perceptions of strategic nuclear forces versus what we thought they had been during the Cold War, there were a lot of very significant profound misunderstandings.

My guess is that the chances to misunderstand the Chinese and to be surprised by them badly is far greater than it was with the Russians during the Cold War.

HEARING CO-CHAIR BLUMENTHAL: Did you want to intervene?

COMMISSIONER BARTHOLOMEW: Just a question, I guess, which is, Mr. Watts, are we really less capable of the insight or are we somehow being blinded by our own paradigm of this is the way that we believe the world will unfold?

MR. WATTS: Well, I don't think it's fundamentally more difficult to get a sense of their strategic culture and where they're really going long-term, but the resources that are being devoted in this country are much less. I you think about the U.S. domestic Sovietology community and how many Russian speakers, linguists and students of Russia we had in the '70s and '80s, compared to the number of people working on China today who

actually can read Chinese, which I can't, it's much smaller—the effort and the number of people and so forth.

COMMISSIONER BARTHOLOMEW: And many of the most talented people, of course, are doing this because they see it as lucrative rather than focusing on the public service.

MR. WATTS: I don't think I'll comment on that one.

[Laughter.]

MR. MacDONALD: I'll comment just in general, but I think it's important for us to be doing what we're doing in terms of trying to talk to them because not that it's necessarily likely to succeed, but it also sends a very important message to other countries in the world, to say we're trying, but I would follow the wisdom of Teddy Roosevelt, to speak softly and carry a big stick.

I think if we totally rely on, oh, that dialogue is going to solve all our problems, I think that's a fool's mission, but I think that we do need to try and along the same lines of what my colleague has said, that when you look at all the money that we spend in various other ways, we are doing nothing like what we used to do with the Soviet Union in terms of analyzing them.

We're not doing that toward China, and I think that's a big mistake, not that we have to spend as much, but we need to spend a lot more in space intelligence toward China and analysis because I mean you can buy analysis a lot cheaper than you can buy stealth fighter planes.

HEARING CO-CHAIR BLUMENTHAL: Well, I think we need both, but that's just my opinion.

MR. WATTS: Yes, that's right.

HEARING CO-CHAIR BLUMENTHAL: Let's conclude. We want to thank you very much for terrific, terrific testimony and very enlightening and edifying for all of us. So thank you so much for your time.

MR. MacDONALD: You're welcome.

HEARING CO-CHAIR BLUMENTHAL: We'll break for lunch and come back at one o'clock.

[Whereupon, at 12:05 p.m., the hearing recessed, to reconvene at 1:02 p.m., this same day.]

AFTERNOON SESSION

PANEL IV: CHINA'S CIVIL SPACE PROGRAM

HEARING CO-CHAIR WESSEL: We'll get started on the afternoon. Most of our colleagues are here.

For our fourth panel today, we have three experts on China's civil space programs. First, we have Dr. Scott Pace, Director of the Space Policy

Institute and Professor of the Practice of International Affairs at the George Washington University. Dr. Pace previously served in high level capacities at NASA.

Dr. Clay Moltz is Associate Professor at the Naval Postgraduate School in Monterey, California. Dr. Moltz is the author of numerous publications on China's space programs including the forthcoming Asia's Space Race: National Motivations, Regional Rivalries and International Risks.

Finally, we have Alanna Krolikowski--Visiting Scholar at the George Washington University Space Policy Institute. As a doctoral student at the University of Toronto, she has traveled in China and conducted extensive research on Chinese space programs.

Thank you for joining us. As I understand it, this is everyone's first appearance here at the Commission. Our rules are quite simple. Roughly seven minutes or so for your opening comments, your written testimony will be submitted for the record, and then we'll have a round of questions.

Why don't we go down the list in the order of my introduction. Dr. Pace.

STATEMENT OF DR. SCOTT PACE
DIRECTOR, GEORGE WASHINGTON UNIVERSITY SPACE POLICY INSTITUTE, WASHINGTON, DC

DR. PACE: Thank you.

It's an honor to be here. In fact, I see some people who have written some of the readings that I assign my students. So this is good for me as well.

HEARING CO-CHAIR WESSEL: We get discounts now.

DR. PACE: Ah, wonderful thing. Thank you, Mr. Chairman, in providing this opportunity.

As you know, earlier presentations today have covered administration and congressional views along with perspectives on China's military space programs. Of course, we'll be focusing on civil issues today on this panel, and I have a written statement, which I believe has been submitted for the record.

The first point that should be made is that China does not really have, in my view, a fully separate civil space program in the model of NASA and U.S. civil space activities. It might be more accurate to say that China has civil space activities such as science and exploration and does not have a civil space program.

An important second point is that China sees its space activities as part of what it might call comprehensive national power. That is the development of space capabilities that contribute to China's overall economic, military, foreign policy, and even social and cultural objectives.

Space launch capabilities represent a dual-use capacity that can be

used for long-range ballistic missiles. Requirements for human space flight are used to improve the quality of Chinese industries. Offers of space technology to developing countries are used to secure access to needed raw materials for the Chinese economy, and Chinese astronauts are helpful in promoting the China brand in promotional videos and international conferences.

A third and final point is that China's current programs are not the result of a crash effort but have spanned almost the entire period of the modern Chinese state. It's not a question of whether China will have a full range of human space flight capabilities, but a question of when and what they intend to do with those capabilities.

The NASA Administrator visited China in October 2010, and recently, in 2011, a U.S.-China summit statement said that discussions of practical cooperation would continue on the basis of transparency, reciprocity, and mutual benefit.

The latter two principles are unremarkable and have been a consideration for all U.S. space cooperation internationally really since the beginning of NASA.

The principle of transparency is a different consideration and goes to one of the central concerns with all Chinese space activities, that is a lack of understanding as to how decisions are made, what strategic intentions drive them. Gaining a better understanding of China's decision-making processes and strategic intentions remains a central objective and problem for the United States in space as well as in other areas.

Now, unfortunately, again, in my view, there are no compelling political or technical reasons to engage in human space flight cooperation with China. The question of cooperation with NASA may be, of course, moot for the moment due to congressional language barring bilateral cooperation in the House 2011 C.R. bill, but even if this language were not in place, I would not recommend engaging with China on human space flight cooperation.

The technical and political challenges are too great as are the political risks of not meeting raised expectations on both sides. However, I do believe that scientific space cooperation with China could be mutually beneficial and reciprocal while improving our understanding of Chinese decision-making and intentions.

Space cooperation with China should start small with scientific projects that have minimal to no technology transfer concerns or potential for dual-use exploitation.

As an example, there could be research in plasma physics, in heliophysics, on the traditional basis of no exchange of funds and open sharing of scientific data. Another area that's a primary source of solar storm warnings is an aging NASA satellite, which is almost 15 years old. Solar storms and coronal mass ejections can cause damage to electrical

power grids and telecommunication networks worldwide, and while plans are in work to replace this satellite, it hasn't been done yet, and it would be very beneficial to have more robust sources of warning, and China could play, in my view, a constructive role in that regard.

China and the United States already participate in international voluntary standard bodies, such as the Consultative Committee on Space Data Standards that work on telecommunications and navigation.

The United States has been engaged in discussions with China for some years on its COMPASS satellite navigation system to ensure compatibility and interoperability.

Commercial competition and open markets are expected to foster sales of satellite navigation receivers that can use the civil or open signals from both systems, ours, as well as--GPS as well as China.

And joint ventures are another way to encourage and engage commercially with China and strengthen international use and acceptance of GPS while avoiding the transfer of sensitive space technologies.

Now, given the reliance of the United States on space systems, it's unsurprising that we seek to reduce and mitigate creation of orbital debris. The Chinese ASAT test was, of course, regrettable for many reasons, among the fact which that China had earlier participated rather constructively in technical discussions within the Scientific and Technical Subcommittee of the U.N. Committee on Peaceful Uses of Outer Space that had developed a consensus set of orbital debris mitigation guidelines.

Nonetheless, the United States continues to seek Chinese cooperation on reducing the creation of orbital debris and provides conjunction warnings, that is risks of collision to countries, including China, at risk from being struck by debris.

If China is successful in maintaining astronauts in orbit for extended periods of time, they may have increased incentives for cooperation with ISS, International Space Station, and becoming partners on reducing hazards to those astronauts.

Now, today, U.S. human space flight capabilities remain considerably ahead of China by all measures. Unfortunately, the United States has failed to develop an assured means of U.S. government human access to space. The International Space Station is reliant on Russian Soyuz and unproven commercial providers with a consequent risk that the space station would be at risk if there were a major accident on orbit.

And the United States has failed to engage its existing international partners in a program of exploration beyond low earth orbit.

All these factors increase the odds that the U.S. will not be a global leader in human space flight after the end of the International Space Station, sometime in the next ten years or so, about the time the Chinese space station should be on orbit and first being occupied.

So, in my view, the most important implication for the United States

from Chinese civil space capabilities is not that China will be in space, but that we may not be. The United States appears to have forgotten the strategic value of a national human space flight program regardless of the existence of successful private endeavors.

This may not have a near-term economic impact, given that we have a wide range of unmanned programs ongoing. However, the lack of a visible U.S. leadership in human space flight may have serious foreign policy and international security impacts. It is a long-standing truism that the rules of international relations in new domains are created by those who show up, not those who stay home.

Thank you for your attention, and I'm happy to answer any questions you may have.

[The written statement follows:]

PREPARED STATEMENT OF DR. SCOTT PACE
DIRECTOR, GEORGE WASHINGTON UNIVERSITY SPACE POLICY INSTITUTE, WASHINGTON, DC

Thank you, Mr. Chairman, for providing an opportunity to discuss this important topic.
Earlier presentations today have covered Administration and Congressional views along with perspectives on China's military space programs and their implications. I am honored to provide some thoughts on China's civil space program and what implications it might have for the United States.

China launched its first satellite in 1970 – the same year as the first satellite launch for Japan. It began offering commercial launch services in 1985, launched its first astronaut in 2003, and sent its first probe to the Moon in 2006. China conducted its first space walk in 2008 and is actively developing a space laboratory and an even more ambitious space station.

The first point that should be made is that China does not have a fully separate civil space program in the model of NASA and U.S. civil space activities. China's development of space capabilities began in the mid-1950s at the direction of the Central Military Commission, less than a decade after the founding of the People's Republic. The development of space launch vehicles were part of the same development of diverse aerospace capabilities such as rockets, guided missiles, and aviation. China's human space flight efforts are managed by the elements of the People's Liberation Army (PLA) and require industrial capabilities that are the same as those used for military programs. Thus it might be more accurate to say that China has civil space activities, such as science and exploration, but does not have a civil space program.

An important second point is that China sees its space activities as part of what it sees as "comprehensive national power." That is, the development of space capabilities contributes to China's overall economic, military, foreign policy, and even social and cultural objectives. Space launch capabilities represent a dual-use capacity that can be used for long-range ballistic missiles. Requirements for human space flight are used to improve the quality control of Chinese industries. Offers of space technology to developing countries are used to secure access to needed raw materials for the Chinese economy. Chinese astronauts are helpful to promoting the China "brand" in promotional videos and international conferences. Interestingly, China has also recognized the achievements of persons of Chinese descent, such as Taylor Wang – an American scientist who flew on the Space Shuttle in 1985. While an American citizen, Dr. Wang's achievement as the first person born in China to fly in space has been included in lists of Chinese achievements in space.

China's first steps toward a manned space program began in 1967 during the height of the U.S.-Soviet space race

with Project 714. This was an ambitious effort to place two astronauts in orbit by 1973. It was cancelled in 1972 due to economic constraints and the domestic turmoil of the Cultural Revolution. In 1986, a new manned space program was proposed by the Chinese Academy of Sciences that sought to create a manned spacecraft and associated space station. This effort became Project 921 that was formally authorized and funded in 1992. Today's Shenzhou spacecraft and the soon to be deployed Tiangong space station module were developed by Project 921.

The history of Chinese manned space activities leads to a third important point. China has engaged in a steady, long standing effort to build and strengthen its space capabilities. Current programs are not the results of "crash" efforts but have spanned almost the entire period of the modern Chinese state. Table 1 shows the dates of major space milestones for China, Russia, and the United States.

China has achieved progressively more ambitious space capabilities over a longer period of time and with fewer missions than those of the United States or the Soviet Union. They have proceeded cautiously but steadily without any sense of racing an adversary. While recognizing the experience gap with the partners on the International Space Station, there is a risk of underestimating how soon China will have comparable space capabilities to those same partners. It is not a question of whether China will have a full range of human space flight capabilities, but a question of when and what they intend to do with those capabilities.

One possible use for Chinese human space flight would be to advance Chinese foreign policy objectives. The Soviet Union and the United States both used flights of foreign astronauts as symbolic means of aiding allies and creating good will. China could do the same as well as using such flights to support economic growth by securing supplies of raw materials and access to markets. Chinese space cooperation agreements in Africa (e.g., Nigeria) and Latin America (e.g., Brazil, Venezuela) have reportedly included offers of technology, training, loan guarantees, and other inducements to trade.

As its space capabilities increase, China is becoming more active in international organizations such as the International Astronautical Federation and is hosting more space conferences. China leads an inter-governmental space cooperation organization, the Asia-Pacific Space Cooperation Organization (APSCO) that is similar in some respects to the European Space Agency. APSCO is based in Beijing with member space agencies from Bangladesh, Indonesia, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey. China is also a member of a less formal association of space agencies, the Asia-Pacific Regional Space Agency Forum, led by Japan. The forum includes space agencies, governmental bodies, and international organizations, as well as non-government organizations such as companies, universities, and research institutes. Japan is among the many Asian countries with its own space ambitions that are paying attention to China.

At recent international conferences, China has given clear indications of what its next steps are in human space flight as shown in Figure 1. It plans to place an unmanned module in space, demonstrate docking using another unmanned module and then send a crew to visit a modest space laboratory, Tiangong. In some respects, this would be similar to what the Soviet Union did in the Salyut space station program. Following the Tiangong would be a more ambitious space station akin to the Soviet and Russian Mir space station. It would consist of multiple modules with an overall mass of about 60 metric tons to which a single Shenzhou ship could dock along with an unmanned cargo resupply vehicle. Interestingly, on current schedules, this station would be deployed about the same time as the International Space Station may be preparing to close down.

China does not publicly have a formal program for sending humans to the Moon. However, the Chinese are making progress toward acquiring the capabilities necessary to conduct such missions. For example, the Chinese EVA suit derived from the Russian Orlan design has boots with heels – and other features for walking on a surface as well as floating outside a spacecraft. While I was at NASA, we did a notional analysis of how Chinese might be able to send a manned mission to the Moon. We concluded that they could use four Long March 5 vehicles, capable of lifting 25 metric tons each, to place a little under 15 metric tons on the lunar surface. This is about the same mass as the U.S. lunar modules that were launched by a single Saturn V. Figure 2 shows the notional concept developed in 2008. As said earlier, it is not a question of whether China will have a full range of manned space flight capabilities, but

what the nation intends to do with those capabilities.

Growing Chinese space capabilities have naturally created speculation about future international space cooperation. A recent issue of *Aviation Week and Space Technology* (April 22, 2011) covered the wide and diverse range of international aerospace cooperation with China, notably in commercial aircraft. Such cooperation includes a full range of U.S. and European suppliers as well as traditional rivals, Boeing and Airbus. The amount and depth of cooperation is even more striking when compared to the minimal level of cooperation in space, even including space and Earth science.

The two most recent U.S.-China summit meetings include brief joint statements on space (emphasis added):

"The United States and China look forward to expanding discussions on space science cooperation and starting a dialogue on human space flight and space exploration, based on the principles of transparency, reciprocity and mutual benefit. Both sides welcome reciprocal visits of the NASA Administrator and *the appropriate Chinese counterpart* in 2010." - Beijing, China – November 17, 2009

"The United States and China agreed to take specific actions to deepen dialogue and exchanges in the field of space. The United States invited a Chinese delegation to visit NASA headquarters and other appropriate NASA facilities in 2011 to reciprocate for the productive visit of the U.S. NASA Administrator to China in (October) 2010. The two sides agreed to continue discussions on opportunities for practical future cooperation in the space arena, based on *principles of transparency, reciprocity, and mutual benefit*." - Washington, DC – January 19, 2011

The 2009 statement was vague regarding who the Chinese counterpart to the NASA Administrator would be as that seems to be unclear even to the Chinese. The China National Space Administration (CNSA) had previously been used as the "civil" interlocutor for space cooperation and it was initially assumed this might hold true for discussions of human space flight. However, the technical capabilities and management of human space missions resides with the PLA and it has not be clear that the CNSA would "add value" to discussions. For the United States, however, it would also seem odd to have a former Marine Corps General (Administrator Bolden) meeting with senior PLA officers if the future for U.S.-China military-to-military dialogue continues to be as uncertain as it has been.[24]

Nonetheless, the NASA Administrator did visit China in October 2010 and the 2011 summit statement said that discussions of practical cooperation would continue on the basis of transparency, reciprocity and mutual benefit. The latter two principles are unremarkable and have been a consideration for all U.S. space cooperation since the beginning of NASA. The principle of transparency is a different consideration and goes to one of the central concerns with all Chinese space activities – a lack of understanding on how decisions are made and what strategic intentions drive them. In large part, such opacity is intentional on the part of Chinese officials. In various discussions, they have expressed their discomfort with even the term "transparency" and preferring other formulations such as "clarity of outcomes" – thus shielding their internal decision-making processes.

Gaining a better understanding of China's decision-making process and strategic intentions remains a central objective and problem for the United States. This applies to civil space cooperation as well as other areas of the relationship. To oversimplify, in the case of the Soviet Union, we knew their intentions as well as their capabilities. China is not the Soviet Union, thankfully, but we may know more about their capabilities than their intentions. It is also possible they may not know themselves, but it is hard to tell even that.

In the aftermath of the Cold War, the demise of the Soviet Union and the emergence of Russia, there was a compelling case for human space flight cooperation with Russia. The Russians had extensive experience with long-duration manned space station just as the United States was building its Space Station with multiple foreign

[24] For the moment, the dialogue is moving forward as the PLA Chief of Staff Chen Bingde will visit the United States this month.

partners. There was a desire to symbolize a new "post-Soviet" relationship with the United States. Finally, there was a desire to engage the Russian space community internationally in a constructive project as opposed to engaging in missile proliferation and other destabilizing activities.

Unfortunately, there are no compelling political or technical reasons to engage in human space flight cooperation with China. The Chinese have space capabilities but nothing unique that the United States needs.[25] As the Chinese themselves said the NASA Administrator Bolden during his 2010 visit (to paraphrase): "we don't need you and you don't need us but we could do good things together."

The question of cooperation with NASA may be moot for the moment due to Congressional language barring bilateral cooperation with China in the House 2011 continuing resolutions appropriations bill:

> SEC. 1340. (a) None of the funds made available by this division may be used for the National Aeronautics and Space Administration or the Office of Science and Technology Policy to develop, design, plan, promulgate, implement, or execute a bilateral policy, program, order, or contract of any kind to participate, collaborate, or coordinate bilaterally in any way with China or any Chinese-owned company unless such activities are specifically authorized by a law enacted after the date of enactment of this division.

Even if this language were not in place, I would not recommend engaging with China on human space flight cooperation. The technical and political challenges are just too great – as are the political risks of not meeting raised expectations. However, I do believe that scientific space cooperation with China could be mutually beneficial and reciprocal while improving our understanding of Chinese decision-making and intentions.

