THE GROWTH OF GLOBAL SPACE CAPABILITIES: WHAT IS HAPPENING AND WHY IT MATTERS

HEARING

BEFORE THE

SUBCOMMITTEE ON SPACE AND AERONAUTICS

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

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November 19, 2009

THE GROWTH OF GLOBAL SPACE CAPABILITIES: WHAT IS HAPPENING AND WHY IT MATTERS

THURSDAY, NOVEMBER 19, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON SPACE AND AERONAUTICS,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Gabrielle Giffords [Chairwoman of the Subcommittee] presiding.

COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SPACE & AERONAUTICS
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, DC 20515

Hearing on

The Growth of Global Space Capabilities: What's Happening and Why It Matters

November 19, 2009
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

WITNESS LIST

Mr. Marty Hauser
Vice President for Research and Analysis, Washington Operations
The Space Foundation

Mr. J.P. Stevens
Vice President, Space Systems
Aerospace Industries Association

Dr. Scott Pace
Director, Space Policy Institute
The George Washington University

Dr. Kai-Uwe Schrogl
Director, European Space Policy Institute

Dr. Ray A. Williamson
Executive Director, Secure World Foundation

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HEARING CHARTER

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SPACE AND AERONAUTICS

The Growth of Global Space Capabilities: What's Happening and Why It Matters

THURSDAY, NOVEMBER 19, 2009
10 A.M.–12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

I. Witnesses

Mr. Marty Hauser
Vice President for Research and Analysis, Washington Operations
The Space Foundation

Mr. J.P. Stevens
Vice President, Space Systems
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Dr. Scott Pace
Director, Space Policy Institute
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Director, European Space Policy Institute

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II. Overview

The space age was an outgrowth of an international initiative in science, the International Geophysical Year (IGY) 1957–1958, that sought to collect coordinated global measurements about the Earth. Following the IGY, a number of nations, including the U.S., the Soviet Union, European states both individually and collectively, Japan, and Canada continued to pursue scientific and other activities in space, in many cases through cooperative projects. These collaborations led to many significant scientific and engineering projects including, for example, the Hubble Space Telescope, the Cassini mission to Saturn, and the International Space Station (ISS), which is the most extensive cooperative effort to date. However, the years following the IGY were also marked by competition, most notably the Cold War "space race" between the United States and the Soviet Union during the 1960s that culminated in the successful American Apollo 11 Moon landing in 1969.

For most of the first half-century of the space age, the U.S. and Russia [formerly the Soviet Union] were the only nations capable of launching humans into space. In 2003, China launched a human into space and continues to take incrementally more challenging steps in human spaceflight. Other nations have recently entered the space arena or are quickly displaying increasing technical capabilities for space activities. As examples, years, China and India have successfully launched their first lunar probes, India has announced plans for a human space program, and numerous countries around the world have established space agencies.

In addition to governmental activities, a space economy has grown to support the global demand for commercial space-related products and services. Over time, a number of foreign nations have acquired the capability to develop satellites and instruments and to deploy them with independent launch systems. Others have purchased space assets such as communications satellites on the commercial market and operate them as part of their national infrastructure.

Attachment A provides a snapshot of international space capabilities and the global space economy.

As an increasing number of nations pursue an active presence in outer space, they do so in a global environment that is increasingly interdependent and competitive economically and geopolitically and in which some of the most pressing societal challenges facing nations will require global solutions. As expressed in a recent report

of the National Research Council, *America's Future in Space: Aligning the Civil Space Program with National Needs, "we live in a globalized world of societies and nations characterized by intertwined economies, trade commitments, and international security arrangements. Mutual dependencies are much more pervasive and important than ever before. Many of the pressing problems that now require our best efforts to understand and resolve—from terrorism to climate change to demand for energy—are also global in nature and must be addressed through mutual worldwide action . . . the ability to operate from, through, and in space will be a key component of potential solutions to 21' century challenges."*

The hearing will examine the growth of global space capabilities -among both established participants and new entrants-why it matters to the United States, and what policy issues it raises.

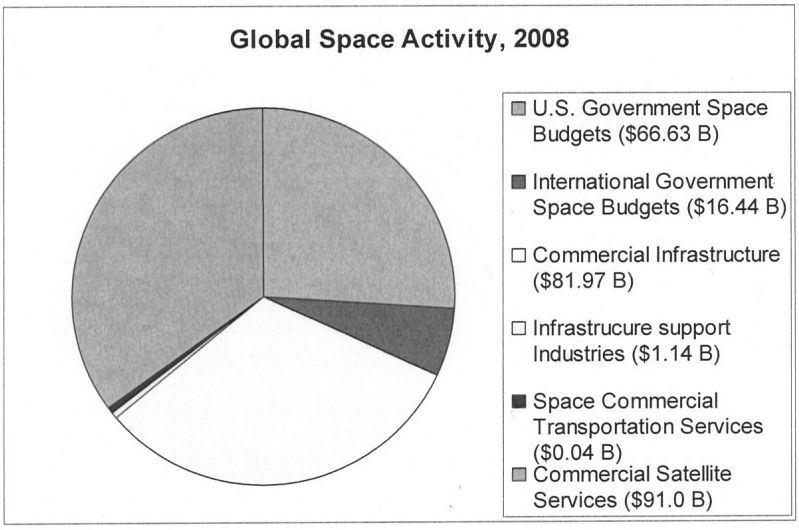
III. Issues

- What space capabilities now exist outside the U.S. and are there any significant trends in that regard?
- Why does the growth of non-U.S. space capabilities matter to the U.S.?
- What opportunities and challenges does the growth of global space capabilities present to the United States?
- What issues does the growth of non-U.S. space capabilities raise for Congress as it assesses the future direction and funding of the U.S. space program?
- What issues does the growth of global space capabilities raise for Europe as it assesses the future direction and funding of its space activities?
- What space capabilities are developing in the emerging space states, and are there any significant trends in that regard?

IV. Background

Global Space Revenues and Budgets for 2008

According to *The Space Report 2009,* global space revenues and government budgets totaled an estimated $257.22 billion in 2008, based on the best available information. In addition, *The Space Report states* that, *"Commercial activity continues to constitute the majority of the space economy, comprising 68% of the $257.22 billion total for 2009."* The chart below shows a breakdown of the overall global space economy.



Source: The Space Foundation, *The Space Report 2009*

The U.S. government space budget is estimated at $66.63 billion for 2008 of which NASA and the Department of Defense comprise 65 percent, according to *The Space Report 2009*. For Fiscal Year 2008, NASA's budget was $17.31 billion and the Department of Defense's space budget was $25.95 billion.

U.S. Government Agency Space Budgets, 2008		
Agency	Budget	Source
Department of Defense (DoD)	$25.95 B	DoD
National Reconnaissance Office (NRO)	$10.00 B	GlobalSecurity.org
National Geospatial-Intelligence Agency (NGA)	$3.00 B	Global Security.org
Missile Defense Agency (MDA)	$8.9 B	MDA
National Aeronautics and Space Administration (NASA)	$17.31 B	NASA
National Oceanic and Atmospheric Administration (NOAA)	$0.95 B	NOAA
Department of Energy (DOE)	$0.03 B	DOE
Federal Aviation Administration (FAA)	$0.01 B	FAA
National Science Foundation (NSF)	$0.48 B	NSF
Total	**$ 66.63 B**	

Source: The Space Foundation, The Space Report 2009

The total estimate of international space budgets for 2008, as published in *The Space Report 2009,* is $16.44 billion. As shown in the table below, the overall international space budget has grown by 12 percent from 2007 to 2008, although the growth was not shared among all space nations. Some foreign space budgets are reported to have grown significantly, while data documented in *The Space Report 2009* shows that other foreign space budgets declined sharply.

Country/Agency	2006 Budget (U.S. Dollars B)	2007 Budget (U.S. Dollars B)	2008 Budget (U.S. Dollars B)†	Growth	Source
European Space Agency (ESA)	$ 3.53	$ 4.02	$ 4.27	6%	ESA
Brazil	-	-	$ 0.13	-	Brazil Ministry of Science and Technology
Canada*	$ 0.33	$ 0.37	$ 0.25	-34%	Canadian Space Agency (CSA)
China**	$ 1.50	$ 1.50	$ 1.70	13%	Washington Post
France	$ 0.85	$ 0.95	$ 0.97	3%	Le Figaro (CNES budget)
Germany	$ 0.36	$ 0.39	$ 0.44	13%	Deutsches Zentrum für Luftund Raumfahrt (DLR)
India	$ 0.82	$ 0.88	$ 0.86	-2%	Embassy of India
Israel	-	-	$ 0.08	-	Israeli National Budget
Italy	$ 0.33	$ 0.65	$ 0.91	40%	Agenzia Spaziale Italiana (ASI)
Japan	$ 2.15	$ 2.21	$ 3.50	58%	Embassy of Japan
Russia	$ 0.87	$ 1.32	$ 1.54	17%	Roscosmos
South Korea	-	-	$ 0.25	-	Korea Times
United Kingdom*	$ 0.13	$ 0.12	$ 0.08	-33%	British National Space Centre (BNSC)
Non-U.S. Military Space, excuding China	$ 2.29	$ 2.29	$ 1.47	-36%	Euroconsult
Total	$ 13.15	$ 14.70	$ 16.44 ‡	12%	

*Civilian agency budget only **Estimated budget

† Currency conversions are standardized to december 31, 2008, except in cases where the origional source presented budget data in the U.S. dollars

‡ Total is not sum of rounded figures

Source: The Space Foundation, The Space Report 2009

Recent Advisory and Other Reports on Global Space Activities and Issues

The goals pursued by nations seeking to develop space capabilities are varied and include fostering national prestige, developing technical skills and infrastructure, national security, innovation, applications to serve societal needs, scientific research, human exploration, commercial opportunities, and international cooperation.

A number of recent reports have considered the benefits of international cooperation in space as well as issues related to the growing number of nations pursuing activities in outer space.

Changing Environment

"There are rapidly emerging foreign space capabilities and the US. does not control their proliferation." (Briefing of the Working Group on the Health of the U.S. Space Industrial Base and the Impact of Export Controls, February 2008.)