Space cooperation with China could start small with scientific projects that have minimal to no technology transfer concerns or potential for dual-use exploitation. As an example, European and Chinese cooperation in space plasma physics has been successful. Two Chinese "Double Star" spacecraft carrying European and Chinese experiments joined four ESA spacecraft in high orbits around the Earth. The combination of six spacecraft had produced new insights into the magnetosphere and the solar wind. A similar U.S. project might extend work in plasma physics and heliophysics on traditional basis of no exchange of funds and open sharing of the scientific data produced. For example, a primary source of solar storm warnings is an aging NASA satellite, the Advanced Composition Explorer (ACE), which is almost 15 years old. Solar storms and coronal mass ejections can cause damage to electrical power grids and telecommunication networks. While plans are in work to replace ACE, it would be beneficial to have more robust sources of warnings.

Cooperation need not involve creating new spacecraft but could involve ensuring compatibility and interoperability with existing spacecraft. China and the United States already participate in international voluntary standards bodies such as the Consultative Committee on Space Data Standards (CCSDS) that develops open standards that enable cross-support for telecommunications and space navigation. The United States has been engaged in discussions with China for some years on its COMPASS satellite navigation system to ensure compatibility and interoperability. While GPS and COMPASS are both dual-use systems, commercial competition and open markets are expected to foster sales for satellite navigation receivers that can use the civil or open signals from both systems. Joint ventures are another way to engage commercially with China and strengthen international use and acceptance of GPS while avoiding transfer of sensitive space technologies.[26]

Given the reliance of United States on space systems, it is unsurprising that it seeks to reduce and mitigate the

[25] There is an argument that sole reliance on Russian Soyuz vehicles for access to the International Space Station (ISS) after the last Shuttle mission is risky. Should potential U.S. commercial suppliers have delays and are unavailable and the Soyuz is also unavailable, then it might be desirable to employ Shenzhou to reach the ISS as a back up capability.

[26] On the topic of U.S. export controls, the sentiment in the Congress is clear. There will be no change to the current treatment of space technologies (U.S. Munitions List Category XV) with respect to China even if broader legislative reforms are passed.

creation of orbital debris. The 2007 Chinese ASAT test of course added greatly to the orbital debris population. This was a regrettable action for many reasons, among which was that fact that China had earlier participated constructively in technical discussions within the Science and Technology Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) that developed a consensus set of orbital debris mitigation guidelines. Nonetheless, the United States continues to seek Chinese cooperation on reducing the creation of orbital debris and routinely provides "conjunction warnings" to countries – including China – at risk from being struck by debris. If China is successful in maintaining astronauts in orbit for extended periods of time, they might have increased incentives to cooperation with ISS partners in reducing potential hazards to those astronauts.

If asked about protecting the space environment today, the likely response from China would include the Russian-Chinese draft "Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects" (PPWT). The PPWT is outside the scope of my presentation today save to note that the United States rightly remains opposed to its adoption. In contrast, the United States is considering a European Union draft proposal for an international, voluntary, non-binding "Code of Conduct for Outer Space Activities" that would promote a variety of transparency and confidence building measures of value to all space-faring states. Such a code would have little value as just an agreement between the United States, Europe, and Japan but would be more effective if space powers such as China and India, as well as emerging space-faring states such as Brazil, Korea, Nigeria, and South Africa, were to adopt it. Thus, the United States should pursue a diplomatic strategy that encourages countries with which China cooperates in space to adopt the Code of Conduct as well as engaging with China directly.

Chinese space capabilities could be of potential value in reducing tensions on the Korean peninsula. While the six-party talks (North Korea, South Korea, China, the United States, Japan and Russia) are currently suspended, future discussions will continue to deal with missile proliferation as well as denuclearization. If North Korea were to give up its long-range missile capabilities and suspend space launch activities, it is likely that North Korean leadership will require inducements or compensation of some sort. One such offset could be Chinese launch services for North Korea satellites as part of broader agreement that eliminated North Korean strategic missiles. While highly speculative, it is possible to imagine constructive outcomes if China chose to pursue them.

On balance, Chinese civil space capabilities can be expected to increase in the future. China will be able to undertake unilateral and international space projects of increasing complexity that will in turn increase commercial, military, and diplomatic opportunities at times and places of China's choosing. Today, U.S. human space flight capabilities remain considerably ahead of China by all measures or experience, technology, industrial base, and partnerships. Unfortunately, the continuation of the current balance is uncertain. The United States has failed to develop an assured means for U.S. Government human access to space, the International Space Station is reliant on the Russian Soyuz and unproven commercial providers with a consequent risk of loss of the Station should there be a major accident on-orbit, and finally, the United States has failed to engage its existing international partners in a program of exploration beyond low Earth orbit. Plans for a human return to the Moon are on hold and no other human exploration missions are in work. All of these factors increase the odds that the United States will not be a global leader in human spaceflight after the end of the International Space Station sometime in the next ten years or so.

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

Thank you for your attention. I would be happy to answer any questions you might have.

Milestones in Space Capability

	China	Russia	United States
Satellite Launch	1970	1957	1958
Human Launch	2003	1961	1962
2-man crew	2005	N/A	1965
3-man crew	2008	1964	1968
Space walk/EVA	2008 (14 min.)	1965 (24 min.)	1965 (20 min.)
Space Laboratory	2011-2020?	1971 (Salyut 1) 1986 (Mir)	1973 (Skylab)
Circum-lunar flight	?	?	1968 (Apollo 8)
Space Station	2020?	2000 (ISS)	2000 (ISS)

Table 1 – Space Milestones

Figure 1 – Slide from Official Chinese Presentation, International Astronautical Conference, Prague, October 2010

Figure 2 – NASA Concept for a Chinese Lunar Landing

HEARING CO-CHAIR WESSEL: Thank you.
Dr. Moltz.

STATEMENT OF DR. CLAY MOLTZ, ASSOCIATE PROFESSOR NAVAL POSTGRADUATE SCHOOL, MONTEREY, CALIFORNIA

DR. MOLTZ: Thank you very much.

I appreciate the invitation to be here today. China certainly is an important and developing space power, and understanding China's space program is critical to dealing with it effectively. We've heard this morning about military goals on China's part. China also has important civil and commercial aims in space.

As a second generation space power, it has very important developmental goals and also prestige-related goals in space.

It has created a variety of institutions including two international organizations to spread its influence throughout Asia in the space field. It has a wide infrastructure for civil space. It also has developed an impressive cadre of young scientists and engineers. All of these represent challenges to the United States.

Since the Cox Committee report in 1999, U.S. has adopted largely what I would call a defensive strategy. It's tried to prevent the theft of technology by China by putting all space items on the ITAR munitions list.

It also has used space to criticize human rights in China. These have been relatively blunt instruments that I would argue have hurt U.S.

companies and also risk isolating the United States. The problem is that the space marketplace has changed significantly since the 1990s. There are a variety of players in the international market that are willing to sell to China, including our allies in Europe, as well as Russia and a variety of other players.

In my testimony, I outline a policy of selective cooperation with China in civil and commercial space and in the field of space security.

Commissioner Wortzel has noted in his writings that we started a space security dialogue with the Soviet Union in the early 1960s, and by the early 1970s had set up a series of rules to govern noninterference with national technical means and other military satellites.

We do not have such a dialogue with China, at least until maybe this week. And this framework is important.

So what I'd like to do in the rest of my remarks is briefly summarize some of the key highlights in China's space history, talk about some of its civil and commercial programs, and then discuss possible areas for cooperation.

China has taken more than 50 years to get where it has arrived at in space. It has done so in fits and starts with a number of setbacks. Only in the late 1970s under Deng Xiaoping did it really begin a steady plan of science and technology development that included space.

This involved, as well, loosening of some of the military's control over space and the beginning of engagement with outside players including France, West Germany, and also the United States.

In contrast to testimony provided by Representative Wolf this morning, in fact, Ronald Reagan greatly expanded space cooperation with China. NASA began discussions that eventually led to the flying of two Chinese experiments on a shuttle mission. The Reagan administration also offered to fly a Chinese astronaut on the shuttle, although that did not eventually occur.

In the commercial sector, the United States allowed China to begin launching American satellites, and by 1998, 26 satellites had flown on Chinese launchers to the benefit of U.S. companies.

The other point is that China's engagement in these activities required it to pass a variety of measures that increased its awareness and its acceptance of space liability and registration requirements that brought it into compliance with the international community.

China also benefited during this period from the normalization of Sino-Soviet ties in 1989. The Soviets provided significant technology for the human space flight program. China also created the Asia-Pacific Multilateral Cooperation in Space Technology Applications in 1992 to begin cooperating with the rest of Asia as a purveyor of technology, and this is part of China's broader strategy within Asia.

In the past decade, we've seen China increase its prominence in space.

We've also seen efforts by our European allies to go around our ITAR restrictions and to begin to sell to China without these hurdles.

As we look to the future, China is beginning to export space technology. It has exported satellites to Nigeria, Pakistan and Venezuela. It also created a new membership organization in 2008 similar to ESA called the Asian-Pacific Space Cooperation Organization in 2008. This is a membership body, although the members include such countries as Pakistan, Mongolia, Thailand and Peru. None of them are major space powers.

China also continues to cooperate with Britain, Germany, France, Russia, Italy and others. The result is that China is no longer isolated, and the United States has lost significant market share.

China also has a number of weaknesses. It has gaps in the quality of its space technology. It has bureaucratic overhang due to inefficiencies of the Socialist economy, and it also lacks close capable allies in space, unlike the United States.

So where do we go from here? What is in our interests? I think it's clear that the United States should not continue to isolate itself from the international commercial market. The United States needs to have a forward-looking plan aimed at positive engagement with its friends and allies, while also encouraging China to engage in more responsible behavior in space. I see the new National Security Space Strategy as one positive step.

Very specifically, I have four recommendations. First, I think we need to step up our engagement with our friends and allies in the region, such as Australia. Japan should be mentioned as well. South Korea is another country. Power in space depends on networks. China has tried to build a network, but it has not been especially successful. We can do much better.

Second, I think we need to begin a space security dialogue with China. We need to build trust and establish the kinds of norms of noninterference that we did with the Soviet Union.

Third, I think we need to reform our ITAR regulations, resume mutually beneficial commercial cooperation with China, and use that to gain access to the Chinese market.

Finally, I would argue that we should resume space science cooperation in a step-by-step manner that will help us learn more about China and also enhance mutual stability in space.

Thank you.

[The written statement follows:]

PREPARED STATEMENT OF DR. CLAY MOLTZ, ASSOCIATE PROFESSOR NAVAL POSTGRADUATE SCHOOL, MONTEREY, CALIFORNIA

I thank the commissioners for the invitation to speak to you today on the topic of China's space technology and how its behavior in the civil space sector affects the United States. I want to emphasize that my remarks today are

my personal views, and not official statements of the U.S. Navy or the Department of Defense.

China has emerged as a major spacefaring nation in the past decade after more than fifty years of effort and many setbacks. Today, it has Asia's second largest space budget (estimated at $2.24 billion) after Japan ($3.83 billion), but is narrowing the gap. It conducted as many launches (15) as the United States in 2010, second only to Russia.

Understanding China's space program and moving the U.S.-Chinese space relationship in a more favorable direction is critical to furthering U.S. interests in space. It is also essential for promoting the broader conditions of safety and stability in the orbital environment that are needed for the successful development and use of U.S. scientific, commercial, and military space assets.

In the emerging post-Cold War space environment, Asian countries—among them China, India, and Japan—have played an increasingly prominent role. The motives of these countries to date have been different from than those of the superpowers, putting a greater emphasis on domestic economic goals, regional competition, and international prestige, as compared to more limited geo-strategic military aims. China's 2006 White Paper on space listed the goal to "build up the comprehensive national strength" as one of the country's core rationales for space activity. Thus, while China has significant military aims in space, it also has important civil space purposes that are often underappreciated. Given the waning relevance of Communist Party doctrine to Chinese reality, the government is using civil space activities to promote its legitimacy in the eyes of its people.

As "second-generation" space actors, Asian space programs have also differed in their development from the superpowers' space programs in the much larger degree of international cooperation involved in their formation: including purchases of technology and joint activities with outside partners. U.S.-Soviet space technological developments, by contrast, took place much more autonomously. Space cooperation by Asian countries with other programs has been extensive and consistent, as states have reached out to foreign partners and have attempted to carry out typical late-developing "import substitution" strategies seen in other industrial fields (such as shipbuilding, electronics, and automobiles). Unlike during the Cold War, space technology is now widely available on the international market due to forces of globalization and the presence of advanced producers (Russia, France, Britain, Italy, Israel, and others) willing to sell. On the other side of the equation, China is now exporting space technology and serving as a trainer for developing countries interested in space. In fact, China has set up specific organizations to facilitate its cooperation with other space programs both within Asia and beyond. China wants to be perceived as a space leader and to build lasting relationships with developing countries.

For these reasons, viewing China's space program solely from the perspective of its military activities is misleading. While China is active in the military sector and is seeking to check current U.S. advantages in this area, China's challenge to the United States in space may eventually be equally significant in the *civil* space sector, where China's expanding infrastructure, growing cadre of space scientists and engineers, and active international outreach puts it in a favorable position for long-term competition. But China still lags behind the United States and suffers from some serious, structural weaknesses in regard to space: bureaucratic overhang, a lack of capable space allies, and tepid receptivity to its efforts at international leadership. Unfortunately, the United States has failed to exercise its advantages in some of these fields. The international space environment is changing, yet Washington has too often fallen back into Cold War patterns, which are ineffectual in the today's expanded space marketplace. The new National Space Policy and National Security Space Strategy have outlined important new directions, but specific steps are now needed to implement them in regard to China and, as importantly, with U.S. allies and friends in the region. Such combined policies would assist in the development of U.S. markets and increase U.S. space security.

My testimony examines how China reached to its current position in space, how it is currently organized for space technology cooperation, and how smarter U.S. policies of both competition and cooperation could better serve U.S. interests.

China's Early Space History

China's space program was founded in the mid-1950s thanks in part to a U.S. decision to expel Cal Tech-trained

missile engineer Dr. Qian Xuesen in 1955 over suspicions of communist leanings. (U.S. Secretary of the Navy [1951-53] Dan Kimball called his expulsion: "the stupidest thing this country ever did.") But China's initial progress in the late 1950s suffered from the loss of Soviet technical help in 1960. Then, Mao Zedong's Cultural Revolution in the mid-1960s led to drastic cuts in its activities and personnel. But China's continuing efforts in the missile delivery field allowed it to launch its first satellite in 1970. Political turmoil set the program back again subsequently, and only in the late 1970s under Deng Xiaoping did the space program began to gain a more stable footing. Deng linked space technology development to the broader process of Chinese economic reform, while freeing Chinese scientists and engineers to work with foreign governments and experts.

Following Nixon's visit to China in 1971 and trips by various U.S. scientific delegations to China as part of efforts to normalize relations, the two sides reached a 1978 pact called for U.S. assistance in installing a Landsat ground station and developing a civil communications and broadcast system for China through the purchase of a U.S. satellite, which would be launched by NASA but operated afterwards by the Chinese. While Premier Deng Xiaoping visited the Johnson Space Center in Houston in 1979, the agreement to acquire a U.S. communications satellite failed to materialize due to its high cost for China.

During the 1978-85 period, space became part of a national science and technology plan. China listed the following priorities for the period: satellites for remote sensing, ground stations, space science research, "skylabs," and new launch vehicles. Although China failed to achieve some of these goals, the government showed a new commitment to space. A front organization called the Ministry of the Space Industry offered a new pubic face for the space program in 1982, although its enterprises remained under the military.

Given shared perceptions of the Soviet military threat, the United States and China began to cooperate more extensively after the election of Ronald Reagan. Ties began to be forged in the area of commercial space, as China sought to enter the international launch services market. President Reagan even offered a slot on a future U.S. shuttle flight to a Chinese astronaut. While the manned mission never occurred (in part due to the *Challenger* disaster in 1986), cooperative scientific exchanges came to fruition when the United States flew two Chinese experiments aboard a U.S. space shuttle mission in 1992.

China rented transponders on French and West German satellites for communications purposes before achieving its first successful satellite insertion to geostationary orbit in April 1984. Its first fully functional communications satellite reached orbit and began operation in February 1986.

After twelve successful flights of its Long March booster, the Chinese government tasked the Great Wall Industry Corporation (GWIC) in 1985 with marketing the launcher's services abroad. President Reagan agreed in 1988 to allow U.S.-made satellites to be launched on Chinese rockets, but the deal required China to sign liability and technological safeguards agreements and agree to a limited quota. The two sides also established yearly government-to-government meetings to review their progress and discuss any problems. China had already joined the Outer Space Treaty in 1983, and it now moved forward with ratification of both the Convention on International Liability for Damage Caused by Space Objects and the U.N. Spacecraft Registration Convention in December 1988. These steps marked a major step forward in China's integration into the world space community and its growing acceptance of international norms.

Meanwhile, China continued to develop its own satellite program—launching nine satellites from 1975 to 1987 and working on technologies associated with reentry and recovery of spacecraft. These missions helped China gradually expand its capabilities and put it on the verge of research into human spaceflight. To acquire technology and build its capabilities, China also cooperated with the European Space Agency (ESA) beginning in the late 1980s in both space science and in commercial applications. China's *Fanhui Shi Weixing-9* satellite in 1987 carried two payloads for a French company, representing one of China's first commercial contracts. China also experimented with photographic remote-sensing, returning wide angle images from film de-orbited to Earth suitable for basic land use and navigational surveys, but far from military standards. China eventually worked with Brazil to develop a higher-resolution Earth resources satellite (*Ziyuan-1*) in the late 1990s capable of digital transmissions, but it still faced considerable limitations.

By the late 1980s, GWIC had opened several offices in the United States and landed its first two contracts, both from the Hughes Corporation. Despite the political problems in U.S.-Chinese relations caused by the crackdown at Tiananmen Square in 1989, President George H. W. Bush waived economic sanctions to allow the launches to proceed due to the interests of the U.S. companies in the launches. Other U.S. corporations seeking to benefit from the Long March's low price and growing record for reliability included: Loral, Martin Marietta, Intelsat, and Echostar. China eventually launched 26 U.S. satellites in the years before 1998.

China's Rise to Space Prominence

Following the normalization of Sino-Soviet ties in 1989 after decades of bilateral hostility, China also purchased significant amounts of technology from the Soviet/Russian space program. Minister of National Defense Chi Haotian traveled to the Russia's Star City space-training facility in 1993, leading to an official bilateral space agreement in 1994. A large Chinese space delegation visited the following year. The Chinese purchased a spacesuit, a complete Soyuz capsule, docking equipment, life support system, and a variety of other hardware and design information to guide their planned human spaceflight program. Chinese delegations returned in 1996 and 1997, gathering more information on cosmonaut training techniques and space medicine. This Russian equipment and know-how proved critical to the eventual Shenzhou program.

In order to facilitate its increasing cooperation with other countries in space, China created the China National Space Administration (CNSA) in 1993. But while CNSA was portrayed by as a NASA equivalent, the bulk of China's space research, production, and operational functions remained within the defense industry. As part of its move to give industry more autonomy from the military, however, China eventually created the Chinese Aerospace Science and Technology Corporation (CASC) in 1999 from a prior industrial organization, bringing together some 300 research and production complexes under nominal civilian control (including those responsible for human spaceflight), as well as organizations like GWIC. The other major industrial actor is now the China Aerospace Science and Industry Corporation (CASIC), which shares an emphasis on rockets but also produces satellites and information technology for the military and civilian sectors.

By the mid-1990s, China had made significant progress in space applications. Beijing reported that communications satellites now reached 83 percent of China's population offering broadcasts, telephone communications to remote areas, data transfers (including printing national newspapers remotely), and educational services.

From 1992-96 China, however, suffered four Long March launch failures. Some crashed near the launch site, causing significant human casualties (many of them covered up), while others failed to deploy satellites into their proper orbits. The U.S. company Loral lost a satellite and Hughes had a satellite delivered to a useless orbit. Communications between the two companies and the Chinese breached U.S. export control regulations, causing the two to be fined. In 1999, the congressionally mandated Cox Commission concluded that the Chinese military had gained technology relevant to nuclear delivery systems from these meetings, although critics doubted these charges. But the result was a U.S. decision to re-categorize all space technology as munitions items under the International Traffic in Arms Regulations (ITAR). The new guidelines halted U.S. space cooperation with China.

Beijing continued to work with other countries to acquire technology and know-how and to promote its space interests. In terms of technology development, China engaged in ongoing cooperation with Brazil, France, Russia, Ukraine, Germany, and the United Kingdom on collaborative missions, commercial purchases, or actual joint development of spacecraft.

The growth of China's space market and the imposition of the U.S. ban caused major European satellite firms to increase their technological independence from the United States in order *not* to have their satellite sales limited by U.S. export control rules. The decision by the private French company Eutelsat Communications Group in 2008 to purchase insurance for up to nine satellites for future "ITAR-free" launches on Chinese rockets marked the effectual end of U.S. success in isolating China.

Other areas of European cooperation with China included joint scientific work between CNSA and the European Space Agency (ESA) from 2001-04 on the Sun's effects on the Earth's environment in the so-called Double Star program, one of the first significant operational missions CNSA conducted with a major foreign space agency.

Recent Civil Space Activity and Plans

For political reasons, China has invested heavily in human spaceflight. It launched its first taikonaut successfully on *Shenzhou V* in October 2003 and has since followed with a two-man flight in October 2005 on *Shenzhou VI* and then a three-man flight with a spacewalk on *Shenzhou VII* in October 2008. Chinese television proudly broadcast the 2008 mission and its spacewalk. The flight also involved the release of a 40-kilogram picosat (*BanXing* [or *BX*]-*1*), which took pictures of the *Shenzhou VII*.

In space science, China's first high-prestige mission came in the form of the *Chang'e 1* lunar probe, which orbited the Moon from 2008 to early 2009, mapping the lunar surface and analyzing the lunar environment. China continues to contract with Russian space enterprises for their expertise in instrumentation, equipment, and control systems for major space missions. In 2006, Russian Space Agency Deputy Director Yuri Nosenko reported that China signed contracts with Russian space enterprises worth tens of millions of dollars. The two sides have announced plans to cooperate on lunar- and Mars-related robotic exploration, including with automated rovers.

China's priorities for the coming five years in space applications, include development of higher-resolution remote-sensing satellites and related ground stations, implementation of its Beidou precision navigational system, completion of the mission of its second lunar orbiter (*Chang'e 2*) launched in October 2010, conduct of a lunar mission and a later sample-return mission in 2017 to 2020, and development of a series of three small space laboratories (called *Tiangong-1*, *-2*, and *-3*) in the coming decade. Further ahead, China has announced plans for a 60-ton space station to be launched by 2020. Some officials have mentioned a possible 2024 Moon mission as well.

China's International Outreach in Space

China has also used space to pursue its foreign policy goals. In 1992, it founded the Asia-Pacific Multilateral Cooperation in Space Technology and Applications (AP-MCSTA). This group, which included Pakistan, Thailand, and a number of other developing countries, eventually began cooperating in several areas, including in the joint development of satellites based on Chinese technology. In 2008, China led a subset of this group to establish the Asia-Pacific Space Cooperation Organization (APSCO)—a formal, membership-only group modeled on ESA. The APSCO organization now includes seven dues-paying members: China, Bangladesh, Iran, Mongolia, Pakistan, Peru, and Thailand. China has high hopes for APSCO, but it has yet to attract more accomplished space powers to the group. APSCO engages in joint research and data-exchange efforts, as well as formal training courses for scientists and engineers from the Asian-Pacific region in space technology and remote sensing.

Through these efforts, China has been able to portray itself as a "purveyor" of space know-how and technology to lesser-developed states in Asia and elsewhere. One target of interest has been Indonesia, which recently received satellite ground stations and communications equipment from China, as well as visit by Chinese taikonauts.

In recent years, China has also begun to engage in considerable commercial space *exports*. It has sold satellite laser-ranging equipment to Argentina and ground stations and satellites to Venezuela, Pakistan, and Nigeria, among others. While China's space enterprises are seeking profits abroad, China also uses space exports for political purposes. Its space deals with Nigeria and Venezuela, for example, were motivated by Chinese interests in long-term energy security. In both cases, these deals for Chinese-built and launched geostationary communications satellites were officially commercial, but on very favorable credit terms to the purchasing countries, with China providing some costs and offering low- or zero-interest rates on its loans. China also provided technical training to each country's space scientists, as well as building ground stations on their territories. This strategy offers political benefits but imposes costs on the Chinese government and the space industry. Looking ahead, China has contracted with Laos to build and launch *Laosat-1* and with Bolivia for the

Tupac Katari communications satellite.

Another example of China's use of space to promote its political interests is the country's history since the mid-1990s of contracting with Intelsat to make direct-to-home broadcasts of China Central Television available in approximately 100 countries.

Chinese Space Problems

But China's recent rise in space does not guarantee its success. China remains behind world standards in a number of critical space technologies, raising questions among partner nations in terms of the quality of its spacecraft. Despite Thailand's membership in APSCO, for example, Bangkok turned to a European consortium to purchase its *Thailand Earth Observation Satellite* (*THEOS*), whose remote-sensing technology is more sophisticated than China's. Similarly, China had technical problems with its *Nigcomsat-1* due to a faulty solar array, causing the spacecraft to cease functioning in 2008. Beijing has had to offer a replacement satellite.

Another problem that China may face in the future relates to its state-run model of organization. With the steady expansion of private entrepreneurship in global space activities, it remains to be seen whether the Chinese state is flexible enough to thrive in the next stage of international space competition. A 2010 study by China expert Eric Hagt for the U.S. Army War College, for example, described China's space industry as "dispersed, bloated, and located in geographically isolated regions." The sector has also had to deal with a series of reforms as Chinese authorities have sought to inject greater civilian management and innovation into hide-bound defense industries. With this in mind, the Chinese State Council demoted the old umbrella organization for scientific research and development for the defense industry, COSTIND, in 2008. In its place, a new department called the State Administration for Science, Technology, and Industry for National Defense (SASTIND) has been created under the new super-Ministry of Industry and Information Technology. Still, many of China's state-run organizations continue to suffer from legacy inefficiencies of the socialist economy.

Another potentially limiting factor is the fact that the State Council and the Military Commission of the Communist Party's Central Committee have since 1997 implemented new export controls and a licensing system. Since 2002, the Military Products Export Control List—administered by SASTIND—has included a special Category 8 for military space items, while other regulations now govern civilian space exports. While possibly reducing China's space trade, this recent development of space-related export controls must be viewed as a positive development from a U.S. perspective, bringing China into greater compliance with international efforts to prevent the proliferation of technologies that could be used for military purposes. Indeed, most Chinese space exports today focus on delivery-on-orbit products and services, rather than direct technology transfer.

Although China's relationship with Europe was reaffirmed in a recent European Union statement calling for new cooperation with China, one sore point has been China's role in Europe's planned Galileo navigation system. Initially, China pledged some $300 million in investment funds in order to become a full partner in the Galileo project, which Beijing viewed as a counterbalance to the U.S.-controlled Global Positioning System (GPS). But the Europeans eventually ousted China out of security concerns and irritation with Beijing's plans to build a competing commercial system as part of its Beidou program, as well as to broadcast its military signal on the same frequency the Europeans had planned to use.

Finally, as noted with APSCO, China has no close allies in space with significant space capabilities. While it cooperates with Russia, the two sides do not share strategic interests, and the bulk of China's cooperative agreements involve developing countries. Thus, China has no capable space allies that it can rely on in a crisis.

Considerations for Renewing U.S.-Chinese Space Cooperation

Supporters of the current freeze in U.S.-Chinese space relations argue that Washington is sending a signal to Beijing about its deplorable human rights record and is also limiting China's ability to develop advanced space systems. Unfortunately, while well-intended, current U.S. policy is ineffective sends a weak and off-target signal. Unless the

United States is also willing to halt U.S. investment in Chinese manufacturing, cut off Chinese access to the U.S. export market, and find a new client for U.S. debt, holding space cooperation hostage will have no significant impact on China, except pushing it to cooperate with others. In addition, it puts the United States in the odd position of promoting "protectionism" in space and adopting a "defensive" strategy, when opening markets and reducing U.S. export barriers instead would strengthen the U.S. space industry and promote American security through greater engagement with the region.

Efforts to keep China off of the *International Space Station* (*ISS*), for example, have only strengthened China's resolve to build its own space stations. Former NASA Administrator Michael Griffin, notably, argues that failing to work with China may cause the United States to be left behind in new international missions, particularly given the fact that current NASA funding will not sustain a unilateral return mission to the Moon, much less continue shouldering of the lion's share of the *ISS* budget. A step-by-step process to begin space science cooperation and (if successful) allow gradual Chinese participation on the *ISS* (first via joint research, then a taikonaut visit, then a possible module) would make more sense: reducing U.S. costs and increasing U.S. knowledge about Chinese space activities.

Similarly, U.S. legislation and ITAR restrictions barring U.S. space technology from being launched aboard Chinese boosters have harmed U.S. satellite sales worldwide, leading to the production of ITAR-free satellites and causing erstwhile clients to turn to other suppliers to avoid U.S. red tape.

The 1999 shift in U.S. policy aimed mainly at addressing national security concerns. But it was an overly blunt instrument, taking up all space technologies rather than only those that cannot be found on the international market. China (like other countries) is certainly interested in acquiring U.S. space technology, yet it is important to point out that the Loral and Hughes investigations in the 1990s did *not* involve illicit Chinese access to U.S. commercial satellites. The problem instead involved improper meetings by U.S. company officials with the Chinese. Thus, the logical solution is not to ban all U.S.-Chinese space contacts, but instead to ensure that U.S. companies observe export control regulations in their meetings. Fortunately, U.S. companies have ample incentive to protect what is actually *inside* their satellites, as they do with Russia and other countries.

Supporters of current restrictions also argue that the policy helps protect U.S. space launchers. Indeed, highly inflated costs for U.S. boosters have supported a few U.S. companies. But they have also hurt the U.S. space industry overall by reducing timely and affordable access to space. Fortunately, thanks to recent developments by such U.S. companies as SpaceX (with its Falcon 1 and 9 boosters), the U.S. launch services sector is becoming competitive on the international marketplace without the need to fall back on protectionism. A stronger U.S. policy would focus instead on lowering global barriers to space competition and reducing subsidies by European producers. As a condition for opening the American market to Chinese launchers, the United States should insist that China open its domestic market to U.S. satellite producers for on-orbit services. The United States fought and won this battle with Japan in the late 1980s and should now use the World Trade Organization and other mechanisms to win this case with China, India, and other countries with closed space markets.

But enhanced U.S.-Chinese space cooperation cannot occur without stabilization of the security relationship with China in regard to space. In this area, it is encouraging that bilateral military-to-military talks are likely to begin soon to discuss parameters for improved space security in the context of the new strategic dialogue with Beijing. It as yet unclear what direction these talks will take, or what initiatives might be possible. Chinese military receptivity and transparency—not seen in recent years—will be necessary to move this dialogue forward. However, if China shows a willingness to respond, the United States should be ready with concrete ideas aimed at creating a framework for more responsible Chinese behavior and mutually beneficial cooperation. Actions by the Nixon administration in the early 1970s established mutually beneficial norms with the Soviet Union under far more difficult circumstances. At a minimum, measures with China should include similar mutual pledges of non-interference with "national technical means" of verification, as well as early-warning satellites. In addition, given China's 2007 ASAT test, it would be beneficial to exchange joint statements rejecting debris-producing events involving orbital objects, particularly those above 150 miles in altitude. Finally, getting China to agree to regular (at least annual) consultations on space security would improve U.S. knowledge of Chinese military programs and

create the mechanisms for the prevention of dangerous activities. All of these mechanisms are in U.S. national interests.

Conclusion

U.S. policy toward China's space program is following respectable but unrealistic goals: to change Chinese human rights policy and military behavior through space sanctions. Sadly, this policy is not working. It is time to explore other options.

The marketplace for space technology has become globalized. It is also now much less dependent on U.S. products. For this reason, our strategy aimed at isolating China in space has become ineffective. Other advanced countries recognize the value of the Chinese space market and can produce technologies that are attractive to China. The United States stands aside to its own disadvantage and to the detriment of our space competitiveness. Russians and Europeans have ITAR-free products that provide nearly comparable space services. Overly restrictive export controls also harm U.S. *political* influence in the space field, as emerging countries form ties with China as a favored supplier.

But, as noted, the United States should not change its space policy without reciprocity. Beijing will need to show more transparency and a willingness to accept restraints on its military programs, as well as new openness in terms of its domestic market. Continued stagnation in the bilateral space relationship and the imposition of blanket ITAR controls on U.S. space technology worldwide, however, puts the United States at risk of losing additional market share in satellites. It also isolates the United States from its own friends and allies, while heightening mistrust and prospects for conflict with China in the space security realm.

Renewing civil and commercial space cooperation with China—as begun by the Reagan administration—is not a blank check and need not provide China with sensitive technologies. Instead, it can be carefully structured to allow reasonable cooperation in space science and in space commerce involving products and services available on the international market. Similarly, building a firm basis for space security relations—while recognizing our differences with China—should be pursued out of American interests. Such contacts need to be regularized and used to prevent harmful activities, increase transparency, and reduce tensions. Absent such contacts, the United States will continue to lack access, knowledge, and leverage on Chinese space activities.

Finally, we need to pursue closer space-related links to U.S. allies and friends, especially in Asia, to help strengthen U.S. capabilities and resiliency. Such actions will help create a stronger political network for U.S. space leadership and establish lasting cooperative ties. Fortunately, the administration has begun such work in the context of the new National Security Space Strategy. But it needs to stay the course and to keep Congress informed of its progress.

HEARING CO-CHAIR WESSEL: Thank you.
Ms. Krolikowski.

STATEMENT OF ALANNA KROLIKOWSKI, VISITING SCHOLAR GEORGE WASHINGTON UNIVERSITY SPACE POLICY INSTITUTE WASHINGTON, DC

MS. KROLIKOWSKI: Good afternoon, Mr. Chairman, Commissioners. Thank you for the opportunity to testify before you today on the topic of China's civil and commercial space activities.

I'll focus my oral remarks today on the role of space in China's overall development strategy and its civil space programs. I'll also discuss cooperation in space between the United States and China.

Space activities play an important role in China's overall development strategy. Chinese leaders and policymakers tend to describe development in comprehensive terms that extend beyond the economy to also include scientific and technological modernization, China's international environment, and domestic political stability. Space activities play a role in each of these aspects.

China's maturing space sector has a greater potential to serve developmental agendas today than it ever has before. Space activities figure in government plans to build a knowledge economy, foster innovation and build an advanced scientific, technical and industrial base.

During the current Five Year Plan, the satellite and telecommunications industries will receive special policy support and public investment. Space-related products and services are also part of a broader effort to promote high-tech, high-value added exports. Developing countries are an increasingly important destination for China's small but growing exports of satellites and launch services.

China's space activities also support specific foreign policy goals. Achieving space capabilities ensures that China will not be excluded from major multilateral processes that will affect the future use of space. Moreover, China integrates space activities into larger efforts to engage developing countries and to build soft power.

These different goals and interests combine to create a strong political commitment to supporting the current civil space programs and the space industry. And major civil space projects are underway and planned. In the human space flight program, the most recent piloted mission was the 2008 Shenzhou 7 flight in which two Chinese astronauts performed extravehicular activity for the first time, one of them in a Chinese-made space suit.

During the current stage of this program, China will launch space laboratory facilities into orbit. The first space lab, Tiangong 1, is scheduled to launch later this year and will be followed by two others. Chinese astronauts will make trips to these labs to conduct small-scale experiments.

The space lab stage is a precursor to a third planned stage, during which a larger space station will be launched and assembled on orbit. By around 2020, this station will be ready to support crews conducting a range of space science and applications experiments.

The Chinese station will be a fraction of the size of the International Space Station, the ISS, and it will support a smaller crew than the ISS. But it will be significant. During the lifetime of the ISS, the Chinese station will likely be the only other space station on orbit. If the ISS ends it operational life in 2020 without a successor, there may be a period during which the

Chinese station is the only long-term human presence in space.

In parallel to the space station, China is also pursuing a successful lunar exploration program. It culminates in the landing of an unpiloted rover on the moon and the return of a lunar sample to Earth around 2020.

Through these activities, China is likely to change the space environment in coming years. As these programs advance, China's footprint in space will be greater. China will have a long-term crew presence in its station on orbit and, through its vehicles, even leave a trace presence on the moon.

With these circumstances in view, I'll conclude by turning to U.S.-China space cooperation. China and the United States already interact in space and will probably do so more in the future. As decision-makers and the public examine whether, when and how the United States should actively cooperate with China in space, I think there are three considerations they might find helpful.

First, ideally, any answer to the question of whether the United States should cooperate with China should be logically derived from an answer to another more fundamental question: what type of space actor does the United States hope China will become?

A clear vision of the desired outcome would make it possible to compare different policy options, including the current approach of almost no cooperation with China.

Second, the discussion over U.S.-China cooperation should, in my view, take into account that every form of international cooperation has domestic effects. Any form of cooperation or noncooperation with the United States will empower some actors within the Chinese space establishment at the expense of others.

Third, the discussion of U.S.-China space cooperation should be broadened to take into account the full range of costs and benefits of cooperating or not with China in space and of how these are changing.

Many of these costs and benefits are rarely acknowledged. While China's capabilities in space are known to the U.S., its intentions are not. Cooperating, especially on technical projects, could open avenues to learning how China's leaders understand their country's interests in space and the means to pursue these, and how they make choices.

Cooperation, especially on technical projects, would create opportunities to engage China's emerging space policy community. A new community of space experts who have increasing policy input over the coming years is emerging in China. Developing long-term relationships with these space professionals could provide the United States with additional points of contact and channels of communication into the Chinese space system.

With that, please accept my sincere thanks for the opportunity to share with you the outcomes of my research and my thoughts. I would be

pleased to answer any questions.

[The written statement follows:]

PREPARED STATEMENT OF ALANNA KROLIKOWSKI, VISITING SCHOLAR GEORGE WASHINGTON UNIVERSITY SPACE POLICY INSTITUTE WASHINGTON, DC

Introduction

I thank the Commission for the opportunity to testify before it on the topic of China's civil and commercial space activities.