"While the United States remains a world leader in advanced science and technology, it not longer dominates; it is now among the leaders. We are increasingly interdependent with the rest of the world." (National Research Council, *Beyond "Fortress America": National Security Controls on Science and Technology in a Globalized World.*)

Potential for New Partnerships

"These maturing capabilities around the world create a plethora of potential partners for cooperative space endeavors, while at the same time heightening competitiveness in . the international space arena." (National Research Council, *Approaches to Future Space Cooperation and Competition in a Globalizing World: Summary of a Workshop.)*

Potential to Serve Broader National and International Objectives

"Some particularly pressing or ambitious space activities currently under discussion (e.g. measuring and monitoring global climate change or continuing with human exploration of the solar system) may only be possible through international collaboration." (National Research Council report, *America's Future in Space: Aligning the Civil Space Program with National Needs.)*

Potential for U.S. Strategic Leadership

"The strategic leadership that the United States needs to exert must be appropriate for the new era of globalization. The United States must strengthen ties to traditional allies and build increasingly effective working relationships with emerging powers." (National Research Council report, *America's Future in Space: Aligning the Civil Space Program with National Needs.)*

"Exerting a global leadership role in space activities is the best means to ensure that space activities can serve the broader security and economic interests of the nation." (National Research Council report, *America's Future in Space: Aligning the Civil Space Program with National Needs.)*

Competitiveness

In 2009, the Futron Corporation prepared Futon's 2009 *Space Competitiveness Index: A Comparative Analysis of How Countries Invest In and Benefit from Space Industry.* According to the executive summary of the report:

- *"The United States (U.S.) remains the current leader in space competitiveness, but its relative position had declined marginally based on increased activity by other space faring nations."*
- *The U.S. still leads in each of the major categories: government, human capital, and industry, however, its comparative advantage is narrowing in category.*
- *European competitiveness remained roughly unchanged, with improvement in government metrics tied to improved policy and successful exploration programs, but offset by lower industry metrics.*
- *Russia also demonstrated improvements in government metrics, alongside relatively lower human capital and industry metrics.*
- Japan posted major gains between the 2008 and 2009 SCI [Space Competitiveness Index] metric evaluations, due to substantial changes in its space strategy as well as its new space law. This resulted in the country jumping ranks from the seventh position in the 2008 SCI to the fourth position in the 2009 SCI.
- *China posted gains of nearly 10 percent in SCI points overall, fueled by government activity and metrics, but fell behind Japan in its overall ranking. The transparency of the Chinese environment remains a hurdle for the country,*

which publicly seeks greater international cooperation and commercial activity.

- *Canada jumped nearly 10 percent in its overall SCI points, based on government metrics around both civilian and military space policy, along with a commitment to increase overall funding on space programs.*
- *India had a strong year of space activity, registering double-digit improvements of government metrics, but lagged in industry scoring."*

Security

"Important components of our civil and military infrastructure reside in space, and America can provide true security for those space assets by committing itself to use of the global commons by all and by and by creating a mutual dependence in space that is in the best interests of all nations to protect." (National Research Council report, *America's Future in Space: Aligning the Civil Space Program with National Needs.)*

Human Spaceflight

"The U.S. can lead a bold new international effort in the human exploration of space. If international partners are actively engaged, including on the "critical path" to success, there could be substantial benefits to foreign relations and more overall resources could become available to the human spaceflight program." (Review of U.S. Human Spaceflight Plans Committee, *Seeking a Human Spaceflight Program Worthy of a Great Nation.)*

In addition, the Review of U.S. Human Spaceflight Plans Committee report also stated that *"an even greater impediment to U.S. involvement in international cooperative programs is the U.S. International Trafficking [sic] in Arms Regulations (ITAR). The Committee deems these laws to be outdated and overly restrictive for the realities of the current technological and international political environment."*

Capabilities. Thematic Areas

Below are brief summaries of key space areas and the degree to which other nations participate in those space sectors.

Spaceflight

A number of nations have developed the capability to launch payloads into orbit. The United States, Russia, Europe, Japan, China, and India possess families of vehicles that can loft payloads into polar and geosynchronous orbits. Early in 2009, Iran made its first successful launch of a satellite into space and in late August of this year, South Korea launched a satellite that was not deployed successfully into its orbital location. North Korea has also pursued development of a launch vehicle capable of launching satellites into orbit. Other nations, including Spain and Brazil, have launch vehicles under development. Many nations with launch vehicle capabilities also maintain sounding rocket programs, which are typically low-cost access to the microgravity environment for research and university programs.

Human Spaceflight

For most of the last half-century, the U.S. and Russia [formerly the Soviet Union] have been the only nations capable of launching humans into space. As noted above, during the 1960s, the U.S. and the Soviet Union competed for primacy in human space flight. Later, in the early-mid 1970s as part of "déntente", the U.S. and the Soviet Union pursued a joint Apollo-Soyuz Test Project (ASTP) mission, which demonstrated the successful docking of a Soviet Soyuz and American Apollo spacecraft. The ASTP represented the first international human spaceflight project. In the early 1990s, the U.S. and Russia agreed to pursue further spaceflight cooperation on the Russian Mir space station and American Space Shuttle, followed by an invitation to Russia to join the International Space Station partnership. In 2003, China became the third nation to launch a piloted vehicle into space and in 2008 a Chinese astronaut conducted that nation's first extravehicular activity (EVA). In addition, over the years both the United States and the Soviet Union/Russia have used their human spaceflight programs to promote their geopolitical objectives through the flight of citizens of countries with which they had agreements to do so.

Other nations have acquired human spaceflight experience as participants in the International Space Station program, including having their astronauts visit the ISS via the U.S. Space Shuttles or Russian Soyuz vehicles. The International Space Station includes European, Japanese, Russian, and Canadian partners that have devel-

oped and contributed modules, nodes, and laboratories, the robotic arm, and other key systems and hardware. Europe and Japan have recently demonstrated the ability to deliver cargo to the Station with the European launch of the Automated Transfer Vehicle (ATV) and the Japanese H–II Transfer Vehicle (HTV). Current plans include additional ATV and HTV cargo deliveries to the ISS. NASA and the European Space Agency recently signed a memorandum of understanding on civil space transportation cooperation in an effort to share engineering analyses and technology concepts that will help work on future launch systems, human spaceflight and exploration beyond low Earth orbit.

According to an article in the October 12, 2009 issue of *Aviation Week and Space Technology,* China plans to launch a 20-metric-ton Space Station by 2020. As part of the preparations for that milestone, a Tiangong 1 target spacecraft will be launched on a Long March launch vehicle within the next year or so. Beginning in 2011, crewed Shenzhou missions will conduct flights and Chinese astronauts will practice docking and EVA activities with the Tiangong 1 spacecraft, according to the *Aviation Week and Space Technology article.*

With the Vision for Space Exploration initiated by President Bush in 2004 and authorized by Congress, fourteen nations came together in 2006 to create a strategy for working together on exploration beyond low-Earth orbit. The results of that cooperative effort, *The Global Exploration Strategy: The Framework for Coordination,* discusses the benefits of coordinating global exploration in space such as leveraging investments, sharing lessons learned, and improving the safety of human spaceflight. The strategy outlines potential areas of coordination that could include, for example, identifying standards to facilitate interoperability, establishing processes to broaden participation in planning and coordination, and assessing international legal agreements and any requirements therein.

President Barack Obama met this week with Chinese President Hu Jintao in Beijing. According to a U.S.-China Joint Statement dated November 17, 2009 and issued by the White House Office of the Press Secretary, *"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."*

Science

With its roots in the IGY, the space sciences have a long heritage of international cooperation and coordination. The U.S. engages in both multilateral and bilateral cooperative efforts in space science. The fruits of these cooperative activities have been realized in several productive scientific missions including the Hubble Space Telescope, the series of ocean altimetry missions that measure sea-surface height, the Solar and Heliospheric Observatory that studies the Sun, and the Tropical Rainforest Measuring Mission to monitor tropical rainfall, among several others. In 1958, after the Soviet launch of Sputnik opened the space age, the International Council for Science (previously the International Council of Scientific Unions) created the Committee on Space Research, a multidisciplinary international science committee to exchange the results of scientific activities conducted in space: COSPAR currently lists 44 member nations.

In addition to the larger national and regional space programs, including those of the U.S., Europe, France, Germany, Japan, and Canada, several nations with emerging space programs, including India and China, have also begun to demonstrate increasing capabilities in space science activities. For example, Brazil and China have cooperated on a series of Earth resources satellites. Japan, China, and India launched lunar orbiters, the first planetary missions for China and India. At the same time, nations with more established space programs also continue to augment their technical skills and abilities to accomplish increasingly challenging scientific activities, often through cooperative projects. As examples, in November of 2009 NASA and the European Space Agency signed a statement of intent for potential joint robotic exploration of Mars, and Russia and India are planning a robotic lander and rover expedition to the Moon.

Global Navigation and Positioning

The U.S. maintains the only completely operational global positioning and navigation system (GPS)—the U.S. Navigation Signal Positioning System, according to *The Space Report 2009.* The U.S. GPS system provides for both military and civilian applications. The Russian satellite navigation system, the Global Navigation Satellite System (GLONASS) is used for military and civilian purposes. According to *The Space Report 2009,* the Russian system *"declined during Russia's economic down-*

turn and is in the process of being reconstituted." The European Union is developing a 30-satellite civilian satellite navigation and positioning constellation, Galileo, with a projected date of service beginning in 2010, according to *The Space Report 2009.* In addition, China is planning to add to its existing Compass Satellite network to provide positioning and navigation services over the Asia Pacific region, Japan is developing the Quasi-Zenith Satellite System to augment GPS service over Japan, and India is developing the Indian Regional Navigational Satellite System.

Global navigation and positioning data are being used in myriad applications including transportation, logistics, and location services, among others. The commercial market for positioning and navigation has been in the devices that receive the signals and in associated services. As stated in *The Space Report 2009, "The satellite positioning market is extremely large, with estimates of the total revenues from equipment and services ranging as high as $56 billion a year, according to a 2008 study from ABI Research."*

Remote Sensing

Remote sensing data are used for a variety of purposes including scientific research about climate change, the Earth system and environment; weather forecasting; intelligence-gathering; urban and land-use planning; and in applications to agriculture, fishing, mining, construction, and public health. As discussed in the National Research Council report, *America's Future In Space: Aligning the Civil Space Program with National Needs, "Changes in land-use patterns, agricultural productivity, ecosystems' health and forest resources are readily observed from space; and their management can be enhanced by the use of accurate position-sensing information and diagnostic measurements taken at multiple wavelengths and as a function of time. Space observations are thus an essential component of the ability to manage the planet's resources, a source of knowledge that might protect against the effects of its most damaging forces, and a tool to verify the impact of international environmental agreements."*

According to *The Space Report 2009, "In 2008 the National Oceanic and Atmospheric Administration's (NOAA) Advisory Committee on Commercial Remote Sensing reported that there were 88 satellites in use or in development . . . operated by 27 different countries"* for civil, scientific, and military applications. In addition, a report by the Center for Strategic and International Studies (CSIS), *Briefing of the Working Group on the Health of the U.S. Space Industrial Base and the Impact of Export Controls,* notes that Russia, France, Israel, Korea, and India have commercial imaging satellites of one meter in resolution or better; Canada, the European Space Agency, Italy, Germany, and Japan have civil radar imaging satellites; India and Argentina will also possess radar imaging capability; and China has deployed two radar imaging spacecraft.

Communications

Communications satellite services are a critical part of the infrastructure in many nations, because they enable connections between distant and remote locations and provide a means to transmit video, data, voice, and radio content to multiple locations at the same time.