The first part of my statement will address the role of space in China's overall development strategy, relating it to different elements of the comprehensive vision of development held by China's leaders. The second part of my statement will survey recent and significant developments in China's civil space programs, setting these in the context of China's space policymaking environment. The third part will discuss China's civil space industry, introducing the major industrial players and the industry's policy landscape. The fourth section of my statement will address the advantages and disadvantages of U.S.-China space cooperation.[27]

Space in China's overall development strategy

The space sector today plays an important role in China's comprehensive development strategy. However, any analysis of the sector's role in overall development is complicated by its unique place and functions in the economy. Moreover, generating concrete benefits to economic development has not been the primary objective of political elites who support the program. As the program has developed and broadened in scope, it has generated more applications and acquired more users in government and enterprises and its potential contribution to China's development has grown.

Sectoral specificity

China's space sector has a complex and evolving relationship to the national economy. Policymakers expect space-sector development to yield positive externalities, such as enabling growth and development in other high-technology industries. At the same time, the space sector has been insulated from many of the pressures affecting the rest of the economy, mainly by its status as a strategic sector and its largely non-market internal relationships.

Because of the space sector's special status, macroeconomic and other aggregate national-level indicators are weak predictors of China's space performance. Prospects for the space sector cannot be directly inferred from the growth of China's gross domestic product or gross national income. Nor can they be read off demographic data, such as characterizations of the workforce's age structure or estimates of the numbers of new scientific and technical university degree holders. Each of these factors will matter, but the relationships between these factors

[27] This statement is based on sources including: in-person interviews and consultations with current and former participants in the Chinese and U.S. space sectors; primary- and secondary-source documents in Chinese and English, including policy statements, media reports, trade and technical journal articles, and think-tank reports; and remarks made by authoritative Chinese and U.S. space-sector participants at public conferences in China and the United States.
Although China's civil and military-intelligence space efforts are closely related, as this panel is about civil space programs, my remarks are confined to civil and commercial space activities. They do not address the relationship between the civil and military space programs, such as civil-military integration efforts.

and space-sector outcomes are likely to be non-linear.

Reaching robust conclusions about China's space sector would require an analysis that incorporates national, sector-specific, and firm-level data and models,[28] a process complicated by a lack of reliable information. In the absence of such an analysis, the best inferences that can be drawn about the space sector's role in economic development are primarily qualitative and descriptive. They are also necessarily partial and evolving.

A weak developmental motive

Although the economic impact of China's space activities is growing, for most of the last two decades, economic development was not the primary motive guiding the civil program. By implication, had investments in space during this time focused more heavily on capabilities that directly serve economic goals, the developmental impact of the program would today be greater.

Proponents of the space program since many decades emphasize its potential contribution to economic development. Taking a systemic view, they argue that space-sector development can "pull" along the rest of the economy. Political elites see the economic, security, and prestige benefits of space activities as inter-related and mutually reinforcing. However, although the space program has had economic goals and impacts, concrete development benefits, as we usually think of them, have not provided the main rationale for the program itself or for decisions within it.

The government's allocation of resources in civil space has not been consistent with developmental priorities since 1992, when the human spaceflight program formally began. The areas of space technology known to generate the most direct and reliable contributions to economic development are those with concrete applications, such as telecommunications satellites and remote-sensing satellites for resource management and weather monitoring. The Japanese and Indian space programs, especially in earlier periods, were designed to serve these developmental priorities.

In China over the past two decades, resources devoted to civil space have been concentrated not in these relatively productive areas, but in a costly human spaceflight engineering program of no evident direct benefit to the national economy. The symbolism of human spaceflight has been an important driver of this pursuit.

Growth in space usage

Today, the broadening and maturing space program more directly serves specific economic development goals. An important recent change in the relationship of the space sector to the rest of the economy is growth in the usage of space-derived products and services. New indigenously supplied space products and services and new users have emerged. Some of the most rapidly growing new applications are in remote sensing for mapping and surveying, natural-resource management, and urban planning, satellite navigation, weather forecasting, and disaster monitoring and mitigation.

The main users of space-derived data are still primarily central government agencies and large state-owned enterprises,[29] but local and provincial governments and small and medium enterprises are increasingly important.

[28] For example, studies of the U.S. space industrial base and its implications for the U.S. economy and national security use these sorts of analyses.

[29] Traditional users include the China Meteorological Administration, the China Oceanic Administration, the Ministry of Science and Technology's National Remote Sensing Center of China, and the Ministry of Environment Protection. Government-owned commercial telecommunications satellite operators, who provide services to millions of individual end users, have been among the largest users for over a decade.

One source reports over 20,000 companies in the surveying and mapping industry alone.[30] Multiple levels of government also participate in large-scale space-related infrastructure projects such as the Digital China Geospatial Network, an initiative that will eventually deliver space-derived data to the public.[31]

The implications of this usage and user growth for economic development are that the space program today has more stakeholders and can be used to advance more policy agendas and commercial interests than ever before. Space is gradually becoming embedded across China's economy and governance structures.

The growing developmental impact of the space sector

Chinese leaders and policymakers tend to describe development in comprehensive terms that extend beyond the economy to include their country's scientific and technological (S&T) modernization, international environment, and domestic political stability. China's space program plays a role in each of these aspects of its overall development strategy.

Economic and S&T modernization goals served by space activities

Space-related industries figure in government plans for building a knowledge economy, increasing domestic consumption, especially of high-technology products, fostering indigenous innovation, and building a sophisticated scientific, technical, and industrial base. High-end manufacturing and information technology, which include satellites and telecommunications, are among the seven new strategic sectors identified in the 2011-2016 Five Year Plan to receive policy support and public investment.

The forms of support and other measures directed at these strategic industries include: direct public investment in research and development; fiscal, tax, and financial policies to support major national S&T projects and indigenous innovation; measures to improve market access; concessional pricing systems for land and utilities; and government oversight of mergers and acquisitions to concentrate and consolidate capacity in the manufacturing industries. Space-sector firms are also targets of initiatives to develop globally recognized Chinese brands and create internationally competitive high-technology companies.

Chinese space professionals emphasize that developing space-related products and services will serve the state's goal of moving the economy into the higher value-added rungs of the export ladder. More generally, they say, the high-profile space program will help build international consumer confidence in Chinese technology products, showing the world that "China doesn't just make shoes."[32]

The export of satellite launch services on Long March-series vehicles remains a priority for the Chinese government and space industry. Since 1999, U.S. export control laws, specifically the International Traffic in Arms Regulations (ITAR) system, have prohibited the launch of satellites containing major U.S. components on Chinese launchers, effectively excluding China from the global launch business.

Senior industry figures continue to stress the mutual benefit to be gained from Chinese launch exports to the United States in public statements. At the same time, they appear to have realistically assessed the prospects of reforms to the U.S. export control regime, judging that any reforms are unlikely to open new launch markets to Chinese firms in the foreseeable future.

Competitively priced Chinese launch services present an opportunity for some satellite manufacturers in other countries. To take advantage of cheap launches, the European firm Thales Alenia Space around 2009 developed a

[30] Niraj Singh, "The flight of the dragon," *Geospatial World* vol. 1, April (2011): 32.

[31] The Digital China Geospatial Network has been described as the Chinese version of the U.S. National Spatial Data Infrastructure (ibid, 33).

[32] Remarks by a Chinese space-sector participant.

satellite devoid of ITAR-controlled technology. However, at least in the short term, an important ITAR-free industry is not expected to emerge, because most international satellite-manufacturing companies still rely heavily on U.S.-made components.

Developing markets occupy an important place in the Chinese space industry's export strategy. The Chinese government and space industry have taken note of the growing demand for space products and services in developing markets. Within the past five years, China has reached agreements to export or effectively donate satellites or launch services to Bangladesh, Bolivia, Indonesia, Laos, Nigeria, Pakistan, and Venezuela. These transactions were not internationally competed sales.

Excluded from important global space markets by restrictions on U.S. technology exports, the Chinese space industry finds opportunities in developing countries that are subject to restrictions similar to those imposed on China. Venezuela and Pakistan are examples of this type of market.

China's approach to space exports also leverages its firms' and government's unique advantage at operating in developing-world markets. Chinese satellite manufacturers are in a position to offer generous terms to buyers in developing countries, for whom price can be a decisive factor. Offering concessional financing terms, providing development assistance (formally or informally) tied to satellite purchases, and even accepting payment for satellites in barter has made it possible for China to create buyers of satellites where none previously existed. These arrangements are made easier by the fact that many buyers in developing countries are governments or state-owned enterprises like their Chinese counterparts.
Chinese official statements frame these space transactions as examples of South-South cooperation and recall the historically close relationship between China and other developing countries. These transactions often also involve technical assistance programs that aim to build capacity for space-asset use and development in the receiving country.[33]

Despite this string of recent deals, expectations for Chinese satellite exports, especially beyond developing markets, remain modest. China's satellite-manufacturing industry is not yet internationally competitive.

Foreign policy agendas served by space activities
Chinese leaders and policymakers emphasize the need to foster international attitudes and institutions that are supportive of their country's peaceful economic rise. The space program serves this end by reinforcing China's position as a capable party requiring inclusion in major international processes affecting space and by enhancing its influence in the developing world.

Conspicuous and autonomous achievements in space also reinforce China's great power status and its membership in the elite club of advanced spacefaring countries. Chinese leaders emphasize the growing importance of space in international and security affairs and in the global economy. Regarding assured access to space as both an economic and national security interest, they fear exclusion from any international process that bears upon how space could be used in the future. Achieving significant space capabilities ensures that China will have a "seat at the table" when decisions about space are made.

China also uses space activities as part of a larger effort to engage developing countries. This approach includes significant and long-standing bilateral space cooperation efforts, such as its program with Brazil. China also provides concessional space exports and technical assistance to poor countries. China is active in multilateral space initiatives with developing countries, including through its leadership of the Asia-Pacific Space Cooperation Organization.

[33] Technical assistance is an important form of China's development assistance, discussed in the recently released white paper on "China's Foreign Aid."

Chinese scholars and policymakers believe it helpful to cultivate China's "soft power," especially among developing countries. Highly visible civil space activities, such as human spaceflight, serve this goal, though they have at times also alarmed China's neighbors and cost it some soft power. Success in space brings China international prestige. Achievements in space are an implicit endorsement of China's political and economic model. Space capability is a marker of modernity and technological progress, signalling that China has overcome a legacy of colonialism and what many in China regard as historical weakness.

Domestic political agendas served by space activities

Chinese leaders and policymakers stress that domestic political stability is a precondition for sustainable economic development. Both proponents and critics of the space program say that it serves an increasingly important domestic political function by bolstering the legitimacy of the regime which created it and by serving as a national achievement in which Chinese, often divided on other issues, can share pride.

Recent and significant trends in China's civil space program

The pace of progress in civil space: Cautious and uneven, but steady

International observers and Chinese media often describe China's civil space program as "soaring" ahead or "leaping" forward. Chinese space professionals familiar with different aspects of the program, however, tend to regard its progress as cautious and unbalanced. They also emphasize that their program is not racing with any other country.

Progress has been steady but not necessarily rapid across the main areas of the civil space program, with some exceptions. The pace of launches accelerated recently. In 2010, China for the first time matched the United States in the number of launches in a single year: 15. By contrast, the human spaceflight program, although reaching new milestones since 2003, has proceeded at a cautious pace. Chinese observers note that their country's crewed launch schedule has been slower than the U.S. Apollo Program's of the 1960s. China has also experienced recent delays and setbacks in satellite production, including the on-orbit failure in 2008 of a satellite delivered to Nigeria, a launch failure in 2009, and delays in launch-vehicle development.

Space policymaking and policy implementation

China's civil space activities are conceived and implemented in a complex policy environment. Diverse institutions and interests are involved in and contend in the space sector. Participants in it frequently point out that their system is difficult to understand, even for insiders, and that systemic reforms begun in 2008 are still incomplete.

A process to rationalize responsibilities and authority over different aspects of the space sector is underway in the form of a comprehensive national space law. When passed, this law will also designate organizations responsible for implementing China's obligations under international agreements. Legal specialists have been developing drafts of this legislation, which may be under review by a committee of members of the National People's Congress.

Despite these changes, several enduring features of the system are discernible. These include top leadership involvement, coordination by leading small groups, operational control by the People's Liberation Army (PLA), and the influence of elite scientists.

Top leadership involvement. Top leaders in the central government have closely overseen the space program since its beginning. Today, Chinese space professionals with program management experience emphasize oversight and attention by political leaders as a factor determining how quickly a program will advance. Leaders will frequently receive briefings on the progress of programs and visit facilities. In some cases, an explicit go-ahead by a senior political leader is needed before a program can advance to its next planned stage. Leaders may even introduce new technical requirements.

Programmatic influence of elite scientists. While program priorities are often handed down from the political leadership to the scientific and technical community, new projects may also originate with individual scientists who entrepreneurially conceive of, advocate for, and push them upward to obtain approval and funding. Examples of this bottom-up process are found in the lunar exploration program and in the Double Star program pursued in cooperation with the European Space Agency.

Coordination by leading small groups. Space activities require the participation of different ministries and organizations, both civil and military, each of which is a stove-piped bureaucracy. Leading small groups fulfil a high-level coordination function among these actors. Usually without a dedicated institutional home, leading small groups pull together representatives from existing offices in participating organizations on an ad hoc, project-specific basis. There are reportedly leading small groups for the lunar projects, human spaceflight, Earth observation satellites, and heavy-lift launch vehicle development.

Operational control by the PLA. Critical space infrastructure, including existing launch facilities, and the day-to-day management of civil space operations, especially in the human spaceflight program, are the responsibility of PLA organs. Within the PLA, the General Armaments Department (GAD) plays the most important role in space activities. In civil space, the GAD acts mainly in and through the Manned Space Engineering Office, the entity responsible for the human spaceflight program. The PLA Air Force plays a role in astronaut training and medicine.

Major recent and planned civil space activities

China's main civil space activities span five areas. These include the human spaceflight program, lunar projects, the development of a next-generation heavy-lift launcher, the Beidou/Compass navigation satellite constellation, and new Earth observation satellites. [34]

Human spaceflight program. The human spaceflight program, under the Manned Space Engineering Office, is China's largest civil space activity. It began in 1992 with the government's adoption of Project 921, which outlined a three-stage national human spaceflight program, focused on a spaceship, a space laboratory, and a space station. These activities are explained in greater detail in Appendix 1.

> **Shenzhou spaceship.** Between 1999 and 2008, the Manned Space Engineering Office conducted a series of piloted and unpiloted missions to develop the Shenzhou series of crew transportation vehicles. The three crewed missions to date have been Shenzhou 5, the first spaceflight by a Chinese national, in 2003; Shenzhou 6, in which two taikonauts remained on orbit for over a day; and Shenzhou 7, in which two taikonauts performed extra-vehicular activity, one of them testing a Chinese-made spacesuit.
>
> **Space laboratory.** The program's space laboratory stage is underway. It involves placing in orbit small facilities, consisting initially of the Tiangong 1 lab, scheduled to launch in the latter half of this year, and to be followed by the Tiangong 2 and 3 labs. Taikonauts will make trips to these facilities lasting up to 40 days to conduct small-scale experiments and technology tests in preparation for building a larger space station. The space lab phase will also develop, test, and refine the capabilities required for longer stays in space and for orbital rendez-vous and docking, necessary for the assembly of the space station.
>
> **Space station.** Between 2015 and 2022, China plans to build a larger space station. It will consist of a core cabin module and two separately launched laboratory modules, making it only the third space structure assembled on orbit, after Mir and the International Space Station (ISS). The station will support crews conducting a wide range of space science and applications experiments and work on long-duration flights.

[34] These remarks will not address Earth observation satellites, which are another important area, or the Beidou/Compass constellation of navigation satellites, both covered in a comprehensive report on China's aerospace industry recently submitted to the Commission.

At 60 metric tons in total, the Chinese station will be far smaller than the ISS, expected to weigh about 450 tons once complete. The ISS supports six astronauts on long-term stays, while the Chinese station is planned to support only three taikonauts at a time.

There are reports that the Chinese station will accept to host experiments from international researchers through a selection process that will be open to participants from any country.

During the lifetime of the ISS, the Chinese station will be the only other space station on orbit. If the ISS ends its operational life in 2020 without a successor, there may be a period during which the Chinese station is the only long-term human presence in space.

Lunar exploration program. The lunar program has three stages, referred to as the orbiting, landing, and sample-return stages. In the first (2002-2007), two satellites, Chang'e 1 and a back-up, orbited the Moon and collected images of the lunar surface. Since the start of the second and current "landing" stage (2008-2014), Chang'e 2 launched and entered lunar orbit, where it continues to collect data. Chang'e 3 will launch around 2013 and land on the Moon with a rover. In the "sample return" stage (2015-2020), another small unpiloted vehicle will land on the Moon, collect samples, and return them to Earth. During this third stage, the human spaceflight program will conduct a human lunar mission concept study, which is to be complete by or around 2020.

Next-generation heavy-lift launch vehicle. The space station requires launching payloads each weighing 20 metric tons into low Earth orbit. To this end, China has started developing a more powerful next-generation carrier rocket, the Long March 5. This vehicle is built in the Tianjin area by the China Academy of Launch Vehicle Technology and will launch out of a new site under construction on the southern island province of Hainan, reportedly by 2014. With an expected capacity of 25 tons to low Earth orbits and 10 tons to geosynchronous orbits, the Long March 5 will increase the range of payloads deliverable and orbits reachable by Chinese vehicles, adding the capability to launch larger telecommunications satellites. Other Chinese launchers are also reported as in development.

China's civil space industry

Major industrial players

Two major players dominate China's space industry: China Aerospace Science and Technology Corporation (Casc) and China Aerospace Science and Industry Corporation (Casic). Both of these entities are large state-owned enterprise (SOE) groups that subsume under them vast and diverse facilities and organizations performing research, development, and production in different parts of the country.

The larger of the two companies, Casc, has focused on more powerful launch vehicles and larger satellites. Casc also subsumes China Great Wall Industry Corporation, the subsidiary responsible for the international marketing of Chinese launch services and satellite systems. In 2009, Casc acquired China Satellite Communications Corporation (China Satcom), expanding its activities into the operation of telecommunications satellites. The smaller Casic has focused more on missiles and on smaller satellites and launchers.

Casc and Casic are both involved in civil and military space technology and both are also involved in other civil industries, ranging from the industrial production of mechanical parts and components to other high-technology products and services, such as large-scale security systems. Casc and Casic's major clients are the government organs that run the space program; large parts of both the civil and military space budgets drain into these two companies.

Besides these two major industrial groups, a growing number of small and medium enterprises are involved in the space sector as users and processors of space-derived data and space-based services.

The space industry's policy landscape

At a general level, the space industry enjoys stable, predictable demand for its products from government customers and a stable space policy environment. Casc and Casic's near- and long-term demand expectations are based on the Five-Year Plans and even longer-term national strategies. These companies do not contend with abrupt program changes and fluctuating budgets in the way firms in other countries do.

Other features of the space industry's policy environment, however, are far less stable. Relations between and the responsibilities of agencies in the space sector are shifting and contentious. At the industry and enterprise-group levels, broad and deep reforms have been implemented several times.

The object of these reforms is a transformation of the space industrial base. Like policies targeting other major defense-industry SOEs, these measures are intended to make the space enterprise groups more efficient and behave more like commercial entities. Casc and Casic have undergone several rounds of reorganization and consolidation and internal reforms intended to introduce market mechanisms into their governance.

Another industrial strategy for the space sector is also taking shape. Central, provincial, and local governments are investing in several space-technology industrial hubs near major historical centers of aerospace research, development, and production across the country. These efforts will leverage existing local competencies to create economies of agglomeration and clusters of networked expertise, conditions usually regarded as conducive to innovation, firm specialization, and small-business development in the lower tiers of high-technology industries.

In addition, China is entering a phase of space-sector development during which even greater emphasis is placed on the commercialization of space technology. A policy priority during this time is making space more relevant to lives of ordinary people and increasing domestic demand for space-related goods and services.

The space industry can be expected to increase its efforts to develop and market commercial ground-based applications of space technology. Historically, the most important domestic consumer market for commercial space applications has been for telecommunications services. More recently, commercial "spin-offs" such as nutritional supplements and agricultural produce made using space-treated inputs have been prominently advertised, though their commercial success and impact is unclear. In coming years, some of the most important space-related products are likely to be receivers and applications that use (perhaps not exclusively) the Compass signals and applications that utilise geospatial data for mining and other resource-management activities.

An evolving international strategy for industry?

A recent shift is detectible in how Casc and, to a lesser extent, Casic orient themselves toward global commercial space markets. The contours of a new approach are still only emerging, and it remains unclear whether it is indeed new and whether it will succeed. Nevertheless, recent developments and statements suggest an approach consisting of three major elements: a new communications effort; a reorientation toward different space products; and a move into new sectors outside space.

Communications to foreign audiences. The Chinese space industry is trying to take control of and improve its international image. At senior levels, there is a recognition that the Chinese space industry has not been proactive enough in communicating its own message abroad, letting its detractors define it. In an apparent rebranding and publicity effort, the industry is selectively seizing opportunities for international exposure. For example, Chinese delegations including Casc and sometimes Casic representatives are making more frequent and visible appearances at international space conferences. Chinese companies are making more information available and producing new promotional material. China Great Wall Industry Corporation recently advertised its launch services in Space News, a widely read U.S. trade publication.

Exploring space-component exports. The space industry has also expressed a new interest in the export of

satellite components, including to Western markets. These products would be less politically sensitive than launches and Chinese producers could sell them competitively. Attention to this area appears to supplement, rather than substitute, a long-standing effort to export launch services and other system-level solutions.

Expanding into new high-technology export sectors. The space industry also expresses an interest in expanding into export sectors outside space. These companies seek to build on their competencies in related high-technology sectors to export new products. For example, one space industry firm has expressed interest in exporting clean energy products, including solar panels. In developing in these new areas, this major industrial player hopes to become a Chinese version of Boeing or GE, global companies that deliver products and services in a range of high-technology civil and military sectors.

Advantages and disadvantages of U.S.-China civil space cooperation

The United States and China increasingly interact in space and already engage in space-related activities that could be termed cooperative. For example, the United States provides China with warnings of imminent orbital conjunctions between Chinese space assets and other space objects, because preventing another debris-producing event serves U.S. interests. Both countries also participate in many of the same multilateral processes addressing space issues.

Decision makers and policy makers exploring whether, when, and how the United States should cooperate with China in additional ways face an elaborate set of choices. The options before them are many and include the current policy of almost no cooperation. Examples of options for cooperation at different levels of sharing, risk, and potential pay-off, are listed in Appendix 2.

As decision makers, policy makers, and the public debate the advantages and disadvantages of cooperating with China in space, several considerations could helpfully inform the conversation.

A vision of a desirable outcome

Any answer to the question of whether the U.S. should cooperate in space with China should be logically derived from an explicit answer to a more fundamental, conceptually prior question: What type of space actor does the United States hope China will become?

If the United States and the international community hope that China becomes a “normal country” in space, then they should seek to foster, rather than stifle, China’s commercial exploitation of space and civil space activities. As China invests in and derives greater benefit from space, it will acquire the same stake in creating a predictable, stable, safe, and sustainable space environment that the U.S., Canada, Japan, and European and other countries already share. There are signs of China’s shift in this direction.

If, on the other hand, decision makers believe that it is undesirable or improbable that China become a regular, integrated spacefaring country, then they must carefully assess how much they can influence China’s space-sector development. This assessment could evolve with changes in the space environment, the commercial and international availability of space technologies, China’s capacity to autonomously develop space technologies, and third-party attitudes toward China’s role in space.

The domestic incidence of international cooperation

The discussion of U.S.-China space cooperation should recognize that every form of international cooperation has domestic effects. Any form of cooperation or non-cooperation with the United States will empower some actors within the Chinese space establishment at the expense of others. Premised on the right conditions, international cooperation projects can make civilian actors more prominent and influential within the Chinese space sector.

For example, international projects can be designed to enhance the role of the Chinese Academy of Sciences, the China National Space Administration, and the Ministry of Foreign Affairs, all civil organizations with an interest in establishing China's reputation as a reliable international partner in space. Cooperative projects designed without this awareness could symbolically and materially reinforce the military's control of the space sector.

The changing costs and benefits of the status quo

The debate over U.S.-China space cooperation should take into account that the costs and benefits of not cooperating with China in space are changing.

Other countries are beginning to build relationships in space with China that exclude the United States.

While China's capabilities in space are known to U.S. observers, its intentions are not. The status quo may deprive the United States of options and tools for learning about these intentions. Cooperating could open avenues to learning how China's leaders understand their country's interests in space and the means to pursue them and how they make choices.

China is one of very few countries where space budgets are stable and might grow. That makes it an important potential partner for large future missions and, possibly, a costly one to exclude. The Chinese market for space-related products is also large and growing, and may develop in a way that excludes U.S. participants more effectively than it would if the bilateral relationship were more robust on space issues.

Cooperation, especially on technical projects, creates an opportunity to engage China's emerging space policy community at a pivotal time. Space is a highly technical policymaking area in which leaders are likely to rely on the input of specialists, especially scientific and technical personnel who work in the sector. There is growing awareness within China that a more systematic and institutionalized process for channelling space expert advice to decision makers is needed.

A community of space experts able to play this policy role is coalescing. So far, however, this community remains nationally focused, with relatively little exposure to international ideas and perspectives, and with an uncertain grasp of evolving U.S. space policy and interests and of trends in the space environment.

At the same time, the Chinese space program is entering a phase during which the demand for this community's expertise will grow, as major space policy decisions present themselves. For example, political leaders will have before them a choice about whether and how China should send taikonauts to the Moon, and whether it should do so alone. The impact of the space policy community on policy outcomes is likely to grow as such questions arise.

Engaging this nascent community in dialogue and introducing it to more international perspectives and new ideas could serve U.S. interests. Developing long-term relationships with these space professionals could also provide the United States with additional points of contact and channels of communication into the Chinese space system, both of which could prove valuable in a crisis.

Conclusion

Please accept my sincere thanks for the opportunity to share with you the outcomes of my research and thoughts. I would be pleased to answer any questions at the hearing or in writing.

Appendix 1: China's human space flight and space exploration programs

Milestones in the development of the Shenzhou-series crew transportation vehicle
In 1992, the human spaceflight program is initiated with the adoption of Project 921, a strategy outlining a three-stage strategy to begin with the development of a crew transportation vehicle, the Shenzhou capsule system.

In 1999, China conducts its first unpiloted spaceflight test. Tests in 2001 and 2002 (March and December) follow.

In 2003, China accomplishes its first human spaceflight mission. Yang Liwei orbits the Earth 15 times and becomes the first Chinese national in space.

In 2005, the Manned Space Engineering office conducts a second piloted mission, Shenzhou 6, a longer, multi-person mission. Fei Junlong and Nie Haisheng orbit the Earth 76 times and conduct scientific experiments on orbit.

In 2008, the program enters a second stage with the launch of Shenzhou 7. This mission's crew conducts extra-vehicular activity (EVA) and space science and technology tests, including tests involving data relay to an accompanying satellite. Taikonauts Zhai Zhigang and Liu Boming, wearing Chinese-developed and imported Russian spacesuits respectively, perform China's first EVA, lasting about 20 minutes. The main Shenzhou 7 "breakthroughs" relate to the testing of the Chinese-made Feitian EVA spacesuit, EVA training, and airlock technology. China is only the third country to possess the technology needed for EVAs.

Plans for the space laboratory
The second stage of China's human spaceflight program involves the launch of a space laboratory that will test space applications and develop capabilities required for the on-orbit assembly and operation of a larger space station.

The launch of the unpiloted Tiangong 1 is scheduled for the second half of 2011. It will serve as a platform for tests of rendez-vous and docking capabilities. On the current schedule, the unpiloted Shenzhou 8 will dock with Tiangong 1 in 2011. The crewed Shenzhou 9 and 10 will also dock with Tiangong 1.

Tiangong 2 will launch around 2013, followed by Tiangong 3 around 2015. Tiangong 2 will support a crew of three for about 20 days. It will refine capabilities required for orbital rendez-vous and docking and longer-term taikonaut stays on orbit. Tiangong 3 will support a crew of three for about 40 days. These crews will carry out small-scale space science research and applications work, accumulating experience for work on the space station. Tiangong 3 will test new life support systems and the on-orbit replenishment of air and propellant.

Plans for the space station
The current human spaceflight program culminates in the construction of a 60-ton, three-module station on orbit, capable of supporting a long-term human presence in space.

At its largest, the space station will include a core cabin module, two laboratory cabin modules, a docked Shenzhou piloted spaceship and a docked Shenzhou cargo vessel. The combined weight of the three modules will be 60 metric tons.

The core cabin module will launch in 2020, followed by he laboratory cabin module 1 in 2021 and the laboratory cabin module 2 in 2022.

The station will support a crew of three astronauts for long-duration flights. During their time on orbit, they will conduct a wide range of space science and applications experiments and work. These activities will span microgravity science, space life science, space astronomy, space physics, and tests of new application technologies.

The Lunar Exploration Program
The lunar program has three stages: orbiting, landing, and sample return.

Orbiting stage. In the first stage, 2002 to 2007, two satellites, Chang'e 1 and a back-up, orbited the Moon and collected scientific data, including images of the lunar surface.

Landing. During the second and current stage, 2008 to 2014, a third satellite, based on the first-stage vehicles, was developed to test additional new technologies. In late 2010, Chang'e 2 launched and entered lunar orbit, where it continues to collect data. The Chang'e 3 satellite will launch around 2013 and land on the Moon, releasing a rover that will operate on the lunar surface for three months. A Chang'e 4 vehicle will serve as a back up to Chang'e 3.

Sample return. In the third stage, 2015 to 2020, a small capsule will land, collect samples using newly developed sampling and drilling machines and robotics, and return the samples to Earth.

Appendix 2: **Options for U.S.-China space cooperation projects and efforts**

Examples of options for low-level cooperation that include relatively little sharing and carry limited risks include:

- minimal bilateral civil-scientific cooperation with no hardware sharing: such as data exchange, briefings on space science activities, and site visits;
- multilateral cooperation to promote international data sharing and interoperability;
- creating arrangements and protocols to systematically collect and share biomedical data on astronauts and taikonauts.

Examples of medium-level cooperation that include some sharing and some, potentially manageable, risk include:

- hosting small Chinese scientific payloads on the ISS or on U.S. assets;
- inviting Chinese taikonauts to fly on the ISS, in the same way as other non-Americans are invited on missions to the station upon the Russian Soyuz and the U.S. Shuttle (and its eventual successor) transportation vehicles.

Examples of substantial cooperation that require sharing hardware and accepting a level of mutual reliance, high levels of risk, and high visibility, and which could also generate important political rewards include:

- jointly developing large instruments for flight aboard the ISS with Chinese institutions;
- jointly building a new unpiloted spacecraft, such as a new space telescope or satellite;
- allowing a Shenzhou-series or other Chinese vehicle, with or without crew, to dock with the ISS;
- inviting China to be a hardware-contributing partner on major new multi-national exploration projects, such as a mission to Mars.

Examples of options for fostering industry-led or commercial activity between the two countries include, in increasing order of significance:

- reforming or adjusting the export control regime to allow relatively circumscribed trade in space products, such as on small satellite components;
- reforming or adjusting the export control regime to allow trade in important space-related goods and services, such the Chinese launch of U.S.-made satellites;
- reforming the export control regime to allow the on-orbit delivery of turnkey satellite systems to users in China.

PANEL IV: Discussion, Questions and Answers

HEARING CO-CHAIR WESSEL: Thanks to each of our witnesses.

We will start with Commissioner Wortzel.

COMMISSIONER WORTZEL: I want to thank all three of you for appearing here and for your testimony.

Dr. Moltz and Ms. Krolikowski, when you discuss the pros and the cons of the U.S. restriction on International Traffic in Arms Regulation controlled technologies to China, you seem to imply that this was a mistake, that it stimulated Europe to develop ITAR free space technology, and that European countries captured the China space market.

Now, last year, the Foreign Affairs Committee suggested loosening ITAR controls, but carving out China. I mean certainly a number of the members of the House Foreign Affairs Committee believe it would be a mistake to loosen ITAR controls related to China. Are you suggesting in your testimony or implying that the U.S. reconsider ITAR controls on China?

And Dr. Pace, if you have any views on the matter, I'd be happy to hear them.

DR. MOLTZ: Thank you for your question.

Yes, I am suggesting that the U.S. reconsider its ITAR restrictions on China. As I said in my testimony, I believe that it has been an overly blunt instrument. When I talk to people in U.S. industry, they don't express a great desire always to launch on Chinese rockets, but they say they need the flexibility to be able to do so if they need it.

In addition, I think part of the reason for the controls had to do with protection of U.S. space launchers. Fortunately, the U.S. today has a growing stable of very capable space launchers with SpaceX Falcon 1 and Falcon 9 coming online. I think the competition is not going to damage the U.S. space industry, as perhaps it would have a decade ago.

In addition, if we revisit the Cox Committee, and we look at what the problem was with the Loral and Hughes cases, it was that they met with Chinese officials without U.S. Export Control Advisors present; they violated U.S. export control regulations.

COMMISSIONER WORTZEL: Sir, that is not true. I was in China then, and there were Export Control Advisors present.

DR. MOLTZ: Well, that's even more interesting. I was told a different story, but I will yield to your greater knowledge.

In any case, the problem was not with Chinese meddling with our actual satellites. The companies involved have a great interest that China does not mettle with their satellites. And so I believe this can be done without risk of loss of U.S. technology.

I would agree also with Ambassador Schulte: we want to build higher barriers around a smaller number of technologies. That would be my recommendation as well.

MS. KROLIKOWSKI: Thank you for your question. I should clarify that in my testimony, both oral and written, I don't exactly express a position on the U.S. Export Control Regime or on any carve-outs for China in it.

I think the issues are complicated. They involve far more than the U.S. space industrial base or any economic interests; they also involve the symbolic benefits and other political costs and benefits of changing these provisions, rules and laws. I, myself, don't have a confident opinion about how those different costs and benefits should be weighed.

I will say that I think the issues with the U.S. space industrial base that were mentioned earlier this morning and that you mentioned are very complex, and many factors account for them. Launch costs are no doubt among them, but they're probably not the sole reason for some of the difficulties we observe today.

In the short term, I think it's unrealistic and probably politically unfeasible to hold out for any modifications to the China exception in the U.S. Export Control Regime. I think if pursuing that kind of change would imperil the larger export control reform process currently underway, the result would be a net loss to the United States. I think it would be unwise to complicate the export control reform process, which is already challenging, with this change right now. That is, of course, an observation from an outsider to the process. I do think that, eventually, in the fullness of time, it would be possible to devise procedures and protocols that would minimize the risk of sensitive technology transfers occurring in the course of launching U.S. satellites on Chinese launchers. I believe that will be something that decision-makers will eventually be able to consider.

DR. PACE: I agree with that assessment about the political infeasibility of taking the China exception out if you want to see export control reform passed. I do believe that the decisions that were made on moving Category 15 space items to the USML was in retrospect a mistake.

However, I don't believe that in rectifying that mistake that we should change the exception on China at this point. Now, the reason why I say it's a mistake may be a somewhat academic reason as well as a practical reason, and the irony is we're having this discussion in this particular building.

I believe that the legislative move to limit what was on one export control list or another interferes with the President's prerogatives to conduct foreign policy. There is nothing that is more an executive branch function than making a list and checking it twice. And therefore, the first role should be to return the authority for that list back to the executive branch and then proceed forward with reforms on that.

So I think we have a separation of powers problem in addressing a very serious issue, and again I don't believe that politically we should try to change the China exception at this point because I think there's a broader problem of export control reform that ought to be addressed first.

HEARING CO-CHAIR WESSEL: Thank you.

If I can ask a couple of questions about the commercial side of all this, commercial civil side, and get a little better understanding about some of the competitive pressures that are faced and competitive opportunities.

And Ambassador Schulte this morning talked briefly about the defense industrial base. To the extent you have knowledge, what is the size of the market we're talking about? What are the challenges that China poses in terms of that global market? What has it done? What advantages or disadvantages has it posed to the U.S. in terms of commercial launch, or satellite building?

So looking at it just straight as an economic issue, is China an aggressive and competent competitor? Are they behind us? What does it mean economically for us in terms of the U.S. interests?

Whoever wants to go first?

DR. MOLTZ: I would say several things. First of all, China and the United States currently occupy different parts of the market. We have the high end. China has the low end. The overall space business is somewhere in the $240 billion range. The bulk of that is in satellite services.

HEARING CO-CHAIR WESSEL: 240 per?

DR. MOLTZ: $240 billion a year.

HEARING CO-CHAIR WESSEL: A year. Okay.

DR. MOLTZ: Approximately, but don't quote me on the exact figure. But again mostly in commercial communication satellites.

China has had trouble in a couple of areas, remote sensing as well as in commercial communications. When countries, for example, Thailand had the offer to purchase new satellites or had a decision to purchase new satellites, even though they're a member of this APSCO organization, they did not buy a Chinese satellite; they bought a French satellite.

The Nigerians received a Chinese satellite to serve as their first telecommunications satellite. It failed on orbit because of problems with the solar cells. So China is still going through a learning curve.

I think the biggest problem, and I would agree here with the testimony of my colleagues, that the market for the rest of the world is really critical. It's the market in Europe. It's the market in a number of developing countries. It's the market in Asia. The United States needs to do more to enter those markets. That's one reason why the ITAR is such a problem.

In addition, the components market is a very significant one. The United States is being pushed out of the components market because countries don't want to deal with the hassle, and so those are the areas I see of greatest concern.

HEARING CO-CHAIR WESSEL: Dr. Pace.

DR. PACE: I would add to that the observation that the international launch market is a relatively thin market, meaning that there's at most maybe two dozen internationally competed launches a year of which most of those are done by Russia and Europe. And China has been held to a

relatively small portion of that market because of the ITAR issues. So there's a counterbalancing here.

I would agree that the second and third tier supplier market has been hurt by the ITAR issues, as people have wanted to avoid dealing with some of that stuff internationally.

On the other hand, the quality advantages that U.S. firms have mean it's mostly still worth putting up with the trouble, but as that differential comes down, the willingness to put up with the ITAR issues will go away.

So the focus to me should not so much be on China as it is upon all the other countries that we're looking for competing with influence as we're looking at where China's foreign policy is taking it.