According to *The Space Report 2009,* the bulk of the satellite communications services are provided by multinational service providers such as Intelsat. In addition, several nations operate satellites that provide communication services to a region or a nation. Nations with the capability to operate fixed communications satellites include China, Argentina, the United Kingdom, Egypt, Greece, Russia, Spain, Indonesia, India, the United States, Kazakhstan, Korea, Philippines, Malaysia, Nigeria, Pakistan, Mexico, Luxembourg, Thailand, Singapore, Japan, Israel, Brazil, Norway, Canada, Turkey, Venezuela, Vietnam, and the UAE, according to *The Space Report.* In addition, *The Space Report* also notes that *"The fixed satellite services revenue was the strongest market growth driver* [for commercial satellite services] *increasing 31% to $16.79 billion in 2008 from $12.82 billion in 2007."*

Space Situational Awareness

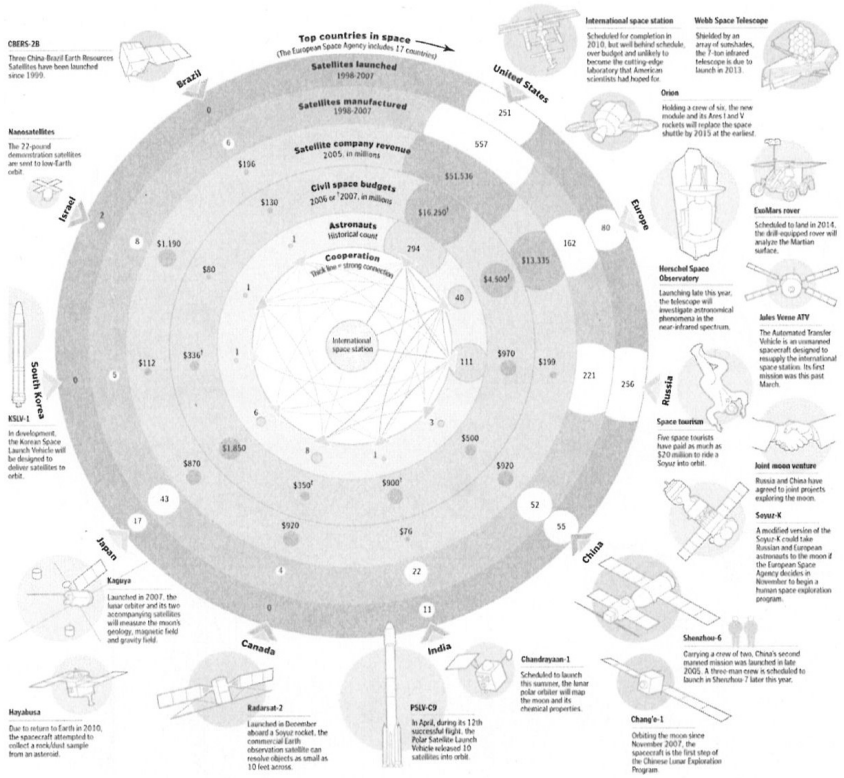
Ensuring the future safety of civil and commercial spacecraft and satellites is becoming a major concern, and one that will require international collaboration. The February 2009 collision between an Iridium Satellite-owned communications satellite and a defunct Russian Cosmos satellite above Northern Siberia highlighted the growing problem of space debris and the need to minimize the chances of in-space collisions. That collision also increased the number of pieces of space debris circling the Earth, a debris population that had already experienced a significant

increase two years earlier following a Chinese anti-satellite weapons test that created thousands of fragments.

While several nations such as Russia, France, Germany and Japan have some form of space surveillance capability, these systems are not interconnected and are neither as capable nor as robust as the United States' Space Surveillance Network (SSN).

Many questions remain as to how to improve space situational awareness with an ever growing population of spacecraft and international operators. Improvements in information services, capabilities, resources, and coordination will all have to be addressed. In addition, although organizations and individuals have examined the pros and cons of potential space traffic management approaches or international "rules of the road", at this point, there does not appear to be a consensus on the appropriate long-term framework for space traffic management.

ATTACHMENT A



GRAPHIC: Patterson Clark - The Washington Post, July 9, 2008

Chairwoman GIFFORDS. This hearing will now come to order.

Good morning, everyone. First of all, I would like to thank all of our witnesses for coming here today and of course our Subcommittee members for being here and all of our staff.

The topic of this hearing, "The Growth of Global Space Capabilities: What Is Happening and Why It Matters", is one that should concern all members of this Subcommittee but also all Members of Congress as well. Because the world is changing, and those changes present both opportunities and frankly some very challenges to the United States that we cannot ignore, and today we are going to hopefully get to the bottom of some of those opportunities and challenges.

While I believe this hearing is particularly timely in light of the President traveling to China, Japan and other nations of the Asian region, there is another reason why we decided to hold this hearing at this time. We are at a critical juncture and decisions are being contemplated that will have a significant impact on both the direction and the health of our Nation's civil space program for decades to come. While the President and his advisors are engaged in their internal deliberations on what to recommend for NASA and its human spaceflight program, we believe it is imperative not for Congress to stand by idly. Instead, I believe that Congress must use the time remaining in this session to carry out the independent oversight necessary to oversee and assess the findings of the Augustine panel, and more importantly, to illuminate the stakes that are involved in whatever decisions the White House and Congress make regarding NASA's funding and future direction. We started that oversight process, you will remember, in September with a review of the overall, the totality of the Augustine report. We followed that full Committee hearing with a Subcommittee hearing to review what needs to be done to improve the effectiveness of NASA's technology programs, an issue raised by the Augustine panel.

Schedule permitting, I intend to follow today's hearing with a hearing to examine human spaceflight safety issues, an area that many believe was given inadequate scrutiny by the Augustine report, and then a hearing to examine workforce and industrial-base issues that are inextricably linked to the decisions we make about NASA's future.

As I mentioned earlier, our hearing this morning focuses on the growth of global space capabilities, capabilities that have significant implications to the United States as we contemplate the future of our own space program. As our witnesses will make clear, at a time when some in the United States seem to be questioning whether we should sustain a strong commitment to investing in our space program, the rest of the world has not hesitated to embrace the promise that the exploration and the utilization of outer space can offer to them. Those other nations recognize that space activities can spur innovation, help improve the quality of life of their citizens, promote national security and economic competitiveness, and advance geopolitical objectives. That recognition echoes the aspirations of our Congressional predecessors, many of whose portraits we see here today, when they first established NASA and undertook other related actions some 50 years ago.

While the Sputnik moment delivered by the Soviet Union in 1957 and the subsequent Space Race helped catalyze action by the United States government, it was not just geopolitical competition that drove us to invest in our U.S. space program. Important as the Cold War rivalry was, I believe that even then, visionaries in the Congress and the Executive Branch recognized the benefits to our society and our country that a strong and robust space program could deliver to the United States. History has proved them right. Here we are today. We can look at the myriad of ways that our space investments have transformed our economy, our defense and our quality of life over the last 50 years to realize that space has become woven into the very fabric of all of our daily lives. So it is no surprise that other nations, seeing the benefits that space investments have delivered to our Nation, they want to share in those benefits as well, and I, for one, see that as a positive development and not one to fear. While we must always be vigilant against those who would use space capabilities to threaten others, we should not turn away from opportunities for constructive engagement in peaceful space cooperation because, as our witnesses make clear, there are no lack of challenges that would benefit from cooperation among nations in the space arena. That of course was expressed by President Kennedy almost 50 years ago. He said, "This generation does not intend to founder in the backwash of the coming age of space. We mean to be part of it. We mean to lead it."

We face of course different challenges today than the ones that were faced by President Kennedy and folks that come before us in the Congress, but it is really that vision of the importance of space to the future of this country and the importance of generally overall U.S. leadership in exploring and utilizing space that has been borne out over the intervening years. It is clear that the space capabilities that have been created around the world can play a constructive and a significant role in addressing the many societal challenges we face today. It is also clear that our next great space endeavor, that of human and robotic exploration of our solar system, can benefit greatly from those same global space capabilities.

Yet if we are to harness those capabilities, the United States needs to make clear to the rest of the world that we are not wavering. We are not wavering in our commitment to space exploration and to the path that we started down. Of course, it is hard to lead without a clear sense of direction. Fortunately, this Congress has a sense of direction. The NASA Authorization Act of 2008 established a Congressional consensus in support of a strong human and robotic exploration initiative as part of a robust and balanced space program and in support of the devoting the resources needed to pay for it. I know the President is currently grappling with many hard decisions in the days ahead as he attempts to balance competing priorities, but what to do about the Nation's space program doesn't have to be one of them.

Based on the actions already taken by Congress over the last four years, I think there is a clear path ahead that already has broad Congressional support, and I am confident that he will support it.

With that, again I thank you. I welcome our witnesses.

And now we will hear from Mr. Olson.
[The prepared statement of Chairwoman Giffords follows:]

PREPARED STATEMENT OF CHAIRWOMAN GABRIELLE GIFFORDS

Good morning. I'd like to begin by welcoming our witnesses to today's hearing and thanking them for their participation.

The topic of this hearing-"The Growth of Global Space Capabilities: What's Happening and Why It Matters" is one that should concern all Members of this Subcommittee, and indeed all Members of Congress.

Because the world is changing—and those changes present both opportunities and challenges to the United States that we cannot ignore . . . nor *should* ignore.

While I believe this hearing is particularly timely given the president's current trip to China, Japan, and other nations of the Asian region, there is another reason why I decided to hold such a hearing at this time.

We are at a critical juncture and decisions are being contemplated that will have a significant impact on both the direction and health of our nation's civil space program for decades to come.

While the president and his advisors are engaged in their internal deliberations on what to recommend for NASA and its human space flight program, I believe it is imperative for Congress to not stand idly by.

Instead, I believe that Congress must use the time remaining in this Session to carry out the independent oversight necessary to assess the findings of the Augustine panel, and more importantly, to illuminate the stakes that are involved in whatever decisions the White House and Congress make regarding NASA's funding and future direction.

We started that oversight process in September with a review of the overall Augustine report.

We followed that full committee hearing with a subcommittee hearing to review what needs to be done to improve the effectiveness of NASA's technology programs—an issue raised by the Augustine panel.

Schedule permitting, I intend to follow today's hearing with a hearing to examine human space flight safety issues—an area that many believe was given inadequate scrutiny in the Augustine report—and then a hearing to examine workforce and industrial base issues that are inextricably linked to the decisions we make on NASA's future.

As I mentioned earlier, our hearing this morning focuses on the growth of global space capabilities—capabilities that have significant implications for the U.S. as we contemplate the future of our own space program.

As our witnesses will make clear, at a time when some in the United States seem to be questioning whether we should sustain a strong commitment to investing in our space program, the rest of the world has not hesitated to embrace the promise that the exploration and utilization of outer space can offer to them.

Those other nations recognize that space activities can spur innovation, help improve the quality of life of our citizens, promote national security and economic competitiveness, and advance geopolitical objectives.

That recognition echoes the aspirations of our congressional predecessors when they established NASA and undertook other related actions some fifty years ago.

While the "Sputnik moment" delivered by the Soviet Union in 1957 and the subsequent "Space Race" helped catalyze action by the U.S. government, it was not just geopolitical competition that drove us to invest in our space program.

Important as the Cold War rivalry was, I believe that even then, visionaries in Congress and the Executive Branch recognized the benefits to our society and our country that a strong and robust space program could deliver to the United States.

History has proved them right.

We can just look at the myriad ways that our space investments have transformed our economy, our defense, and our quality of life over the last fifty years to realize the space has become woven into the very fabric of our daily life.

So it's no surprise that other nations, seeing the benefits that space investments have delivered to our nation want to share in those benefits.

I, for one, see that as a positive development and not one to fear.

While we must always be vigilant against those who would use space capabilities to threaten others, we should not turn away from opportunities for constructive engagement in peaceful space cooperation.

Because, as our witnesses make clear, there are no lack of challenges that would benefit from cooperation among nations in the space arena.

That said, I agree with the sentiment expressed by President Kennedy when he said 47 years ago that:

"This generation does not intend to founder in the backwash of the coming age of space. We mean to be part of it—we mean to lead it."

We face different challenges today than the ones faced by President Kennedy, but his vision of the importance of space to the future of this country and the importance of *U.S. leadership* in exploring and utilizing space has been borne out over the intervening years.

It's clear that the space capabilities that are been created around the world can play a constructive and significant role in addressing the many societal challenges we face today.

It's also clear that our next great space endeavor—that of human and robotic exploration of our solar system—can benefit greatly from those same global space capabilities.

Yet if we are to harness those capabilities, the United States needs to make clear to the rest of the world that we are not wavering in our *own* commitment to space exploration and to the path we have started down.

It's hard to lead without a clear sense of direction.

Or as Yogi Berra once said:

"If you don't know where you're going, you'll probably end up somewhere else."

Fortunately, I believe we do know.

The NASA Authorization Act of 2008 established a congressional consensus in support of a strong human and robotic exploration initiative as part of a robust and balanced space program—and in support of devoting the resources needed to pay for it.

I know that the president will be grappling with many hard decisions in the days ahead as he attempts to balance competing priorities.

But what to do about the nation's space program doesn't have to be one of them.

Based on the actions already taken by Congress over the last four years, I think there is a clear path ahead that already has broad congressional support, and I am confident that he will support it too.

With that, I again want to welcome our witnesses, and I look forward to your testimony.

Mr. OLSON. Madam Chairwoman, thank you for calling this morning's hearing to examine the efforts and goals of countries around the world that have recognized the importance of space capabilities to their respective nations. Understanding their objectives and how the United States can work with them directly and indirectly to achieve common goals must, must be an aspect of our own Nation's space program.

Let me begin by thanking our witnesses for their appearance here today. I recognize that each of you has spent considerable time and effort preparing for this hearing and in some cases traveling a considerable distance to be here. Please know that this Subcommittee appreciates your efforts as well as the wisdom and experience you bring and that we will refer to your guidance in the months and years ahead.

As has been well documented, the Space Age was born out of international cooperation, came of age during a time of international competition and now is maturing under a period of both. How we progress going forward has global implications beyond what we witnessed in the Cold War. We see nation after nation recognize that space-based capabilities are beneficial in the areas of disaster relief, broadband deployment, telemedicine, agriculture, training and education and climate monitoring, just to name a very few.

As interested as I am to hear what other countries are doing and how they are investing their resources, I want to not lose sight of how those efforts should impact the United States of America. I am all for talking about global partnerships but we should never, ever cede American leadership in endeavors we have earned and in-

vested in for several decades now. In the area of human spaceflight in particular, the activity of other nations is extremely telling. With each nation that commits to the goal of sending humans into orbit and with each promise of missions to the moon, both manned and unmanned, we should recommit ourselves to an unequivocal path of human spaceflight that serves as an example of leadership and potential partnership for other nations.

Continuously since 2000, the International Space Station has orbited the earth as an example of how nations can work together to achieve great goals. The engineering, scientific and diplomatic achievements of this lab should be an example of the type of partnership we can achieve going forward. In an era of lowered economic resources, particularly in our Nation, we must find creative solutions to fund worthy enterprises.

We spend a lot of time in this room talking about the benefits of space-based technologies, industries and exploration, and it is critical to convey that those benefits are not limited to the United States but that the impact is global. After all, satellites don't just orbit America.

Whether the efforts are made at understanding our climate, to help people recover from natural disasters or to connect economies around the globe, we can look to space to help make our world a better place. When that is the goal we are discussing, it is more than worth the time of this Committee and our witnesses again for sharing your insights with us.

Thank you, Madam Chairwoman. I yield back my time.

[The prepared statement of Mr. Olson follows:]

PREPARED STATEMENT OF REPRESENTATIVE PETE OLSON

Madam Chairwoman, thank you for calling this morning's hearing to examine the efforts and goals of countries around the world that have recognized the importance of space capabilities to their respective nations. Understanding their objectives, and how the United States can work with them directly and indirectly to achieve common goals must be an aspect of our own nation's space program.

Let me begin by thanking our witnesses for their appearance today before this subcommittee. I recognize that each of you has spent considerable time and effort preparing for this hearing, and in some cases traveling considerable distance to be here. Please know that this subcommittee appreciates your efforts, as well as the wisdom and experience that you bring, and that we will refer to your guidance in the months and years ahead.

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As interested as I am to hear what other countries are doing and how they are investing their resources, I want to not lose sight of how those efforts should impact the United States. I'm all for talking about global partnerships, but we should never cede American leadership in endeavors we have earned and invested in for several decades now.

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of partnership going forward. In an era of limited economic resources, particularly in our nation, we must work to find creative solutions to fund worthy enterprises.

We have spent a lot of time in this room talking about the benefits of space-based technologies, industries, and exploration. It is critical to convey that those benefits are not limited to the United States, but that the impact is global. After all, satellites don't just orbit over America.

Whether the efforts are to better understand our climate, to help people recover from natural disasters, or to connect economies around the globe, we can look to space to help make our world a better place. When that is the goal we are discussing, it is more than worth the time of this committee and I thank our witnesses again for sharing your insights with us.

Thank you, Madam Chairwoman. I yield back my time.

[The prepared statement of Mr. Griffith follows:]

PREPARED STATEMENT OF REPRESENTATIVE PARKER GRIFFITH

I would first like to thank Chairwoman Giffords and Ranking Member Olson for their work on this hearing. The Space and Aeronautics industry has become a booming industry ever since the Space race of the 1960's. While the United States won the space race when Apollo 11 landed on the moon in 1969, numerous countries before and after that time, have sent astronauts to space and established space agencies. America must continue to maintain its space dominance as superiority in space equals excellence in national defense, intelligence, education, future technologies, trade, and economic development. We can continue to be America, or we can settle for second best. We should never be satisfied with second best.

Chairwoman GIFFORDS. Thank you, Mr. Olson.

If there are members who wish to submit additional opening statements, your statements will be added to the record at this point.

Today we have a distinguished set of witnesses but we also have a new Member of Congress, John Garamendi, who is sitting in the audience. He is from California. John, where are you? Congressman, good to see you. Welcome. We are excited about having you in our Committee and we just want to welcome you and make sure you're feeling at home here.

Mr. GARAMENDI. Thank you very much.

Chairwoman GIFFORDS. Okay. Let us take a moment to introduce our witnesses. First up we have Dr. Marty Hauser, who is the Vice President of Research and Analysis of the Washington Operations of the Space Foundation. As someone who played a key role in the Space Report 2009, he is well positioned to talk about the status of global space capabilities and the global space economy. Next up we are going to hear from Mr. J.P. Stevens, who is the Vice President for Space Systems at the Aerospace Industries Association. He is going to provide for us a perspective on the emerging global space environment and the implications for the U.S. aerospace industry and its workforce. We are also going to hear this morning from Dr. Pace, Dr. Scott Pace, who is the Director of the Space Policy Institute at the George Washington University. He is going to provide some insights on what is growing in terms of global space capabilities, what that means for the United States leadership and associated policies that we will need to confront. Also, we are going to hear from Dr. Kai-Uwe Schrogl, who is the Director of the European Space Policy Institute. He has agreed to provide a European perspective on the impact and implications of growing space capabilities, and we are pleased to have that foreign perspective this morning, so good morning. And finally we have Dr. Ray Williamson, who is the Executive Director of the Secure World

Foundation. Dr. Williamson will provide perspectives on the capabilities of emerging space nations and as well some of the issues that we are going to need to consider when engaging with them.

I will let all our witnesses know that you will each have five minutes for your spoken testimony. I know that is not a very long period of time but I know we are going to have some really good questions and discussion a little bit later. Your written testimony will be included in the record for the hearing, and when you have completed your spoken testimony, we will begin questions, and of course, each member will have five questions. So Mr. Hauser, we are going to start with you.

STATEMENTS OF MR. MARTY HAUSER, VICE PRESIDENT FOR RESEARCH AND ANALYSIS, WASHINGTON OPERATIONS, THE SPACE FOUNDATION

Mr. HAUSER. Thank you, and good morning, Chairwoman Giffords, Ranking Member Olson and distinguished members of the Subcommittee. I am Marty Hauser and I am Vice President of Washington Operations Research and Analysis at the Space Foundation. On behalf of our board of directors and CEO, it is a pleasure to be here today and I want to thank you for holding this event.The Space Age is now more than 50 years old and has given birth to a global industry valued at more than $257 billion. What was once the providence of only the United States and the former Soviet Union is now a dramatically growing industry. Many of our allies are catching up and they are catching up fast. They have developed their nascent space capabilities and are modestly and steadily investing in their own space capabilities.

The trend we all know is that the U.S. leadership in space is eroding on multiple fronts and legislative policy and fiscal redirections are all critical. Most any space capability we have in the United States now exists in other nations. Quality may vary and no other country currently can do what we do but the number of countries' capabilities are growing and again growing steadily. Lots of countries have active space programs, even countries at the low- and middle-income levels. The fact is that more than 60 countries now have a space agency. This is a significant trend as it wasn't half that large just a few years ago. That said, with all of these nations so active in space, it is increasing opportunities for more international collaboration. Benefits can be found.

Another trend is an increasing willingness to share knowledge and expertise about space. An example is China agreeing to build and launch satellites for Nigeria and Venezuela. They also train the staff in those countries how to operate those systems. Established space companies are also involved in training. The European company EADS is partnering with Kazakhstan to build satellites, operate a satellite integration center and train Kazak engineers. This is difficult for American firms to do because of ITAR restrictions.

We also can't underestimate these countries either. Europe, Japan, Russia, India and China have first-rate launch capabilities. Japan, China and India all have programs today that include lunar exploration. This past September a Space Foundation delegation visited China and toured a number of previously classified facili-

ties. While I was not on that trip, I was told it was quite stunning; the facilities are state-of-the-art. Another member also went to French Guyana on a trip and came back saying it is a launch site can teach us many things about how to improve our launch infrastructure. He also noted the large numbers of young men and women doing engineering and technical work, that we need to better engage young Americans and we need to encourage them to work in America's space program. We are losing our competitive position in some of the most critical disciplines such as launch, manufacturing and services. We must work harder to preserve and retain strategic, technical and commercial advantages to remain the market leader in any global technology field.

In some cases, international capabilities provide opportunities for us in terms of technology exchange, exports, outcomes through direct foreign investment. In other instances, the international capabilities may be competitive in nature and may reduce U.S. capability and economic opportunity over the long term. It can also create rivals, and I doubt that any of us want to hear about a Soviet-Chinese relationship and cooperation that goes on without involving the United States. From a purely pragmatic point of view, space is—are crowded and we need to reduce the debris that is up there because of potential for satellite collisions is great.

Historically, the United States has held the position of space superiority. This means we are in a more favorable position than most other nations in space. However, this space superiority is declining quickly towards parity. A few quick examples. The Russians lead the world in space launch over the past five years. They intend to increase that dramatically. While Russia and the United States provide the most orbital launches from year to year, 2007-2008 the share of non-U.S.-Russian launches grew from 34 to 41 percent.

I don't envy your task but I agree with much of what you both said in your opening statements. So for me, this is my personal view as because comes down to one simple question: Does the United States want to continue to be the leader in space? If the answer is no, then we are already living our future. If the answer is yes, however, we must remember that our leadership position in space is not a birthright. Over the past 50 years we have had to make bold decisions and earn that leadership position. To continue being the global space leader, we must bite the financial bullet, roll up our sleeves and get to work. We apply our great minds and our great talent, find better and smarter ways. We make the tradeoffs to do what is necessary to get to and work in space. We build international partnerships and share costs. Where no one else can, we stand up and we lead the way we always have. We innovate, we educate, we produce and we lead. Space is an enabler for people around the world and a multitude of industries that can better our world, but to better our world, we must first as the United States once again enable space.