The second thing I would say is that U.S. policy instability is actually the bigger threat to the U.S. industrial base than China's actions in the market or not. By the cancellation of the former Constellation Program, which I admit to a bias as having been part of, it threw into doubt production runs for rocket engines in the United States, and notwithstanding the new commercial competitors who are coming on line, our industrial base is in great uncertainty right now in both solid and liquid propulsion systems because we have large fixed costs. We don't know what programs we're supposed to spread those fixed costs over; prices are going up. In a bad budget environment, the industrial base is under a great amount of stress.

China is largely irrelevant to that stress right now, but because of instability on our side, our industrial base is getting weaker, which produces opportunities I would argue longer term for China. So really the first problem is to fix ourselves at home and then be prepared to compete with China on a better basis internationally.

HEARING CO-CHAIR WESSEL: Ms. Krolikowski.

MS. KROLIKOWSKI: I would add an observation about the sales to developing countries. To keep everything in perspective, China is effectively excluded from the global launch business because almost all satellites produced include U.S. components, and that means that China can't launch them.

So those export opportunities that China does find are in a very circumscribed set of countries and under a very particular set of conditions. The arrangements we've observed so far have been with about six developing countries. Most recently we've heard that there may be an agreement in the works with Belarus, but so far China has reached agreements with Bangladesh, Bolivia, Indonesia, Lao, Nigeria, Pakistan and Venezuela for exports of either launches or satellites or both.

Those arrangements have not been internationally-competed sales in the sense that we understand them. They have been very concessional arrangements. The exports of these products and services have been helped by substantial development assistance and technical assistance tied to them,

and very soft-term loans, very generous financing.

In a lot of ways, China hasn't taken these opportunities away from the United States. China has created new buyers of space products where they didn't previously exist. An interest in space assets does exist in these developing countries, but it is not expressed as demand on world markets because most of these countries don't have the budgets or the foreign currency reserves to spend $300 million purchasing a satellite the way buyers in developed countries do.

So China has leveraged a unique advantage it enjoys in these developing markets. The Chinese space industry has operated in partnership with the government to arrange concessional sales. But I think these cases are isolated and very different from the broader trends in the global launch and satellite industry. Having said that, though, there has been a string of these sales recently, and I think we can expect more. As the Chinese space industry continues to use these opportunities, it will develop a better and better record of reliability and more and more experience exporting. We can expect that there will be greater and greater interest in turning to Chinese space products over the very long term.

HEARING CO-CHAIR WESSEL: Thank you.

Commissioner Blumenthal.

HEARING CO-CHAIR BLUMENTHAL: Yes, I had a follow-up to the last question on the commercial market and the competition within the commercial market. So you say it's about $240 billion a year. That's the size of the market. It includes launch. It includes the use of satellites, the buying and acquisition of satellites. You said that China is having particular problems in remote sensing and what else?

DR. MOLTZ: Telecommunication satellites.

HEARING CO-CHAIR BLUMENTHAL: Telecommunications--a set of questions related to that. So $240 billion of business. Where do the biggest markets lie? That would be question number one. In that 240 billion dollars a year, where are the big markets for what capabilities? I mean 24 launches a year doesn't sound like a lot, but maybe they're very expensive. And where would our companies actually be competing with China? In what capabilities if they're having certain problems? You made a high end/low end comparison.

Where are we actually competing with China? Is China our biggest competitor, I suppose, versus Europe or Russia for that $240 billion a year market? That's for all of you.

DR. PACE: I would say that China is not a major competitor right now in space, in part due to its own limitations and in part due to some of the export control restrictions. When you break that $240 billion number down--which by the way I believe comes from the U.S. Space Foundation which has an annual report, global space report, and you can get that online from the Space Foundation--is that the biggest number is in services. So direct

broadcast satellite services, direct broadcast TV, satellite communications, and point-to-point mobile services.

The second large chunk of--

HEARING CO-CHAIR BLUMENTHAL: GPS?

DR. PACE: No, because we don't charge for that, GPS, and for good reasons, which I could go on at length about, but I won't. The other area is in manufacturing satellites and ground equipment. So services make the most money. Manufacturing makes the next most amount of money, of which GPS parts and components are part of the manufacturing side.

And the area that makes the least amount of money is launch services. So countries want to get into the launch market for national prestige reasons, dual-use reasons, it is a lousy business to be in. It has probably the least margins. It's very stretched. You're up against all kinds of other kinds of competition of which China epitomizes.

The big competitors in the international launch market today are Europe and Russia. So if China were to enter the market in some unrestricted way, the people who would lose immediate market share would be Europe and Russia. The U.S. has largely been driven from the field in internationally-competed launch services. We used to have a fairly large proportion of it in the 1990s, and for a variety of reasons we have largely been driven out.

U.S. launch providers largely subsist on government tied capabilities. We are not fully competitive.

HEARING CO-CHAIR BLUMENTHAL: But you're saying that that's not that lucrative of a market, right? So from a commercial perspective, it sounds like the services market would be the most lucrative, and where is the competition coming from to U.S. businesses on the services side?

DR. PACE: On the services side, it's primarily Europe. I mean Europe and satellite operators in Europe, Intelsat and SES based in Luxembourg. I mean the satellite services market is a very intensely competitive commercial market of which manufacturing satellites is related to that.

HEARING CO-CHAIR BLUMENTHAL: And how are we doing in terms of market share?

DR. PACE: Not too bad. I think that it could always be better, but there is a fairly robust and market-driven competition. The concerns with China have largely been in the nature of non-market competition so I take the point made about in many cases China has created new demand with people that we probably would not pay that much attention to or have difficulty dealing with or are not that attractive.

To that extent, China is bringing new demand to the market in a way, due to its approach, but for our commercial companies, I think they are mostly concerned with other market-driven economies and not so much with China.

DR. MOLTZ: I would just add one point. When you launch a satellite,

the rocket itself is actually not the biggest expense. It's the stuff on top. Those can be over a billion dollars, especially if they're multiple satellites, and so the question that I hear commercial representatives talk about is: we have a satellite that's ready to go, but we can't find an American launcher that's ready to go. We waste a lot of money. And so they want to be able to have the ability to turn to other launchers occasionally for these kinds of services.

The one change, though, again, is SpaceX, and they are beginning to get foreign commercial contracts, not a lot, but a few, and so we are beginning to see a change. We have other products that are available, and I think that will increase in the future.

HEARING CO-CHAIR WESSEL: Commissioner Shea.

COMMISSIONER SHEA: Just thank you, all three of you, for being here.

Let's start off with a simple factual question. Our briefing memo says China was not asked to participate in the International Space Station, and something in the back of my mind says that that might not be correct. Was China asked to participate in the space station?

DR. PACE: From my knowledge of the history, no. The first invitations to participate in the International Space Station were decided by President Reagan, and went out to our traditional friends and allies in Europe, Canada, and Japan, and then later Russia was added. There was never a formal invitation issued to China.

The point that Dr. Moltz mentioned earlier about consideration of a Chinese astronaut going aboard the space shuttle I think was in the context of the late 1980s, and looking at the changes that were happening in China, and I believe in post-Tiananmen all that discussion went away.

COMMISSIONER SHEA: Has there been any reconsideration of that to invite? I mean China is building its own space station, but has there been a reconsideration of inviting to China to participate in the ISS?

DR. PACE: Not that I've heard of. There have been a couple of these tentative discussions between NASA and the China National Space Agency. I don't believe that there's particularly anything formal or anything committed there. When talking about manned space flight, I said that I thought there were a lot of technical as well as political hurdles.

One of the things I meant by technical hurdles is that flying someone aboard your spacecraft or working that closely with them involves a deep, deep degree of cooperation and trust and transparency with each other. In the case of Russia, it took about eight years of living, breathing, working with them, us flying astronauts aboard the Mir Space Station, flying cosmonauts aboard shuttle, setting up a NASA facility in Star City outside of Moscow, translating languages, going through technical details. I mean it was an intense long process before you got to launching the first space station component.

So whenever someone talks about manned space flight cooperation

with China, I go, okay, ten years after the political decision is made, you have a long process that you're going to go through, which is why I personally go more toward smaller scientific cooperation first. Don't start me with manned space flight.

COMMISSIONER SHEA: Sure.

DR. MOLTZ: Just to follow up, I would just want to point out that the Apollo-Soyuz mission in 1975 did that not require that level of planning in advance and was carried out successfully.

I've also talked to a number of astronauts about this issue and asked them flat out, do you think we should allow the Chinese? To my surprise, many former military astronauts said yes, I don't see why not. I don't disagree with Scott's point. It's going to take a lot of work, but I think this is an interesting data point.

COMMISSIONER SHEA: I'd like to ask another question. Does China provide any critical--we've been talking about U.S. technology being transferred to China--does China provide any critical materials or technology to the U.S. space sector? For example, when the shuttle goes up or when it went up, were there Chinese source components on the shuttle?

DR. PACE: No. And the area, though, I think of concern, it's a low level concern, but it's growing, is the general problem of counterfeit parts, aircraft, aviation parts, counterfeit spacecraft parts that are showing up in the supply chain.

Some of those may have links back to China. So electronics and so forth. So to the extent--

COMMISSIONER SHEA: In the space program. I've heard it in the aeronautics.

DR. PACE: Right. That has not shown up yet, but people are starting to worry about it. The NASA Chief Engineer's Office worries about counterfeit parts and components. Some of those may be sourced to Chinese controlled territory. And so that's a background worry, but in terms of your question, are there any things legitimately that we rely on, the answer is no.

COMMISSIONER SHEA: Okay. Thank you.

HEARING CO-CHAIR WESSEL: Commissioner Slane.

VICE CHAIRMAN SLANE: I'd like to thank all of you for taking the time to come here. It's been very helpful.

Dr. Pace, I was intrigued by your remarks about areas of cooperation with China. I think you talked about the solar storms and some of the physics aspects. Could you go into a little more detail and maybe how that might work out?

DR. PACE: Sure. Actually the model I was thinking of is the European Space Agency had a program called Cluster, which is a series of satellites that monitor the solar environment, solar storms, and the magnetosphere around the sun, and they had a series of satellites, and the Chinese

contributed satellites of their own in a program called Double Star.

And they put these in different orbits around the sun. They got data from different areas around the sun. They combined that data. There was open sharing of scientific data from that. So that's an example of cooperative research.

When I talk to National Research Council scientists and so forth, and I ask them about what could you possibly do with China, and plasma physics, heliophysics comes up first. Earth science research comes up as well. The solar storm warning is another classic one where you're dealing with basic physics. You're not dealing with things that involve highly proprietary technology, and you start developing relationships with the Chinese university system.

You don't necessarily have to deal with PLA offices although obviously the PLA is pervasive throughout the space program. But you start developing relationships with the scientific community.

In my mind, in a way that's analogous to what was done with the Soviet Union in 1960s. Even during the height of the Cold War, we had some discussions and exchanges on relatively non-sensitive areas to start laying some relationships in place that may or may not come to fruition in the future, but I think were a manageable risk.

MS. KROLIKOWSKI: Can I?

VICE CHAIRMAN SLANE: Please.

MS. KROLIKOWSKI: The Double Star program illustrates the extent of institutional and organizational diversity that exists within the Chinese space establishment. The Double Star program, of which many in the Chinese space community are extremely proud, was, unlike many other space activities, instigated from within the technical community, from the bottom up. It did not result from a specific priority identified at the top by the central leadership, but came from within the scientific community.

It’s an example of the kind of project that China can undertake in partnership with other countries, at the initiative of the Chinese scientific community. It shows the promise and potential of China's professional space community for international engagement and for programmatic agenda-setting.

VICE CHAIRMAN SLANE: Thank you.

HEARING CO-CHAIR WESSEL: Commissioner Mulloy.

COMMISSIONER MULLOY: Thank you, Mr. Chairman.

Dr. Watts, who testified earlier today, in his prepared testimony, he noted that China's space program contributes to China's comprehensive national power above its contributions to China's military power.

Ms. Krolikowski, on page three of your testimony, you talk about that China's space program is an important part of building a high tech industrial base in that country, and you even say that, quote, "high-end manufacturing and information technology, which includes satellites and

telecommunications, are among the seven new strategic sectors identified in the new Five Year Plan to receive policy support and public investment."

What is it about these industries that contribute to China's comprehensive national power, and why are they giving them special attention as part of their new Five Year Plan? What's driving that in China? If you could comment and address it, and anybody else want to add to it?

MS. KROLIKOWSKI: I think Chinese leaders and policymakers have recognized that space plays an increasingly important role in the global economy, that the use of space assets can contribute to economic modernization and economic development. They also, as I mentioned in my testimony, identify other objectives that space activities can help meet.

On the whole, China's development strategy is increasingly oriented toward the development of advanced, sophisticated technical capabilities. Space is one of many areas that are receiving increased attention, as part of this larger effort to build a knowledge economy, foster innovation, and cultivate a sophisticated scientific, technical and industrial manufacturing base that is capable of producing high-tech products to be sold not only at home but also abroad.

I was told several times by people I consulted in China that China doesn't want to just make shoes anymore. From that perspective, it is a natural objective for a country facing China's development challenges and opportunities to want to move into higher-value-added export areas.

So I regard space as one area among many, one prong among several, used to create that type of economy. In space, some of the most interesting measures have been forms of policy support to the space industry, as well as dramatic marketizing reforms that are intended to make the space industry more efficient and to improve its performance.

The outcomes of these efforts remain to be seen. There are still obviously huge technical challenges that China has to overcome, especially in areas like satellite manufacturing. But on the whole, I don't see the strategy changing, and I think the commitment to it is very strong.

DR. PACE: I would just add to that in the case of the Shenzhou system, it's considered quite an honor, I am told, to be a supplier to Shenzhou. So if you're supplying something for the manned spacecraft business, that means you have to be operating at a certain quality level. You are not just a routine supplier, but you're supplying something of high prestige to the country.

So in many ways the space business is a teaching business. It's a way of teaching high-level system engineering. It's a way of raising quality control. It's a way of saying if you're not up to meeting quality standards that we specify; you're not going to be part of the program.

So as an educational and training activity, as part of the overall economic policy spur that is described, space is a tool of overall economic development, not just for itself, but the educational value it has on the rest

of the economy and supply chain.

COMMISSIONER MULLOY: Mr. Moltz, on page nine of your testimony, you say, "As a condition for opening the American market to Chinese launchers." Does that mean permitting the export of satellites to China to be launched by China? What does that mean?

And then you say, "the United States should insist that China open its domestic market to U.S. satellite producers for on-orbit services." I didn't understand what that sentence meant, and--

DR. MOLTZ: No one is talking about sending China satellites for them to look at, take apart, whatever. What we're talking about is the American manufacturers to launch on Chinese rockets under controlled conditions, obviously so that the satellite is not tampered with.

COMMISSIONER MULLOY: Where would they be launched? In China?

DR. MOLTZ: They would be launched in China.

COMMISSIONER MULLOY: Okay.

DR. MOLTZ: Now, in addition, there could be on-orbit services, in other words, satellites that are launched elsewhere that provide communications or something like that to China. It could be Direct TV. It could be anything along those lines because that is a growing market that the United State is active in elsewhere.

COMMISSIONER MULLOY: So you're saying--

DR. MOLTZ: It's not providing manufacturing technology in any shape, manner or form. It's not providing satellites that they would open up and look at.

COMMISSIONER MULLOY: Okay. Thank you very much.

HEARING CO-CHAIR WESSEL: Chairman Reinsch.

CHAIRMAN REINSCH: Well, first of all, on the ITAR issue, Dr. Moltz, stick to your guns. I don't agree with Larry. I think you've got the history right.

[Laughter.]

COMMISSIONER FIEDLER: He asked me to turn the microphone off now.

[Laughter.]

CHAIRMAN REINSCH: I had some involvement in it at the time. I think you're on target in terms of what I want to pursue. I have two questions.

Dr. Pace, you mentioned in passing that the U.S. industry's market share had declined for a variety of reasons since the late '90s.

Can you elaborate a little bit on what the variety of reasons was, were? And if the other two want to join you, go ahead.

DR. PACE: Sure. Well, a couple things happened. First of all, there was a decline in the overall market. There were expectations for mobile satellite service systems, like Iridium and Globalstar and so forth, and there was a large increase in capacity worldwide where the demand simply didn't materialize and therefore with the dot-com bust in the 1990s, a lot of that

collapsed.

And therefore those companies that were more market driven and had private investors to satisfy found themselves in deeper trouble. Those launch suppliers that were essentially parastatal enterprises of some sort, such as the Russians or Arianespace, which are not fully market-driven, were able to survive that downturn better.

Also, U.S. suppliers, I think, found the government market more attractive and easier to work with. The margins were better, change orders were compensated, and as a result there was a natural migration to serving the U.S. government market.

As they did so, their ability and flexibility to deal with international commercial competition also went down. I've had friends, major launch suppliers, satellite service companies like Intelsat complain that they want backup systems. They want a U.S. option, but many cases, the U.S. launch providers are more oriented toward meeting DoD and NASA needs, not unreasonably, and therefore the Europeans and Russians actually are more flexible in terms of handling schedule and handling conflicts. So just from a convenience standpoint.

Market decline, other more attractive opportunities at home, not really being fully market driven, and being up against other parastatal enterprises. Particularly in a thin market like international launch, a little bit of government support goes an incredibly long way towards surviving.

CHAIRMAN REINSCH: Thank you.

Comments from either of the others?

DR. MOLTZ: Can I just add that I think the only missing factor in Dr. Pace's answer is again the ITAR issues. I have talked to several foreign producers who are interested in working with the United States, even in Canada, and they say that the ITAR regulations are simply too burdensome, and they decide not to purchase American equipment for that reason.

CHAIRMAN REINSCH: Ms. Krolikowski, do you have anything you want to add on that one?

MS. KROLIKOWSKI: The ITAR issue is very different with respect to China than it is with respect to all other countries. And in that sense, I think it's difficult to draw general conclusions about ITAR that could extend to a trade relationship with China in space.

CHAIRMAN REINSCH: Thank you.

Finally, several of you alluded to either the possibility or likelihood that the U.S. space station would essentially go out of business at roughly the same time as the Chinese space station is coming on line. It seems to me the symbolic impact of that globally would be enormous. Is that right? Or would this just pass unnoticed?

[Laughter.]

DR. MOLTZ: One quick comment is that that's all true, but again, like Bigelow Aerospace, there are going to be other providers up there by then.

So I think we will notice it less than we would in the current environment.

DR. PACE: And I hope that's true. I had those providers sit in my office when I was at NASA and tell me by what dates they would have so many vehicles flying, and I'm still looking at my watch.

I think they will succeed. They will succeed in time, but this goes to the deeper problem of do we think of space as a strategic national capability or not? If we think it's simply something for entertainment value, prestige value, then that's one thing. If we think we have a strategic reason for being in space for economic or military reasons, and that human operations through space is an important capability to have, then we're in a different category.

So it depends on what kind of space program we think we want to have. If we're okay with relying on the Russians say through the gap, we're ending the shuttle program, we're not going to have access to the space station for several years, we're going to be reliant on the Russians for several more years, if the commercial providers succeed, great. If they don't succeed on time, the answer is we're going to be reliant on the Russians for a longer period of time.

If, God forbid, there is a problem with the station between now and over the next decade, and we don't have a way of getting there with U.S. government systems and the commercial systems are not ready, and the Russians could have their own problems.

We have set up a very undiversified portfolio for our access to space, and, in fact, one of the points I mentioned in a footnote in my written testimony, is there are colleagues of mine who argue for human space flight cooperation with China as a better hedge. That is as an alternative to having to rely on the Russians, we should have Chinese ability to have access to space, which is technically possible.