Thank you for your time. I will be prepared to answer your questions later.

[The prepared statement of Mr. Hauser follows:]

PREPARED STATEMENT OF MARTY HAUSER

INTRODUCTION

Good morning Chairwoman Giffords, Ranking Member Olson, and distinguished members of the subcommittee. My name is Marty Hauser and I am Vice President of Washington Operations, Research and Analysis for the Space Foundation. On behalf of myself and Space Foundation CEO, Elliot Holokauahi Pulham, I want to thank the subcommittee for providing the Space Foundation the honor to sit before you today to talk about the trends we are seeing in non-U.S. space programs.

The Space Age is now more than fifty years old and it has given birth to a global industry valued at more than $257 billion. Early on, space was the province of only the former Soviet Union and the United States. By the 1970's, many of our allies had developed nascent space capabilities and they have modestly, yet steadily, invested in their capabilities. Today we have an International Space Station and more than 60 nations maintain space agencies with active space programs. Space is getting more crowded, not only due to a rise in government-funded space activity on a global scale, but also due to significant growth in commercial space activity.

The world's oceans and airspace have been transformed over the centuries from dangerous frontiers into channels through which trade and travel are routine occurrences. A similartransformation is taking place in space, as the global economy further establishes its dominance over the frontier beyond the Earth's atmosphere. The challenging and demanding environment of space means that activity there is expensive and time-consuming. In spite of this, other nations clearly see the value in space systems for a variety of reasons and they are devoting scarce resources to create and expand space capabilities.

WHAT SPACE CAPABILITIES EXIST OUTSIDE THE U.S. AND ARE THERE ANY SIGNIFICANT TRENDS IN THAT REGARD?

U.S. leadership is eroding on multiple fronts and both legislative and policy redirections are critical.

Almost any general space capability that exists in the United States, including human spaceflight, satellite manufacturing, launch, space science, and military applications, also exists in other nations. The quality of the capability may vary, but no other country has the same breadth and depth of capabilities as the United States. However, the number of countries with space capabilities is growing. This is illustrated by Iran's recently acquired satellite launch capability and efforts by the two Koreas to develop a launch capability. India has plans to develop a human spaceflight program and the quality of its other capabilities is improving. China has gone from rudimentary human spaceflight to plans for a space station in the coming decade. China clearly intends to achieve and maintain- status as a major space power. Other countries have selected leadership in certain niches and large number of countries have targeted development efforts toward Earth observation and remote sensing, including military intelligence and reconnaissance capabilities.

Canada, China, much of Europe, Brazil, Israel, India, Japan, Russia, Iran and South Korea all have very active space programs. Some are more capable than others; however, even among nations ranked by the World Bank as having low or middle income levels, investments are being made in the acquisition and use of space hardware and expertise. In all, there are more than 60 nations that maintain space agencies. This is a significant trend, as we see steady growth in the number of nations whose governments are active in space in some fashion.

As the number of spacefaring nations increases, so do the opportunities for international collaboration. The United States can reap benefits from this in the form of new partnerships, but another result could be that foreign governments will partner with each other instead of the U.S. space program. To maximize the return on smaller budgets, many nations seek to develop limited capabilities with the expectation that they will be able to partner with another nation that has complementary capabilities. For instance, a government may choose between satellite development and launch vehicle technology, rather than spending money on both. The natural partnerships that develop between two such countries are likely to extend into other areas of space activity because they already understand each other.

Another trend is an increasing willingness to share knowledge and expertise about space technology and operations. Some countries take the approach demonstrated by China when it agreed to build and launch satellites for Nigeria and Venezuela, and to train staff in those countries to operate the systems. Established space companies are also involved in training, as when the European company EADS entered a partnership earlier this year with the government of Kazakhstan to build satellites, operate a satellite integration center, and train Kazakhengineers.

The details of such agreements are as varied as the needs and abilities of the countries and companies that participate, but they all indicate an interest in generating returns on a collective investment rather than an individual one. This kind of activity is more difficult in the United States due to the restrictions imposed by ITAR, meaning that U.S. companies and government agencies are less desirable partners because of the regulatory complications involved.

Europe, Japan, Russia, India, and China have first-rate launch capabilities. Japan, China and India all have programs today that include lunar exploration. Europe, Israel, and India have robust remote sensing capabilities. Canada has a wide range of niche specialties, most notably in robotics. Of particular note over the past decade is the emergence of China's human spaceflight capabilities.

At present, there are only three nations with human spaceflight capabilities; the United States, Russia, and now China. Once we retire the Space Shuttle, that "club" will be just Russia and China for many years. I would also add that India has also been working on its own human spaceflight program as well.

In September 2009, a delegation led by the Space Foundation visited China and toured a number of previously secret space facilities. It was a stunning experience. Not only are China's facilities newer than ours, but they are also state-of-the-art.

This past summer, a Space Foundation member visited the European launch facilities in French Guiana. This modem and very active launch site can teach us many things about how to improve our launch infrastructure. Additionally, the large number of young twenty/thirty-something men and women doing engineering and technical work in French Guiana should make us sit up and realize that we need to better engage young Americans and encourage them to join the space industry. I should add that China has a lot of young people working on its space program also.

WHY DOES THE GROWTH OF NON-U.S. SPACE CAPABILITIES MATTER TO THE U.S.?

Space provides many kinds of strategic, economic, scientific and geopolitical benefits. Other nations understand this and they are spending time and resources on it.

The United States is losing its relative competitive position in most critical space industry disciplines such as launch, manufacturing, service provision, and specialized services. Our relative competitive position matters a great deal economically in the near- to mid-term, and over the-longer term it is essential to our national defense and security position. It is also essential to retaining the strategic, technical and commercial advantages which accrue to the market leader in any global technology field.

In some instances, international capability provides opportunities for enhanced outcomes, benefiting the United States through technology exchange, economic opportunity from exports, direct foreign investment, or lower costs. These capabilities are complementary and beneficial, and can provide additional means of cooperation on space ventures (like NASA flying instruments on the first Indian lunar mission, Chandrayaan-1), which can . become part of achieving broader U.S. foreign policy goals.

Other international capabilities are competitive in nature and may reduce U.S. capability and economic opportunity. In addition, some technologies and capabilities are strategic, meaning U.S. leadership confers value to the nation beyond pure capability or economic benefit. In some cases the growth of non-U.S. space capabilities can be threatening, as in the cases of Iran and North Korea. It can also create rivals to U.S. capabilities in space if other countries such as China and Russia cooperate with one another and/or other nations on projects without involving the United States.

From a purely pragmatic viewpoint, the more actors in space, the greater the chances of collisions between spacecraft, increased lethal debris and associated traffic management problems, especially in low Earth orbit. This poses a problem for the U.S. since we have the largest number of space assets in orbit and the United States Air Force is charged with cataloging and tracking all active and inactive space objects. Currently the Air Force tracks more than 20,000 items in space. The U.S. should take a leadership role and encourage other spacefaring nations to agree to "rules of the road" for responsible action in space. If this does not happen, there is a greater risk to our space systems and it is more likely that we will lose access to those vital capabilities.

From competitiveness viewpoint, having a strong technical workforce is essential for a nation to be a serious competitor in the global economy. Space is a potent lure

for talented young minds. Competency in space activities translates easily into other high-tech sectors of the economy.

We reported a trend of concern in our book, *The Space Report 2009,* showing that the United States is losing its lead in producing bachelor-equivalent degrees in technical fields critical to sustaining the space industry. In 2004, China produced approximately seven times the number of engineering graduates from a population four times that of the United States. In addition the National Science Foundation reports that graduate student visas have declined since the attacks of September 11, 2001 and that could translate into a declining talent pool for U.S. space industry recruiting.

WHAT ISSUES DOES THE GROWTH OF NON-U.S. SPACE CAPABILITIES RAISE FOR CONGRESS AS IT ASSESSES THE FUTURE DIRECTION AND FUNDING OF THE U.S. SPACE PROGRAM?

Congress and the Administration must decide if America will continue to lead in space. The position of the United States is one of "space superiority," which means we have a more favorable position than most others nations in space. However, even that space superiority is beginning to slide toward greater parity.

For example, the Russians are the world leaders in space launches over the past five years. While Russia and the United States provide the most orbital space launches from year to year, in 20072008 alone, the share of non-U.S./Russian launches grew from 34% to 41%. Similarly in spacecraft manufacturing trends, the United States fell from clear dominance in the 1990's to the point where in 2008 we produced the same number of satellites as Europe. These are just a couple of the trends and realities that become more clear each year.

Earlier in my—testimony I highlighted the wonderful assets and facilities our European colleagues have in French Guiana. They should be commended for the intelligent and effective investments they continue to make in their launch site. They are not pouring vast sums of money into their facilities in an effort to outspend us, but they are certainly getting more out of their investments. While the funding amounts and budgetary processes of China's investment in space capabilities are hazy at best, I would posit to the subcommittee that they are not outspending us either. It is interesting to note that some nations, such as Russia and India, devote about half a percent of their national budgets to space, a proportion similar to U.S. funding for NASA. The reason that NASA's budget is larger than these other space programs is because the total U.S. budget is considerably larger.

All of this begs several questions. What role does the United States want or need to play in the global space industry? What does securing and maintaining that position over time require both financially and strategically? Does the U.S. government fully understand the likely impacts of failing to achieve those goals? Can the nation afford to assume a second-tier role in certain areas? If so, what are those roles and what would the trade-offs be nationally for making such a choice?

We must also sort out where the best opportunities for government and industry partnerships are to improve results, reduce duplicative effort and achieve the greatest cost efficiency? What are the best opportunities for international collaboration to achieve the same goals? Are there cost and effort efficiencies available within current programs which would permit the deployment of resources to the most essential future programs?

Given the high projected costs of the ultimate goals of human space exploration, it seems unnecessary and unwise for one nation, such as the United States, to go it alone. The growing capabilities of these countries allow for cost-sharing on various aspects of such efforts, while maintaining U.S. leadership. However, as the number of spacefaring countries and their capabilities grow, it is not unreasonable to think that a consortium of them could work together on such missions without any involvement by the United States, if we decide to exclude them or decide not to undertake such efforts.

If would be foolhardy for us to assume we know best for any and all things related to space. I suggest we take a hard look at our space capabilities and see where we have gaps and other failings. We should see where other nations are doing better in those areas and learn some lessons from them and in some cases partner with them. In areas where no one else is able to lead, the United States should stand up and lead.

I've stated that other nations clearly and easily understand the value in investing in space systems. In the United States, we seem to perpetually ask ourselves if we should continue to invest in space systems. We currently lead the world in space, but that leadership position is not a birthright. We must choose to continue to lead. If we do not, we will be supplanted as the premier spacefaring nation.

I stand ready to answer any questions.
Thank you.

Chairwoman GIFFORDS. Thank you, Mr. Hauser.
Mr. Stevens.

STATEMENT OF MR. J.P. STEVENS, VICE PRESIDENT, SPACE SYSTEMS, AEROSPACE INDUSTRIES ASSOCIATION

Mr. STEVENS. Good morning, Chairwoman Giffords, Ranking Member Olson and members of the committee, I am grateful to be here to testify before you today.

The Aerospace Industries Association is the largest aerospace trade association in the United States and we represent—we have about 300 members and we represent over 640,000 high-wage workers and indirectly support another 2 million workers, 30 suppliers in all 50 states. We appreciate the efforts of Congress to keep both our civil and national security programs healthy.

Commercial interests such as banking transactions, business and personal communications, all depend on communications and GPS satellite. Essential national security information and all of our military operations depend on space assets, and weather and climate satellites give us lifesaving warnings and information on climate change.

Now, for many years the benefits of space programs were provided primarily by the United States and Russia. Our lead was achieved because space was given a Cold War priority as far as funding but funding is no longer at the level it was back then. Other nations with the proper workforce and foresight to make the necessary investments have rapidly caught up to us. Allow me just quickly to mention a few areas where I believe the United States has either lost or is losing its leadership in space, and that includes satellites, human spaceflight and launch systems.

As you are well aware, satellites are employed and built by a number of nations. However, because of export control restrictions, many countries are building and employing satellites and advertising them as ITAR free. This is not good for our companies when our share of the world market now is only 29 percent. Global positioning system satellites are used by our airlines, our emergency responders and others and they also provide exact timing, which is critical to both the financial and banking industry. Of the $144 billion that is generated worldwide by satellite revenues, roughly $23 billion come out of our system, our GPS system. However, other nations are developing their own. Russia is about to launch six more satellites and will have their system completed by March. The Europeans and Chinese are working on theirs and they will have their systems completed sometime between 2014 and 2017, and India and Japan are developing their own systems. New global navigation satellite systems compete with our system but most importantly they raise the issues of compatibility and interoperability not only between the systems but also the systems they support.

In regard to human spaceflight, the Chinese orbited an astronaut, as you are well aware, for a day in 2003 and since then they have made significant milestones. They have had multiple crews, orbital maneuvers and space walks. The thing to remember here is that they are on the same pace as we were during the moon race

with the Russians but most importantly they are doing it with fewer flights. The Europeans and Japanese have flown cargo vessels to the International Space Station and the Europeans are now talking about taking that cargo section of their spacecraft and adding a human-rated capsule. India is planning to set up astronaut training in 2012 and hope to have their first astronaut in space by 2015.

Another area of concern for us is the U.S. commercial space launch industry which now only has about 15 percent of the global market. Now, why is all this important to Congress? Well, space is an excellent technology driver and military programs enabled early human spaceflight. Recall John Glenn, my former boss, and Yuri Gagarin were both launched on military ICBMs. Well, the reverse is also true. These countries that are getting into the space race now can enable their space capabilities into military capabilities.

So what can you do? Well, the first thing we need from your is your commitment to maintain space leadership. To do this, we need stable and robust funding. Space programs take time to develop, test and build. Fluctuating budgets and delayed programs take their toll on agencies like NASA. We need your leadership to support space being treated as a singular enterprise where all the decisions and strategies of all the agencies that deal with space are coordinated at the White House level.

We need your support with our future workforce. Currently we graduate only 74,000 engineers a year, and out of that many of them are foreign nationals that return to their countries to work on things like ITAR-free satellites and so that ends up leaving us about 60,000, and you compare that with China and India, basically they graduate hundreds of thousands each year.

Space systems are also producing small numbers, so interruptions or cancellations negatively impact our big companies but they can be catastrophic to the small suppliers that often produce the small but critical components on which huge portions of our economy, infrastructure and national security depend.

I agree with you, Chairwoman, that as a Nation we need to consider international partnerships but I will say cooperation needs to be equitable with our partners and not adversely impact our industrial base or our national security, and I think a good example of this is the International Space Station and I believe that the International Space Station should be funded and flown until at least 2020.

In conclusion, our space technologies have become an important part of our Nation's economic and national security capabilities but our leadership in space and everything that space supports is no longer guaranteed.

We thank the Committee for their time and I look forward to your questions.

[The prepared statement of Mr. Stevens follows:]

PREPARED STATEMENT OF J.P. STEVENS

Introduction

Good morning Chairwoman Giffords, Ranking Member Olson and members of the Subcommittee. I am grateful for the opportunity to testify before you today on the growth of global space capabilities.

As the largest aerospace trade association in the United States, the Aerospace Industries Association (AIA) represents nearly 300 manufacturing companies with over 640,000 high-wage, highly skilled aerospace employees across the three sectors: civil aviation, space systems and national defense. This includes over 140,000 workers who make the satellites, space sensors, spacecraft, launch vehicles and ground support systems employed by NASA, DOD, NOAH, NRO and other civil, military and intelligence space efforts. Our member companies export 40 percent of their total output, and we routinely post the nation's largest manufacturing trade surplus, which was over $57 billion in 2008. Aerospace indirectly supports 2 million middle class jobs and 30,000 suppliers from all 50 states. The aerospace industry continues to look to the future, investing heavily in research and development, spending more than $100 billion over the last 15 years.

AIA appreciates the efforts of the Congress to keep our civil and national security space programs healthy, as well as in promoting commercial space ventures. Over several decades space technologies have increasingly become a part of our daily lives with virtually every part of the U.S. economy being touched by their applications.

Commercial interests such as banking transactions, business. and personal communications, and precise location for our emergency responders, airliners and automobiles all depend on communications and GPS satellites.

Essential national security information and support of our troops' military operations are all are dependent upon space assets.

Weather and climate satellites give us life saving warnings and provide us recurring, global wide data on climate change.

Observing, monitoring and exploring space relies on incredibly robust equipment functioning in extremely hostile and demanding environments.

Additionally our space programs, particularly NASA's work, remain an excellent source of inspiration for our youth to study science, technology, engineering and mathematics and to enter our aerospace workforce on which much of our nation's transportation, security and satellite infrastructure depend.

Global space capabilities

For many years the benefits of space programs were provided primarily by the United States and Russia. Our leadership was based on the strength of our engineers and scientists, and research and development supported by our industrial base. Our lead was also achieved because space was given a 'Cold War' priority and funding at a level it no longer receives.

Now other nations with the foresight to make the necessary investments and a pool of talented workers have rapidly caught up. By learning from our early successes and mistakes their investments—while not insubstantial—have generally not needed to be as great as ours to reach near parity,

Allow me to quickly mention just a couple of areas where the U.S. can rapidly lose its leadership edge in space: satellites and human spaceflight.

Satellites are now employed and built by a number of nations. Because of U.S. export control restrictions some foreign built satellites actually advertise themselves as "ITAR free." The U.S. share of overall world wide satellite manufacturing revenues was 47 percent—or 4.6 billion dollars—in 2003 but it decreased to only 29 percent—or 3.1 billion dollars, in 2008.

An example of other nations developing their own satellite systems can be seen with Global Positioning System satellites, or GPS. Our GPS system is used by our military, airlines and emergency responders. It also provides exact timing that allows our communications to share limited bandwidth with more than one party at a time. This timing is also important to accurately mark financial and banking transactions.

Of the 144 billion dollars generated world wide by satellite revenues in 2008, roughly 23 billion are directly related to America's GPS system.

As a result, other nations are moving into the global navigation satellite market. Russia has modernized its GLONASS system and plans to launch six more satellites by March. It should be complete next year. The Europeans and Chinese both plan to have their systems—Galileo and Compass—operational between 2014 and 2017. India and Japan are also developing their own systems.

New global navigation satellite systems will compete with our system, impacting our revenues. They will also raise issues of compatibility (ensuring new systems don't impact the function of existing ones) and interoperability (where the systems can work together).

In regard to human spaceflight, other nations clearly recognize the value of space programs as innovation drivers, increasing world stature and as a source of national pride.

The Chinese orbited one "Taikonaut" for nearly a full day in 2003. Since then they have achieved significant milestones (multiple crews, orbital maneuvers and space walks). The Chinese have made these steps at about the same pace as the U.S. and U.S.S.R. did during the moon race and they are doing it with far fewer flights.

The Chinese "Shenzhou" spacecraft is an adapted design of the Russian Soyaz, which the U.S.S.R. once sent around the moon and returned safely to the Earth with turtles aboard as biological specimens. Using several flights on. its Long March V rocket—currently under development—they could make a human moon landing within a decade.

India is planning to set up an astronaut training center in 2012 and is looking at a human launch around 2015. They have also sent a probe into lunar orbit.

The Europeans and Japanese have developed and flown remote control cargo ships—the ATV and the HTV—to the International Space Station. The Europeans have suggested in time they can replace the cargo section of their craft with a capsule creating a human rated spacecraft.

Why is this important to Congress?

There is a clear trend that the projects other nations have for space are already in place or could potentially be achieved within a decade.

Space is a major demonstration of 'smart power.' The United States is a world power—as is Russia—and we have strong space programs. China and India are becoming large players in the global economy and they will certainly continue demonstrating their prowess with space systems.

Even more substantial is that space is an excellent technology driver. Military programs enabled early human space exploration. Recall John Glenn and the Russian Yuri Gagarin were launched on ICBMs. It is important to remember that the reverse is also true—strides other countries make in their civil or commercial space programs can enable military capabilities. From a security point of view we always want our space capabilities to be leading edge.

Our lead has already shortened in many places. Over the last 20 years competition from foreign launch systems has grown significantly. The U.S. Commercial Space Launch industry now only has about 15 percent of the global commercial launch market.

What can Congress do?

Congress should maintain its commitment—both through the actions of its Appropriators and Authorizers—to U.S. space leadership so we have an edge, or at least are "first among equals." This can best be done by ensuring our nation maintains its industrial drive.

To do this first and foremost, our nation's space programs need stable and robust funding. By their very nature space programs take several years to develop, test and build. Once launched, satellites are not accessible, so systems must work with high reliability the first time. Fluctuating budgets and delayed programs take their toll on schedule, production and maintaining a skilled workforce on the project. Budget shortfalls also deeply impact agencies like NASA that have been asked to take on many valuable projects simultaneously.

We need Congressional leadership to also support space being treated as a "singular enterprise" where the decisions and strategies of the many agencies using space are coordinated at a White House level.

We face challenges with our future workforce. AIA members have identified that a "lack of trained technical workforce for the future" is one of the most important long-term issues facing our industry. Currently the U.S. annually graduates just 74,000 engineers in total—covering all fields in the discipline. Further, many of these students are foreign nationals who return home shortly after graduating which drops the number of domestically employable engineers under 60,000. In comparison, China and India respectively graduate 600,000 and 350,000 engineering students each year. The U.S. runs the real risk of losing its skilled engineering lead over other nations.

Our space industrial base designs, develops, produces and supports our spacecraft, satellites, launch systems and supporting infrastructure. These systems are often produced in small, or even single, numbers. We need to keep this base healthy. We ask that Congress remember that interruptions or cancellations negatively impact large companies and can be catastrophic to smaller firms—often the only entities with the unique abilities to produce small but critical components on which huge portions of our economy, infrastructure and security depend. As an example, only one firm in the U.S. produces ammonium perchlorate which is used in solid rocket

propellants including the space shuttle solid rocket boosters, other space launch and military capabilities.

Additionally all other nations provide their commercial launchers with some form of government indemnification. The House recently extended our form of indemnification until the end of 2012 through the Commercial Space Launch Act. We hope the Senate follows suit. Elimination of U.S. government indemnification would drive even more launch business overseas and could also impact launches of U.S. civil and national security payloads. AIA. believes the indemnification of U.S. commercial space launch should be made permanent.