We could do it. I don't agree with that, but you have technical people talking, "umm," we might want to have a China access to the space station as a hedge in case the Russians run into difficulties, we have no shuttle, we don't know what the commercial guys are going to be capable of in human space flight for some time, what other options do we have?

I think that's a terrible situation to be in, doing those kind of triage decisions, and again it goes back to what is the U.S. policy and objectives and what kind of a program do we want? The choices are more in our hands, and China is really a separate external issue.

CHAIRMAN REINSCH: That's worth pursuing--go ahead, Ms. Krolikowski.

MS. KROLIKOWSKI: The issue of a U.S. capability to provide crew transportation services to the ISS is certainly important, but I don't think it's as important as other issues. There have, after all, been recent periods during which the U.S. temporarily didn't have the capacity to send its crew up to the space station. Those periods were survived. They were overcome.

And both times a U.S. capability was restored. What I think has been contemplated far less, what I don't think has been realized more broadly by the public that reads about space in the news, is that there will probably be a time during which there are only two space stations on orbit. One of those will be an international space station that has several international partners--the U.S., Russia, Japan, Canada, ESA--and the other will be a Chinese national space station. If the International Space Station ends its operational life in 2020, the only long-term human presence on orbit for a period of time might be the Chinese space station.

Right now it's very difficult to measure what the symbolic impact of that would be. But as we rely on space more and more, as we talk more regularly of human beings being part of a space-faring civilization, the symbolic value of the only human outpost on orbit being a Chinese national station is likely to only grow. And I don't know that that issue has been discussed nearly as much as the crew transportation issue. So I hope more people turn their attention to that particular question.

CHAIRMAN REINSCH: Thank you.

HEARING CO-CHAIR WESSEL: Commissioner Cleveland.

COMMISSIONER CLEVELAND: I think that this question for Mr. Pace probably falls in the entertainment category rather than the strategic, but I was curious in your prepared statement, when you were discussing the Chinese potential for sending humans to the moon, you referred to an Orlan design for their EVA suit that has boots with heels, and I would like to understand why that's important.

DR. PACE: Because that was one the easiest examples I often make for audiences as to what the suit contains. EVA is a very, very sophisticated technical activity, and when you look at what the Chinese did, they built their own suit based upon a Russian design, the Orlan suit, and so it's not just for transiting outside of the space vehicle when you're floating, but also for being able to walk on a planetary surface.

The Russian suit was developed as part of an earlier Soviet lunar program and evolved from that so it has capabilities for surviving on a lunar surface, handling the degrees of temperature, cold and hot.

And simple things like a heel, things like notepads on your wrists, mirrors so that you can see what your instruments look like, a lot of little practical details if you're actually going to operate outside.

If they wanted to build a suit solely for operations on orbit, they wouldn't have done some of the other things that the Russians did. The Chinese took that design and have an EVA suit that has the potential for being eventually used on a planetary surface.

They do not have a lunar program. They don't have plans formalized for that. They're merely doing studies at this point, but the point that I was trying to make in that example is that they are achieving the capabilities where they will have the option of choosing whether or not they want to

have a lunar program.

They are piece by piece building, and so having a suit with a heel on the bottom that you can walk on the surface, to me, was I thought an entertaining way of making the point.

COMMISSIONER CLEVELAND: The heel essentially gives them traction is what you're saying? This is not a Dior sort of--

DR. PACE: It is not a high heel of any sort.

[Laughter.]

COMMISSIONER CLEVELAND: We were, probably you all didn't read that in the testimony, but Carolyn and I were very taken with that. Is there anything you would like to add?

DR. PACE: That is a later design improvement that I'm sure our Italian colleagues will pay attention to.

COMMISSIONER FIEDLER: Is that a Mars and Venus moment?

COMMISSIONER BARTHOLOMEW: Well, yes, unusual that heels would actually facilitate the walking process. That I think is probably what we noted.

DR. PACE: Within reason.

HEARING CO-CHAIR WESSEL: They don't?

COMMISSIONER CLEVELAND: Somebody has to bring some levity to this.

HEARING CO-CHAIR WESSEL: So to speak.

[Laughter.]

COMMISSIONER CLEVELAND: I'd like to take two of your pieces of testimony and ask you to square them, if you would.

Mr. Moltz, you said, on balance, Chinese civil space capabilities can be expected to increase in the future. They will be able to undertake unilateral and international space projects of increasing complexity that will, in turn, increase commercial--

DR. MOLTZ: You're reading someone else's testimony.

COMMISSIONER CLEVELAND: This is Mr. Pace. I'm reading Mr. Pace's--yes, sorry--increase commercial military and diplomatic opportunities at times and places of China's choosing.

And Mr. Moltz, you note that, in reference to an Army War College report, you describe China's space industry as "dispersed, bloated and located in geographically isolated regions." And the sector has yet to deal with a series of reforms as Chinese authorities have sought to inject greater civilian management.

Could you two sort of debate those two points?

DR. MOLTZ: Actually I don't think we're debating. I would think we probably both agree on those points. I think they're both true.

DR. PACE: An example of this is the launch sites. If you look at the Chinese launch sites, most all of them today are fairly far inland. That was done because Mao feared attack so they liked having them a little bit

farther away from the sea. If you look at the development they're doing on Hainan Island, which is near the coast, they even have golf resorts. So they hope to have tourism as well as space launch. It is obviously closer to the ocean and arguably more vulnerable, but they're doing that because they see preparation for that as a way to get into the commercial market.

There's an evolution going on over time. There are these incredibly bloated and isolated facilities, but the PLA has gone through a series of reforms. It is not the old PLA, as you have experts here who can certainly describe better than I can, and the space business, in my view, is in the same situation. You're seeing one that's becoming more efficient. It's making changes to be more engaged with the outside, outside world. So they are in transition.

And so some things like Hainan represent I think more of the future. Some of the older sites represent the past.

COMMISSIONER CLEVELAND: And the specific reforms that you could identify that are current and maybe going forward that we could look for that would reflect a more competitive industry?

DR. PACE: Well, one of the things I would say, is that I usually reserve a lot of criticism for Chinese transparency or lack thereof. I will say however that at international conferences, you are seeing people--PLA officers usually in civilian clothes--giving very frank and open presentations that would have been remarkable, I think, several years ago.

You're seeing technical models show up. They're answering technical questions. They're showing photographs of their training facilities and so forth. So there has been this process where it's like "no," and then, well, we'll show you a little bit more, well, then we'll have some more engagement.

So there is an evolution going on, and part of that is simply more of a frank sharing and discussion of those plans, even if it's not clear how they're making those decisions or how they got to that point.

DR. MOLTZ: If I could just add, though, the one, I think, advantage that I think the United States is not fully exploiting in space is our entrepreneurship. We have a lot of companies that are trying to get into space that are developing a lot of new technologies. China is still a planned economy, and China, I think, will be at a disadvantage if the United States is able to get its commercial house in order.

MS. KROLIKOWSKI: I think a helpful way to understand what's happening in the space industry and some of the efforts underway to make it more effective is to see these efforts as a combination of strategies.

In the broadest sense, there are several economy-wide policies that are favorable to the space sector. The space sector benefits from a range of general policy measures which include public investment and other forms of policy support directed at all strategic sectors.

More specifically, within the space sector, the state has implemented

several measures that specifically target space companies. One of those has been a cycle of consolidations, deconsolidations, and reconsolidations between Casc and Casic. That's at the industry-wide level.

Within those firms, a series of reforms have been introduced to make those firms more responsive to profit-like motives, to make them behave more like commercial entities, to introduce market mechanisms into their governance, and to incite them to raise financing and capital in new ways.

These firm-level efforts targeting the space industrial groups are also set against a broader systemic effort to create globally competitive and globally recognized Chinese brands and to promote the export of high-tech products.

COMMISSIONER CLEVELAND: Thank you.

HEARING CO-CHAIR WESSEL: Commissioner D'Amato.

COMMISSIONER D'AMATO: Thank you, Mr. Chairman, and thank the panel for very interesting dialogue.

I have a question that's been alluded to in different ways by you all and by Commissioners, and I just wanted to clarify my thinking on it, that is this sector--this space sector--fundamentally different from other sectors? Because it's so big, so complicated, so many opportunities for cooperation, for competition, for creativity, that there may be a different way that the United States and the Chinese can relate than we do in other more traditional sectors. In other sectors the Chinese seek technology in various ways from our firms, get the technology, build national champions, exclude us, and we're out the window, and they've got a branded technology in an industry that they've sought to get as a national champion.

Or is the nature of this sector more complicated than that, and we should look for opportunities that might be more fruitful to cooperate with the Chinese and actually could cooperate with the Chinese?

In terms of visuals, the history of this country was fundamentally changed by the fact that we got to the moon. That visual has been with us for decades and decades and has affected the attitude and reputation of this country across the world. So the visuals are critically important here, and the Chinese are certainly aware of that.

But we have all kinds of a cooperative institutions that we're erecting in the Joint Strategic Economic Dialogue, for example, but that doesn't seem to be changing too much of the competitive nature of the Chinese attitude toward us.

So I guess my question is, is this fundamentally different from what we have seen in sector after sector, and does it provide opportunity for a different paradigm, which would be nice, than we've had before with the Chinese?

DR. MOLTZ: This is your area if you want to go ahead.

DR. PACE: That's yours.

MS. KROLIKOWSKI: Thank you.

[Laughter.]

MS. KROLIKOWSKI: I spend a lot of time thinking about whether space is a special sector or not, and whether it can be profitably compared to other sectors. I think the answer to both questions is yes and no.

Economically, I think the space sector in China is different from some other high-tech sectors in that market relations within it have been slower to develop than they have been in other sectors. Space activities require huge infrastructural investments and, for that reason, there will probably always be a big government role in them.

So I don't think you can infer too many conclusions or predictions about China's space sector performance from looking at what has happened in other sectors. And, indeed, historically, Chinese space activities have been pretty insulated from broader societal developments. The legacies of that are still visible in the way China's program is organized today.

Space is also special in that civil or commercial space technologies have a close relationship to defense technologies. Space technologies have an important and well-known dual-use dimension.

But I think there's a certain lag in how we think about the dual-use nature of space technologies. More and more of space and of technologies in space are primarily commercial, and more and more activity in space is commercially motivated. And yet we still tend to overwhelmingly associate space with strategic competition and defense activities, when in reality much of what is happening in space is undertaken by private enterprises for commercial reasons. There are many other high-technology sectors in which products have important dual applications, but that we are more comfortable regarding as primarily commercial sectors.

One area in which space is obviously unique is in the symbolism that you point out, although here again I believe the uniqueness of space is sometimes exaggerated. There are other high-tech areas that are highly symbolic. I think aircraft manufacturing is a very symbolic industry, and we do also see China pursuing an advanced aircraft manufacturing program.

Having pointed out all of these ways in which space might be unique, I do think it's still useful to compare policy on space--whether it's U.S. export control policy, foreign policy involving space or any other area of policy touching upon space--with policy developed for other industries and other technical areas.

There's a lot to be learned about how to manage some of the risks and challenges in international space activity from examining how we manage those risks and challenges in other high-tech dual-use areas.

HEARING CO-CHAIR WESSEL: Commissioner Bartholomew.

COMMISSIONER D'AMATO: I think he may have had a comment.

HEARING CO-CHAIR WESSEL: Oh.

DR. PACE: I was just going to add to that, an area where there may be opportunities for cooperation with China is really a diplomatic one. One of

the areas where space is both symbolic area and somewhat special is how global it is. That is why we worry about orbital debris. We cooperate and compete in the International Telecommunications Union over frequency allocations.

China is a central figure in thinking about a code of conduct for space, the code of conduct says to reduce the chance of mishaps or accidents, we should establish limits on proximity operations, launch notifications, that sort of thing.

China and Russia have had a proposal for a Treaty for the Prevention of an Arms Race in Outer Space, as they call it, and it's a very flawed treaty, and I could go on at length about why it's bad, but as a counter to that, the European Union has a draft proposal for this space code of conduct.

Well, one question is, what is China's reaction to that potential code of conduct going to be? Will they join with us in doing that? When we look at orbital debris, are they going to work with us post the ASAT test, again, in a more constructive way?

When we look at the ITU, as they get into satellite services, as there are conflicts over geosynchronous slots and over frequency allocations, are they going to work with their neighbors in the Asian region and work with us in a more cooperative way?

So space has a lot of opportunities, not just for bilateral cooperation, but also for very sophisticated multilateral cooperation, and it's really unclear which way China is going to go. They don't necessarily see institutions that were created prior to the founding of the People's Republic as necessarily being something they're committed to.

They make a judgment as to whether or not it's in their interests to be part of these multilateral organizations, and so space is, I think, a diplomatic cutting-edge subject as to how China is going to engage with the rest of the world in these multilateral fora.

COMMISSIONER BARTHOLOMEW: Thank you. And thanks to all of our witnesses.

I'm always particularly pleased to see bright young women appearing before us and working on some of these traditionally more male-dominated national security fields.

I want to loop this panel. I know that we asked you to come and talk about commercial space issues, but I'd like to connect it back to the first panels that we had which were talking about some of the military activities.

Dr. Pace, you mentioned, of course, that China does not have a fully separate civil space program, and we know that in China, in the civil aircraft field, of course, what they are learning and what they are doing is inextricably tied to what they're doing in military advancements.

COMMISSIONER CLEVELAND: On the commercial side.

COMMISSIONER BARTHOLOMEW: And civilian aircraft in China are--the things they're learning are having spillover effects.

And I'd like to know if you, all of you, think that the Chinese are using or attempting to use their commercial space activities in order to improve their military capabilities?

DR. PACE: Well, I think no doubt that would be something they would hope to do. I mean even the very act of launching a commercial satellite, even if there was zero technology transfer per se, as a result, it is another piece of experience that helps them improve the reliability of their systems.

The very act of engaging in certain activities is a helpful learning experience. But I don't think they've been as successful in those areas as maybe they might have hoped. It's been a longer, harder slog to get the quality levels up, to get the system engineering expertise and skills done, and so they're still going to keep at it.

So do I think they have the intention or desire to learn from their commercial activities? Absolutely. But again it's part of--as was said earlier-- comprehensive national power. It's not just about military capabilities. It's about becoming an economic power. It's about becoming culturally influential. It's about shaping international institutions, about having that place at the table.

Some of those things are perfectly consistent in my view with U.S. interests. Some of them might not be. But they are gaining capabilities where it's up to them now to choose what they intend to do with that, and since we don't really have a lot of insight into what some of those intentions are, that's where it's problematic for us. That's where I think we have these uncertainties in our own mind.

They are not the Soviet Union. Thank goodness. But neither do we have a fully normal relationship with them that we do, say, with our European friends and allies.

COMMISSIONER BARTHOLOMEW: Dr. Moltz?

DR. MOLTZ: I would agree with Dr. Pace. I think that China certainly is interested in using the commercial space sector to learn whatever it can for the military, but there's not always a one-to-one correlation here, and in addition, you have a lot of institutional issues that you have to solve when you're standing up a military space command or you're trying to operate using space assets.

This has taken us a long time to develop. It will take China a long time to develop. We obviously need to be careful about what kinds of technology we work with the Chinese with if we decide to go in that route. But at the same time, I think some of the comments this morning about building networks among our allies and friends highlights one of the critical ways to reduce any vulnerability that might result from that.

I think we have advantages in this area that we haven't pursued, and I think that's a way to in the future make sure that as China gains in capability, which it will, that we have other advantages in terms of having redundancy and having reconstitution capability, that will allow us to

function in an environment if they choose to create a space conflict.

COMMISSIONER BARTHOLOMEW: Ms. Krolikowski.

MS. KROLIKOWSKI: For Chinese leaders and Chinese policymakers, the distinction between the economic, national security, prestige and foreign policy interests served by space activities is artificial.

They see the benefits generated by activities in those areas as closely interrelated and as mutually reinforcing. In contrast to how we often approach some of these questions, many Chinese leaders and policymakers don't emphasize the direct contribution of any one activity on the civil-commercial side to any one specific military capability.

Instead, they often think of indirect potential contributions from one area to another, from one sector of the economy to another, from the civil side to the defense side. That is because they take a very systemic view of the economy and the country's level of technical capacity. They conceive of a national base, an overall national technical and industrial base, that can be used toward a variety of ends, some of which are defense oriented and some of which are primarily economic. They think holistically about these issues, and often think of the spillovers as indirect and non-specific.

Still, it is important to draw a distinction between those civil and commercial activities that really can develop military capabilities and those that we would strain to imagine yielding any additional defense capabilities.

For example, human space flight may in some conceivable sense enhance China's military space capabilities, but there would be far more efficient ways of allocating resources to develop military space capabilities than to invest in a very large, costly, risky, highly visible human space flight program. The military significance of some civil space activities such as human spaceflight can be overstated or overemphasized.

On the whole, then, China's space activities serve a range of different motives, and these are often seen as closely tied together.

COMMISSIONER BARTHOLOMEW: Thank you.

HEARING CO-CHAIR WESSEL: For a quick final question, Commissioner Mulloy.

COMMISSIONER MULLOY: One, I want to thank the Chair and the Vice Chair for putting together this hearing, and the staff who helped them, and for bringing a group like this before us.

Clearly from what I understand based on the testimony today on the new Five Year Plan, China has an industrial policy and which they're not afraid to say they're picking winners and losers. They're picking winners.

Whenever we talk about doing that in this country, there's a debate saying we don't pick winners and losers, we leave it to the market.

Dr. Pace, I wanted to go back to, I remember, I was a young college student when President Kennedy spoke at Rice University and said we're going to put a man on the moon in this decade and bring him back safely, and then we put in a national effort, that created all kinds of spinoffs,

industries. Was that essentially an industrial policy?

DR. PACE: Not from President Kennedy's viewpoint. But from the viewpoint of say James Webb, the NASA Administrator, yes, that President Kennedy did that because he had a very specific political problem to solve at that point in time.

Actually, one of my colleagues, Dr. John Logsdon, just wrote a book on the history of the period after that speech and what some of his motivations were, and Kennedy was interested in a lot of international cooperation.

James Webb, the NASA Administrator, saw the space activities as a way to energize really the entire economy, which was not just part of John F. Kennedy's New Frontier, but also later part of Lyndon Johnson's ideas on Great Society.

So Kennedy's purposes were narrower. Webb took a broader view. There were members of Congress who took a bit of a broader view. Unfortunately, with the success of the Apollo Program, there was not a similar vision going beyond that, and so when President Nixon made the decision about the space shuttle, it was in part a negative decision because he didn't want to see the United States withdraw from human space flight, but he didn't really articulate a positive vision going forward that we would be using that for.

Space, human space flight is a very discretionary activity. And much as space enthusiasts as myself might think the answers as to why we do it should be obvious, they're not always obvious to members of this body or the White House, and so you have to put space in a context of what question are you trying to answer? What purpose are you trying to serve at this point in time?

President Kennedy decision was in answer to a particular point in time. We're at a different time now, and that actually is one of the key cutting edges of the debate in space right now, is why are we doing human space flight, for what purposes? Is there a strategic purpose or not?

COMMISSIONER MULLOY: Thank you very much.

HEARING CO-CHAIR WESSEL: Thank you to all our witnesses and to our staff, as has been noted, who put together a great hearing today. Thank you. And without further ado, we will be adjourned.