Our nation needs to ramp up technological development, which has atrophied in recent years. In the September the Review of U.S. Human Spaceflight—or Augustine—Committee recommended NASA once again put greater focus into this area.

As a nation, we need to consider future international partnerships, pooling funds, talent and resources for space exploration or climate study from space based sensors. International participation will increase the number of possible projects, providing us with a win-win situation. It will however, be important to ensure our cooperation is equitable with our partners, opening opportunities for all but not adversely impacting the U.S. industrial base.

An important step to promoting further international cooperation in space is continuing U.S. participation on the International Space Station until at least 2020. U.S. involvement is currently in danger of ending in 2015. Supporting the ISS will clearly demonstrate America's commitment in other areas of international cooperation in space. Further this will allow America to continue utilizing the ISS as a National Laboratory.

While AIA believes it is important to protect critical U.S. capabilities, many U.S. export control policies are counterproductive for our industry, negatively impacting our security interests. While we must keep sensitive technologies out of the wrong hands, we also must facilitate technology trade and cooperation critical to U.S. interests with our friends and allies in a timely manner. Barriers to the export competitiveness of U.S. companies have prompted numerous countries to develop their own indigenous aerospace capabilities., leveraging their own R&D and innovation. Without a cutting edge U.S. space industrial base, our government could be forced to rely on foreign suppliers for key components.

Conclusion

Over the last 50 years, space technologies have become an increasingly important part of our nation's economic, scientific and national security capabilities. Over time, all sectors of the U.S. economy have become inextricably reliant upon space systems. As other nations make rapid advancements in acquiring or exploring space capabilities, America's leadership in space is no longer guaranteed and the securing of its space assets is no longer assured.

I thank the committee for their time and attention and would be happy to answer any questions.

Chairwoman GIFFORDS. Thank you, Mr. Stevens.

Dr. Pace.

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

Dr. PACE. Thank you, Madam Chairwoman and Ranking Member Olson, for providing this opportunity to talk about this important topic, and I particularly commend the international orientation that you decided to take on this because I think this goes to the heart of the geopolitical significance of space that often isn't recognized.

The geosynchronous arc is crowded with communication satellites. As you have heard, Russia, Europe, Japan, China, India are modernizing or building their own satellite-based navigation systems. The U.N. Committee on the Peaceful Uses of Outer Space is larger than ever with 69 member states. In some cases, developments are cause for congratulations, as is I believe the case when China became the third country to independently conduct a space

walk. In others, these developments are a cause for concern as the case of North Korea and Iranian missile programs.

Last month, I attended an annual meeting of the International Astronautical Federation in Daejeon, South Korea. There is a statute of South Korea's first astronaut on the main boulevard. The president of South Korea spoke at the opening ceremony and said, "Space technology is already being applied in various areas of our daily lives. Space technology is the growth engine that will open the future of mankind and has become a necessary tool of our own survival." Representatives from Europe, Japan, Russian, China, India and Korea presented their increasingly specific plans for exploration of the moon and missions to Mars.

NASA also presented current U.S. plans, and images of hardware being built and tested I have to say were quite impressive. Just as impressive was the expressed spirit of international cooperation and coordination not only among International Space Station partners but rapidly rising powers such as India, China and Korea, and this spirit has been in development not overnight but over the last three years and is part of an inclusive U.S. diplomatic strategy that resulted in 14 space agencies agreeing to a common global exploration strategy.

Unfortunately, ongoing U.S. debates combined with the realities of the fiscal year 2010 NASA budget have created an air of uncertainty over U.S. intentions. To borrow from Norm Augustine, you know, it is hard to get others to work on your garden if you are pulling up the flowers to check the roots.

So the United States is a founding member of the space club, as you have heard, but we are at the risk of shifting to an emeritus status. The Chinese in particular have laid out a careful, logical approach in which they plan to launch a mission in 2011 to test docking and rendezvous techniques followed by a man-tended laboratory in 2015 and a three-man space station by 2020, an interesting date. The selection of 45 new taikonauts is underway along with plans for a lunar sample return and a Mars orbiter, and I have to say I welcome peaceful Chinese space exploration efforts. However, I don't want to see them or other nations to be on the frontier of space without us.

If we are not planning for what comes after the ISS, the government is in effect getting out of the human space launch business. There may be space tourists launched by U.S. companies, and I certainly hope so. But tourism alone cannot sustain a major international cooperative human spaceflight effort. If we are not going beyond the earth orbit, we are ignoring both the recommendations of the Columbia Accident Investigation Board and the reality of increasing globalization of space activity.

For India, ambitious space efforts are to attract new human capital to a strategic aerospace sector which must compete with a growing information technology sector. For China, human spaceflight experiences are training a new generation of technical specialists and raising the quality level of industrial suppliers. For Japan and Europe, spaceflight demands are creating interdisciplinary skills that can increase the competitiveness of their aerospace and their non-aerospace sectors. The sophisticated system engineering demanded by human spaceflight is part and parcel of what

a great nation does, and more importantly, a symbol of what it is capable of doing.

Human spaceflight is the most demanding space activity technically, financially and organizationally. From the beginning it has also been the most symbolic activity both at home and abroad, a powerful symbol of cooperation among former adversaries such as on the International Space Station and the deep international relationships built through the ISS are among its most impressive and perhaps most enduring achievements to date.

For the future, we need to continue efforts to bind friends and allies to us in a multi-partner world in which space capabilities are globalized. We need friends and allies to secure the global commons of space upon which we all depend. We need to inspire a new generation of Americans to take on many demands in a globally competitive environment driven by scientific and technical innovation. The international norms for human space activity will be shaped by those who are there, not by those who stay behind. If we want to see a human future in space that reflects our values, then we must be a part of that effort.

The NASA Authorization Acts of 2005 and 2008, as mentioned, combined with the global exploration strategy that was developed with U.S. participation provides, in my view, a clear and practical way forward for this Nation. I hope the Administration and Congress will support the restoration and necessary NASA funds for exploration and carrying out those directions.

The United States is facing a generational transition away from the period represented by the space shuttle and is just as profound as the transition from Apollo was. The Nation will need to compete and cooperate in space as never before. The transition is upon us now at home and abroad. Just as we see that others are not delaying their entries into space, the question before this House will be, what will this Nation do?

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

[The prepared statement of Dr. Pace follows:]

PREPARED STATEMENT OF SCOTT PACE

Thank you, Madam Chairman, for providing an opportunity to discuss this important topic. The growth of global space capabilities presents several important opportunities and challenges in charting future directions and funding choices for U.S. space efforts. An understanding of the changing international landscape, from low Earth orbit to geosynchronous orbit, to the Moon and beyond, is of fundamental importance to many national interests. Our national security and public safety, global economic competitiveness and scientific capabilities, are all reliant on access to space and space-based capabilities.

The geosynchronous arc is crowded with international communication satellites. Russia, 'Europe, Japan, China and India are modernizing or building their own satellite-based navigation systems. With Russian assistance, South Korea attempted to launch a satellite from its own territory this past August. Many smaller countries are organizing their own space agencies to support scientific and technical research in space, The United Nations Committee on the Peaceful Uses of Outer Space is larger than ever—with 69 member states. As with many other technologies, space capabilities are increasingly globalized—including human space flight. In some cases, these developments are a cause for congratulations as when China became the third country to independently conduct a spacewalk. In others, these developments are a cause for concern as in the case of North Korean and Iranian missile programs.

Globalization and Space

Last month I attended the annual meeting of the International Astronautical Federation in Daejeon, South Korea. There was a statue of South Korea's first astronaut, Yi So-Yeon, on the main boulevard. The President of South Korea, Lee Myung-bak, spoke at the opening ceremony and said, "Space technology is already being applied in various areas of our daily lives. Space technology is the growth engine that will open the future of the mankind, and it has become a necessary tool for our own survival." Representatives from Europe, Japan, Russia, China, India, and Korea presented their increasingly specific plans for explorations of the Moon and missions to Mars.

NASA also presented current U.S. plans for replacing the Space Shuttle, and the images of the hardware being built and tested were quite impressive. just as impressive was the expressed spirit of international cooperation and coordination, not only among International Space Station partners, but rapidly rising space powers such as India, China, and Korea. This spirit has been in development for three years, based on an inclusive U.S. diplomatic strategy that resulted in 14 space agencies agreeing to a common Global Exploration Strategy.

Let me quote from that strategy:

> *Space exploration follows a logical set of steps, starting with basic knowledge and culminating, it is hoped, in a sustained human presence in space. This journey requires a variety of both robotic and human missions. The Global Exploration Strategy provides a framework to coordinate the efforts and contributions of all nations so that all may participate in the expansion into space and benefit from it.*

Unfortunately, the internal U.S. debate this past summer, combined with the realities of the Fiscal Year 2010 NASA budget have created an air of uncertainty over U.S. intentions. To borrow from Norm Augustine, it's hard to get others to work on a garden if we're pulling up flowers to check the roots. It's hard for many of our international friends to secure support for human spaceflight from their governments if we appear to have doubts about the value of the effort.

The United States is a founding member of the space club, but we're at risk of shifting to emeritus status while others with more energy step up. The Chinese in particular have laid out a careful, logical approach in which they plan to launch a mission in 2011 to test docking and rendezvous techniques, followed by a man-tended laboratory in 2015, and a three-man space station by 2020. The selection of 45 new taikonauts is underway along with plans for a lunar sample return missions and Mars orbiter by 2013. To be clear, I welcome peaceful Chinese space exploration efforts. However, I don't want them and other nations to be on the frontier of space without us. We may not be in a race, but we need to keep up with the new arrivals.

The Apollo program was intentionally a unilateral U.S. effort. The whole point was to beat the Soviet Union to the Moon. The Space Shuttle included international contributions such as the Canadian robot arm and a European Spacelab. The space station began as a U.S.centered international effort but evolved into the fully integrated partnership that is the International Space Station (ISS) today. After the loss of the Columbia, sustaining the ISS would not have been possible without the international partners.

Questions for Space

Today, we have the Global Exploration Strategy as an international common approach to human and robotic exploration of the Moon, Mars, and beyond. There is no question about the practical, scientific, and even diplomatic value of space exploration and this is recognized by other spacefaring nations as well. What about humans in space? That is the key question for our nation's civil space policy.

What are the questions that will drive and sustain a human space exploration effort, if nations are not competing against each other in Cold War-like competitions for prestige?

Challenger forced the question of whether we should risk humans flying payloads that could be launched in other ways. The answer was no and we moved satellites to expendable launch vehicles operated by private companies.

Columbia forced the question of why are we risking humans at all. The Columbia Accident Investigation Board (CAIB) said that travel beyond Low Earth Orbit was necessary if we were to justify the risks involved. The current U.S. Space Exploration Policy, past NASAauthorizations by Congress, and Global Exploration Strategy are consistent with the views of the CAIB.

If we are not planning for what comes after the ISS, the government is, in effect, getting out of the human spaceflight business. There may be space tourists launched

by U.S. companies—I certainly hope so—but tourism cannot sustain a major international cooperative human space exploration effort. If we are not going beyond low Earth orbit, we are ignoring both the recommendations of the CAIB and the reality of the increasing globalization of space activity.