[Whereupon, at 2:28 p.m., the hearing was adjourned.]

ADDITIONAL MATERIAL SUBMITTED FOR THE RECORD

STATEMENT OF DR. DEAN CHENG, RESEARCH FELLOW, ASIAN STUDIES CENTER, HERITAGE FOUNDATION, WASHINGTON, DC

I would like to express my thanks to the US China Economic and Security Review Commission for the opportunity to present this testimony.

In the last several years, China has been steadily expanding its space efforts. This has included the third manned *Shenzhou* mission, which included a space-walk; expansion of the indigenous Chinese Compass satellite navigation system; and deployment of a range of new remote sensing satellites, such as the *Yaogan* series.

At the same time, there has been growing concern about the likelihood that China is pursuing a policy of space dominance, including programs specifically oriented towards counter-space operations. The most well-known example is the 2007 anti-satellite (ASAT) test, which generated enormous debris. Since then, though, the Chinese have engaged in further tests with potential anti-satellite implications. In January 2010, they undertook a test in which "two geographically separated missile launch events with an exo-atmospheric collision."[35] Between June and August 2010, two Chinese satellites, SJ-06F and SJ-12, engaged in orbital rendezvous maneuvers that appear to have included "bumping" into each other.[36] None of these tests involved prior notification or announcement, heightening concerns and underscoring the opaque nature of China's space program.

It is important to recognize, however, that these Chinese efforts are not simply the actions of the People's Liberation Army (PLA), nor efforts at political signaling to obtain a space arms control treaty, as some have posited. Rather, these actions occur within a particular strategic and military context.

The first contextual element is the broadening view of the responsibilities of the People's Liberation Army. One of the first and foremost responsibilities of the PLA is the preservation of the rule of the Chinese Communist Party. As the PRC's economic and national interests have expanded beyond its borders, however, what is deemed essential for preserving the power of the Party has also expanded. To this end, Hu Jintao and his predecessor Jiang Zemin set forth what are now termed the "Historic Missions" of the PLA. Not only do these historic missions sustain the longstanding task of providing support to the CCP, but now the PLA is responsible for helping safeguard China's national development, its expanding national interests, and furthering the objective of maintaining global stability and peace.

It is in this strategic, national light, and especially given the PLA's roles in safeguarding national development and national interests, that China's space capabilities have been expanding. If the PLA is to fulfill these historic missions, it will have to be able to exploit space at times and places of its own choosing, and, as important, be able to deny an opponent the same freedom of action.

We also find increasing mention in PLA writings of the need for a deterrence capacity. Thus, to these historic missions must be added the additional task of constraining conflicts, both by

[35] "China Did Not Notify US Before Anti-Missile Test," AFP (January 12, 2010). http://www.google.com/hostednews/afp/article/ALeqM5gIyJwTWQjzwLtHke9NhVHNS7qiHQ

[36] Brian Weeden, "Dancing in the Dark: The Orbital Rendezvous of SJ-12 and SJ-06F," The Space Review (August 30, 2010). http://www.thespacereview.com/article/1689/1

preventing their outbreak, and limiting their extent should they nonetheless occur. Both of these tasks fall under the rubric of "deterrence."

What is striking, however, is that, whereas Western writings on deterrence generally focus on ***dissuading*** an opponent from performing actions that the deterring power would prefer they not undertake, Chinese writings also talk about ***compellence***. That is, if the PLA is to be successful in deterring an opponent, not only should it be able to dissuade, but it must also be able to coerce an opponent into undertaking actions that the deterred power would prefer not to. In this regard, Chinese discussions about deterrence note roles not only for conventional and nuclear forces, but also highlight the importance of space deterrence as well.

Finally, by way of context, the PLA continues to improve its ability to undertake joint operations. This interest in joint operations was already evident a decade ago, when the PLA promulgated a variety of *gangyao* that would help guide future military planning, training, and operations. The capstone of these *gangyao* was devoted to joint military operations.

The ability to conduct joint operations is portrayed as a hallmark of Local Wars Under High-Tech Conditions, because they allow synergies among services, pit one's strengths against opponent's strengths, and shield one's weaknesses. As the 2010 edition of *China's National Defense* notes, "The PLA takes the building of joint operation systems as the focal point of its modernization and preparations for military struggle."[37]

As PLA analyses have emphasized over the past decade, however, joint operations are founded upon the ability to gather, transmit, and exploit information. Indeed, the very description of future wars has shifted from Local Wars under High-Tech Conditions, to Local Wars under Informationalized Conditions; the most important high-technologies are those related to information technology. Similarly, the 2010 Chinese defense white paper goes on to note that the PLA "strives to enhance its fighting capabilities based on information systems."[38]

Widely dispersed units must be able to establish a common situational awareness framework. They must be able to coordinate their activities, timing their operations to maximize effects. And, if future wars will be marked by the "three non's" of non-contact, non-linear, and non-symmetrical operations, then information will be the *sine qua non* of successfully conducting these future wars.

In order to effect joint operations, according to PLA analyses, a military must be able to exploit space. Only from the high ground of space can one gather information, transmit it rapidly, securely, and reliably, and exploit it promptly. Space is described in PLA writings as essential for

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[37] State Council Information Office, "National Defence Policy," *China's National Defence in 2010* (Beijing, PRC: Information Office of the State Council, 2011).

[38] State Council Information Office, "National Defence Policy," *China's National Defence in 2010* (Beijing, PRC: Information Office of the State Council, 2011).

reconnaissance and surveillance, for communications, for navigation, for weather forecasting, and for battle damage assessment. And a military that is capable of undertaking effective joint operations is one that can also deter an opponent. Thus, space capabilities help strengthen conventional deterrence, as well as deterring in its own right.

So, the PLA has an interest in being able to achieve space dominance, in order to fulfill its historic tasks, in order to deter future conflicts if possible, and to fight and win Local Wars Under Informationalized Conditions if necessary.

With this context in mind, it suggests that there is a particular method to China's development of an expanding array of space capabilities, including not only an ever-growing range of satellites, but a new heavy-lift space launcher and a fourth launch site, one that is much nearer the equator.

These are reflected in certain space missions, which PLA writings suggest are of particular importance.

Most obviously, the PLA expects improved space information support. With each passing year, China's satellite constellations will provide better information to military users. Chinese systems today provide not only basic earth observation capabilities, but also:

- an autonomous navigation system, which, unlike the European Galileo system, is already operational;
- data relay capacity;
- weather forecasting
- earth observation, including maritime surveillance

In addition, China's improving space capabilities, coupled with its steadily advancing conventional capabilities, will provide it with better ability to seek space superiority or space dominance (*zhitian quan*), through a combination of space offensive and defensive operations.

In discussing Chinese space offensive and defensive operations, it is important to note that, while many of the tasks associated with these efforts align with what American military planners consider "counter-space" activities, the Chinese themselves do not employ such a term. Moreover, Chinese writings on offensive and defensive space operations are not limited to, or even primarily focused on, attacking systems in orbit. Instead, they discuss a range of efforts aimed at affecting the range of space-related capabilities, from orbiting satellites, through space-related terrestrial facilities, to the data, communications, and telemetry links that tie all these systems together. Thus, the improvements in the PLA's broader conventional portfolio are also important, because they, too, may be employed to debilitate portions of the overall American space infrastructure.

For example, space offensive operations include not only applying hard-kill capabilities against satellites, but also attacking launch bases and tracking, telemetry, and control facilities. They also discuss the use of soft-kill techniques, such as jamming and dazzling, against satellites, in order to minimize the generation of debris, and the attendant physical and diplomatic consequences. And they also will likely involve the application of cyberwarfare methods against the various data and communications links that transfer information and allow satellites to maintain their orbits.

Similarly, space defensive operations incorporate a range of measures of information denial. These include passive measures such as camouflage and deception, so that the information an opponent derives from ***their*** space-based systems are inaccurate. But, in addition, it also includes efforts to prevent an opponent from attacking Chinese space-related systems, meaning efforts to neutralize and suppress the enemy's space infrastructure. This includes both kinetic as well as electronic means, directed at space-based systems, terrestrial facilities, and, again, the data and communications links between and among them.

This is all consistent with what may be a guiding concept for space operations, unified operations, key point is space dominance. Unified operations refers to applying all types of capabilities, terrestrial and space-based, active- and passive-measures, hard-kill and soft-kill, focused on assuring that the PLA can derive and exploit space at times and places of its choosing, while preventing an opponent from doing so.

Finally, as I indicated earlier, the PLA also views space capabilities as essential for deterring an opponent. Given the importance of this issue both in shaping peacetime space postures and crisis management, it merits further discussion.

Chinese Views on Space Deterrent Forces

In the view of PLA authors, the information that enables local wars under modern, informationalized conditions flows through space assets. Space systems are essential for the gathering, transmission, and exploitation of information, which allows non-contact, non-linear, non-symmetrical warfare, and which allows disparate forces, operating across a vast expanse, to coordinate their movements and their activities. In this context, then, space systems are essential for deterrence.

Several characteristics of space systems make their deterrent capacity especially powerful.[39] In the first place, space systems are seen as more credible than nuclear ones; they are more usable, and indeed, have been employed in many recent wars. Consequently, in the context of the three pre-requisites for deterrence, they are not only real combat capabilities, but leaders are likely to have the will to employ them, unlike nuclear weapons.

[39] This section is drawn from Xu Wei and Chang Xianqi, "Discussing Space Deterrence," *Journal of the Academy of Command Equipment and Technology* (XIII, #1, February 2002)

At the same time, PLA space writers suggest that space systems offer the potential capacity to neutralize an opponent's nuclear deterrent, while expanding one's own integrated deterrent capability. Space defenses can intercept an opponent's nuclear forces while they are still en route, minimizing damage to oneself. As one PLA article suggests, by pairing space defense with nuclear forces, one can attack or defend at will, retaining the initiative while confronting an opponent with an unpalatable set of choices.[40]

Space systems also are seen as a vital partner for conventional deterrence. In the first place, space systems allow for the detection and location of enemy forces. This alone may be sufficient to deter, since it potentially removes the prospect of surprise. Moreover, as noted previously, space systems are essential for coordinating terrestrial forces, allowing them to communicate with each other and to synchronize their activities. This makes conventional forces able to operate jointly, making them much more powerful than when they were only able to operate in combined arms fashion.

Finally, by enhancing conventional forces' lethality and range, space systems enable them to engage in "non-contact warfare," striking the enemy with great accuracy yet limited expenditure of weapons. This combination will make an opponent less likely to be willing to engage in conventional warfare at all.

In addition to complementing nuclear and conventional deterrence, PLA writings suggest that space systems may deter an opponent on their own. A space force effects deterrence in a number of ways.

In the first place, it is hardly a secret that space systems are very expensive and fairly fragile. Furthermore, they are in predictable orbits. This makes them extremely vulnerable. In essence, because of the combination of expense, fragility, and vulnerability, one can hold an opponent's space infrastructure hostage. Much like nuclear deterrence, space deterrence, in this regard, becomes a question of cost-benefit analysis: is the focus of deterrence, say, Taiwan, worth the likely cost of repairing or replacing a badly damaged or even destroyed space infrastructure?[41]

Moreover, because space systems affect not only military but economic, political, and diplomatic spheres, damage to space systems will have wide-ranging second-order repercussions.[42] Damaging an opponent's space infrastructure will impose economic and diplomatic costs, beyond simply that of replacing satellite systems. The combination of first- and second-order effects may be sufficient to persuade an opponent that they cannot attain

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[40] Hong Bin and Liang Xiaoqiu, "The Basics of Space Strategic Theory" *China Military Science* (#1, 2002).

[41] Xu Wei and Chang Xianqi, "Discussing Space Deterrence," *Journal of the Academy of Command Equipment and Technology* (XIII, #1, February 2002).

[42] Li Jingjun and Dan Yuquan, "The Strategy of Space Deterrence," *China Military Science* (#1, 2002).

victory at an acceptable price. "Then, they may not be willing to undertake hostile activities."[43]

EFFECTING SPACE DETERRENCE

In light of the potential import of space deterrence, how do PLA authors envision the actual implementation of space deterrence? It appears that there is a concept of an "escalation ladder" of PLA measures that one might employ to effect space deterrence. These involve testing space weapons, exercising space forces, reinforcing space capabilities, and actually employing space forces.

Testing space weapons. Several Chinese articles suggest that testing space weapons, especially in peacetime, can influence an opponent's psychological perceptions. Thus, even if the tests fail, they nonetheless reflect a certain level of capability and interest.[44] An opponent must presume that the deterring nation is engaging in R&D of space weapons and that their own assets are likely to be vulnerable, or at least jeopardized.

To this end, maximum publicity is seen as enhancing the deterrent effect of such tests. Any potential opponent is therefore effectively notified that their space assets are likely to be placed in jeopardy in event of crisis. Not only might this dissuade an opponent from pursuing aggression, but it might also undercut their political and diplomatic standing. Conversely, by undertaking such tests, one's own overall national level of science and technology are made clear, reinforcing concepts of comprehensive national power, and feeding political and technological deterrent capacities.[45]

Exercising space forces. The next level of deterrence involves exercising one's space forces. These exercises can include such elements as space offense and defense operations, anti-missile exercises, space strategic strike rehearsals, and displays of joint military operations involving both space and non-space forces. Each such type of exercise has its own intended meaning. Space offense and defense operations, for example, indicate the ability to seize space dominance, whereas anti-missile exercises reflect one's strategic defensive capacity, even in the face of nuclear weapons. Space strike exercises implicitly threaten the entire strategic depth of an opponent, whereas joint exercises with other forces serve as a reminder that a full range of capabilities are potentially at play, and not simply space capabilities.[46]

Whereas tests of space weapons might be part of a peacetime routine, PLA authors suggest that exercises should be undertaken in the context of an ongoing crisis. By holding such exercises, according to one analysis, a nation is helping to mold other's perceptions. Exercises may be seen as an expression of will or commitment, signaling an opponent of the deterrer's

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[43] Xu and Chang, "Discussing Space Deterrence."

[44] Xu and Chang, "Discussing Space Deterrence."

[45] Li and Dan, "The Strategy of Space Deterrence."

[46] Xu and Chang, "Discussing Space Deterrence."

readiness for war.[47] Similarly, some PLA analysts suggest that such exercises should be held in sensitive space areas, in order to underscore the seriousness of one's resolve.[48]

As an added benefit, such exercises not only display the space deterrent capabilities of the forces involved, but they also provide valuable unit training. This additional training, in and of itself, can also enhance deterrent effects. Well-trained forces are better able to implement operational plans. Thus, in the opinion of some PLA officers, US military space exercises have improved America's space deterrent capacity.

Deployment of additional space forces. In the event of an ongoing, escalating crisis, where space exercises may not have proven sufficient to constrain the crisis, the next step would be to reinforce available space forces. This includes both deploying additional systems, and maneuvering those already in orbit towards "sensitive areas of space (*mingan de kongjian quyu*; 敏感的空间区域)," so as to create a local advantage over an opponent.[49]

Not only does reinforcement of available space forces signal an opponent of one's resolve, but increased reconnaissance and surveillance assets will also complicate an opponent's efforts at maintaining secrecy. The likelihood of discovery, in turn, may dissuade an opponent from commencing hostilities, as the element of surprise is jeopardized. Moreover, should an opponent nonetheless not take steps to de-escalate, increased deployments will also provide greater redundancy in the event of war.[50]

Actual use of space forces. The actual use of space forces is seen as the ultimate form of deterrence. Different PLA analyses, however, seem to have different definitions of what this means. One article, for example, seem to suggest that ***prior*** use of space forces lends credibility for subsequent deterrent efforts. Thus, the employment of space forces in previous local wars provide an unmistakable statement of one's own capabilities, as well as one's willingness to take losses and inflict punishment. According to this view, the foundation of space deterrence rests upon actual capabilities that are displayed in real wars.

Other analyses, however, suggest that the deterrence involved in actual attacks is not based on prior experience, but on the effective implementing of *actual attacks* in the course of an ongoing crisis. One author describes such operations as reprimand or punishment strikes (*chengjie daji*; 惩戒打击). The actual employment of space forces, in this view, constitutes the strongest kind of deterrent (*zuigao qiangdu de weishe*; 最高强度的威慑).[51] The aim is to undertake point strikes to effect "cow the enemy with small battles (*yixiaozhan er quren*

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[47] Xu and Chang, "Discussing Space Deterrence."

[48] Chang Xianqi, *Military Astronautics*, 2nd ed., p. 303.

[49] Xu and Chang "Discussing Space Deterrence."

[50] Chang Xianqi, *Military Astronautics*, 2nd ed., pp. 303-304.

[51] Chang Xianqi, *Military Astronautics*, 2nd ed., p. 304.

zhibing; 以小战而屈人之兵)." [52]

One type of punishment strike would be to interfere, suppress, or otherwise disrupt enemy space systems, such as by jamming communications and data links or damaging their command system through computer network attacks.[53] By inflicting confusion and disruption on their space systems, an opponent may yet decide to cease hostilities. If they do not, then one's own military activities will operate from a more advantageous position.

The other option is to undertake sudden, short-duration strikes against enemy space systems. In light of the previous option, this would imply that such strikes would involve kinetic means. The types of targets would reinforce this implication: space information systems, command and control centers, communications nodes, guided missile launch bases, energy storage sites and other strategic targets. Such strikes, it is suggested, will inflict a psychological impact upon the enemy, as well as likely produce cascading effects throughout their space system, due to their linked nature.[54]

This sort of deterrence logic would seem to be rooted in the idea that the ability to inflict punishment is the greatest deterrent. Thus, as one Chinese author suggests, "the foundation of space deterrence must be preparation for real war (*bixu yi shizhan zhunbei zuowei kongjian weishe de jichu*; 必须以实战准备作为空间威慑的基础)," or war-fighting.[55]

PROBLEMATIC ASPECTS OF CHINESE VIEWS ON SPACE DETERRENCE

The divergence of views on how to emplace a policy of space deterrence raises questions about the extent to which the PLA necessarily governs larger Chinese space policy. This is underscored by the discrepancy between how PLA authors describe the utility of testing space weapons, and how the PRC actually behaved at the time of the January 2007 ASAT test. Not only was there no prior publicity, but the PRC Foreign Ministry seemed to handle the aftermath in a singularly hesitant fashion. Consequently, one must wonder whether the Chinese civilian leadership necessarily subscribes to the same view of deterrence as that laid out by Chinese military space analysts.

On the other hand, some PLA writers, including the author of a PLA textbook on military space operations, suggest that such tests should not be announced, precisely in order to foster uncertainty in an opponent. Given that the other Chinese tests appear to have involved no real advance warning, it suggests that this may be a matter of policy.

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[52] Chang Xianqi, *Military Astronautics*, 2nd ed., p. 302.

[53] Chang Xianqi, *Military Astronautics*, 2nd ed., p. 304.

[54] Xu and Chang, "Discussing Space Deterrence."

[55] Chang Xianqi, *Military Astronautics*, 2nd ed., p. 302.

Which to believe?

Similarly, the description of reinforcing available space forces would seem to imply a very slowly developing crisis. It is open to question whether such measured steps would be possible, or whether they would be interpreted in the manner presented, in the event of a rapidly escalating situation. Again, the track record of Chinese crisis management, including the Belgrade embassy bombing and the EP-3 incident, as well as the more recent Senkakus/Diaoyutai fishing boat incident, hardly inspire confidence..