We should take a page from our science colleagues in asking simple, but profound questions to shape an implementation strategy. In science, questions such as "Does life exist elsewhere in the solar system?" or "What is dark energy?" help shape and sustain scientific strategies and programs over long periods.

What is the question for human spaceflight? I believe it's asking whether there is a human future beyond the Earth,

Dr. Harry Shipman posed two questions in his 1989 book Humans in Space whose answers lead to very different human destinies. The first is, "Can extraterrestrial materials be used to support life in locations other than Earth?" And the second is, "Can activities of sustained economic worth be carried out at those locations?" Or as I shorten it: "Can we live off the land?" and "Can we make it pay?"

If the answer to both questions is yes, we will see space settlements and the incorporation of the Solar System into our economic sphere as former Science Advisor Jack Marburger has suggested. If the answer is no, then space is a form of Mount Everest—good for personal challenge and tourism but nobody really lives there. Other answers might see Antarctica-like outposts or perhaps a North Sea oil platform exploiting space resources but without sustainable human communities in space.

Many people seem to have faith-based answers to these questions but I would suggest a greater humility in admitting that we don't really know. And therefore our efforts should be to answer these questions as in the course of human and robotic exploration beyond the Earth. The quest to do so will teach us much of practical benefit as we seek to do things that are hard. The experiences we gain in exploration will give us new insights into what humans can do and who we are.

Value From Space

The practical benefits of sending humans beyond the Earth are the "acceptable reasons" of supporting national interests in science, technology development, and international relations. For many countries, these reasons are not just "nice to do" but serious reasons of state. For India, ambitious space efforts attract new human capital to the strategic aerospace sector, which must compete with a growing information technology industry. For China, human spaceflight experiences are training a new generation of technical specialists in many fields and raising the quality level of industrial suppliers. For Japan and Europe, space flight demands interdisciplinary skills that can increase competitiveness in aerospace and non-aerospace sectors. The sophisticated systems engineering demanded by human space flight are part and parcel of what a great nation does, and more importantly, what it is capable of doing.

Human spaceflight is the most demanding space activity, technically, financially, and organizationally. From the beginning it has also been the most symbolic activity, both at home and abroad. In the past, it responded to the question of who we were as Americans in the Cold War. Today, it is a powerful symbol of cooperation among former adversaries on the International Space Station. The deep international relationships built through the ISS are among its most impressive and perhaps most enduring achievements to date.

The question of whether there is a human future beyond the Earth will not be answered in a decade or five decades. It is a question that will evolve, challenge, confound, and test.us for a long time as we try to answer it.

For the future, we need to continue efforts to bind friends and allies to us in a *multi-partner world* in which space capabilities are globalized,

We need friends and allies to help secure the global commons of space upon which we depend, to ensure that the space environment remains free of interference and open to peaceful uses by all.

We need to inspire a new generation of Americans to take of the many demands of a *globally competitive environment driven by scientific and technical innovation.* The interdisciplinary demands of space flight and human space flight in particular can be a highly effective school for meeting those challenges.

It is not just our machines or even our DNA that travel into space but our values as well. What values to we want to see be the norm in human activities beyond low Earth orbit? The international norms for human space activity will be shaped by those who are there, not by those who stay behind. If we want to see a human future in space that reflects our values then we must be part of that effort.

What Will the United States do?

Ambitious goals and rhetoric require difficult actions and serious resources or the symbolism and actuality of human spaceflight will be hollow. The President is critical to effectively setting space policy priorities in budget requests to the Congress. All Presidents have put their stamp on the nation's space efforts, from Kennedy and Nixon to Clinton and Bush. Their actions have typically reflected the broader international approach the United States seeks to play in the world. Their decisions reflected considerations of national security and foreign policy as well as scientific interests and budget constraints.

While each President has responded to the need to provide space policy direction within the specific context of his era, beliefs, and political priorities, in retrospect it is clear that many of these choices have not proven advantageous to the long-term interests of the United States. Many examples could be offered but it is not my intent to review this history in detail. However, as the Congress considers the future direction and funding of U.S. efforts in space—especially human space exploration—I would hope that it takes a broad and strategic view of global space developments. Those developments are enabling new opportunities for international cooperation from the International Space Station to lunar outposts and scientific missions to Mars. Those same developments also mean the United States cannot stand still and expect to influence the international development of space. The NASA Authorization Acts of 2005 and 2008, combined with the Global Exploration Strategy that was developed with U.S. participation, provides a clear and practical way forward for the nation. 1 hope the Administration and Congress will support the restoration of NASA funds for exploration necessary to execute existing authorizations and international strategies.

The United States is facing a generational transition away from the period represented by the Space Shuttle that is just as profound as the transition from Apollo was. We are facing a transition not just of hardware and contracts, but also of leadership and values. NASA will be cooperating more with commercial and international partners than ever before. The nation will need to compete and cooperate in space as never before. The transition is upon us at home and abroad, just as we see that others are not delaying their entries into space. The question before us is simple: What will this nation do?

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

Chairwoman GIFFORDS. Thank you, Dr. Pace.

Dr. Schrogl.

STATEMENT OF DR. KAI-UWE SCHROGL, DIRECTOR, EUROPEAN SPACE POLICY INSTITUTE

Dr. SCHROGL. Thank you very much. Madam Chairwoman, Ranking Member, members of the subcommittee, thank you for the opportunity to appear today. In this intervention, I would like to provide European perspectives on the implications of the growth of global space-faring capabilities and to point out some implications of these current trends for the trans-Atlantic relations.

The European Space Policy Institute, ESPI, is the central European think tank for space policy, created following a decision by the member states of the European Space Agency, ESA, and established as an independent institution in Vienna, Austria. ESPI prepares analysis and conducts activities addressed to policymakers in Europe with the aim of facilitating the decision-making processes in the field of space policy.

Madam Chairwoman, in addressing the first issue, the European perspectives on the implications of the growth of global space-faring capabilities, it should be pointed out that Europe regards this trend as basically positive, but also identifies numerous threats. The opportunities are twofold: a rising number of space-faring countries and a broadening of space programs and missions can be a beneficial tool for supporting joint efforts for dealing with

global problems. Two examples are global climate change monitoring and disaster management and mitigation. In both cases, the number of coordinated satellite missions cannot be large enough in order to achieve the highest impact possible. A second area of opportunities lies in the possibility to develop markets for space-related products and services on an international and global scale. Threats, however, can be seen in the proliferation of critical technologies or in the field of lacking regulations in emerging spacefaring countries, leading to flags of convenience and distorting fair international competition. Europe also understands that it can lose international prestige, if it is passed by space powers like China or India, which would have consequences for the attractiveness of Europe as a high-technology partner. But this consequence should only encourage Europe to further increase its own efforts.

Now, Madam Chairwoman, the consequences of these trends for the trans-Atlantic relations can be set out as three categories: a promising field, which is cooperation in the field of space for security, a necessary field, which is space as a strategic economic issue area and tool to deal with climate change, and the third, a potential field, which is space exploration.

In our view, the most promising field for trans-Atlantic cooperation today is space for security. Space situational awareness should be addressed and organized in a cooperative way between the United States and Europe. The European Draft Code of Conduct for Outer Space Activities is the first major European diplomatic initiative in this field and should be actively supported by the United States, since it matches completely its interests. Other areas for cooperation could be space for internal security or homeland security, maritime security and responsive space, where both the United States and Europe could benefit from closer cooperation. In addition to that, the United States could consider benefiting from recent technology developments made in Europe, for example, in the field of radar technology.

A necessary field, the second one I want to mention, for trans-Atlantic cooperation is the coordination in issues related to space as a strategic economic area. ESPI has recently published a joint memorandum with the Space Policy Institute led by Dr. Pace identifying numerous actions. Amongst them are the protection of the radio frequency spectrum for space services, the promotion of open, interoperable standards and the promotion of open international markets in space goods and services as well as closer international consultations on the development or modification of domestic regulations. The United States and Europe should also jointly lead efforts in using space for tackling the global problems, as I mentioned, climate change.

Before that background, space exploration, while leading the debate today, can only be regarded as a potential field of trans-Atlantic cooperation. While first deliberations have to be made now, the priority has to be the full and successful use of the International Space Station as the basis for an international space exploration program.

In summarizing, I first of all would like to point out that the trans-Atlantic relations should receive your high attention, since they are crucial in organizing the most important aspects of space

activities which are space for security and space as a strategic economic field.

Dialogue and partnership in this field, with the European Union and the European Space Agency as well as the European Parliaments, should be intensified and institutionally strengthened. The single issues, I have mentioned in these areas, require roadmaps for implementing joint activities. This might be reflected in the ongoing space policy review in the United States and a strong United States-European partnership can certainly strengthen security and successfully tackle global challenges.

Thank you very much for your attention.

[The prepared statement of Dr. Schrogl follows:]

PREPARED STATEMENT OF KAI-UWE SCHROGL

Madame Chairwoman and Members of the Subcommittee, thank you for the opportunity to appear today. In this intervention, I would like to provide European perspectives on the implications of the growth of global space-faring capabilities and to point out some implications of these current trends for the trans-Atlantic relations.

In the outset, please allow me to introduce to you the European Space Policy Institute (ESPI), which is the central European think tank for space policy, created following a decision by the Member States of the European Space Agency (ESA) and established as an independent institution in Vienna, Austria. ESPI prepares analyses and conducts activities addressed to policy-makers in Europe with the aim of facilitating the decision-making processes in the field of space policy.

1. In addressing the first issue, the European perspectives on the implications of the growth of global space-faring capabilities, it should be pointed out that Europe regards this trend as basically positive, but also identifies numerous threats. The opportunities are twofold: a raising number of space-faring countries and a broadening of space programs and missions can be a beneficial tool for supporting joint efforts for dealing with global problems. Two examples are global climate change monitoring and disaster management and mitigation. In both cases, the number of coordinated satellite missions cannot be large enough in order to achieve the highest impact possible. A second area of opportunities lies in the possibility to develop markets for space-related products and services on an international and global scale. Threats, however, can be seen in the proliferation of critical technologies or in the field of lacking regulations in emerging space-faring countries, leading to "flags of convenience" and distorting fair international competition. Europe also understands that it can loose international prestige, if it is passed by space powers like China or India, which could have consequences for the attractiveness of Europe as a high-technology partner. But this consequence should only encourage Europe to further increase its own efforts.

2. The consequences of these trends for the trans-Atlantic relations can be set out as three categories:

- a promising field, which is cooperation in the field of space for security,
- a necessary field, which is space as a strategic economic issue area and tool to deal with climate change,
- a potential field, which is space exploration.

In our view, the most promising field for trans-Atlantic cooperation today is space for security. Space Situational Awareness should be addressed and organized in a cooperative way between the U.S. and Europe. The European Draft Code of Conduct for Outer Space Activities is the first major European diplomatic initiative in this field and should be actively supported by the U.S., since it matches completely its interests. Other areas for cooperation could be space for internal security/homeland security, maritime security and responsive space, where both the U.S. and Europe could benefit from closer cooperation. In addition to that, the U.S. could consider benefiting from recent technology developments made in Europe, for example in the field of radar sensors.

A necessary field for trans-Atlantic cooperation is the coordination in issues related to space as a strategic economic area. ESPI has recently published a joint memorandum with the Space Policy institute at George Washington University identifying numerous actions. Amongst them are the protection of the radio frequency spectrum for space services, the promotion of open, inter-operable standards

and the promotion of open international markets in space goods and services as well as closer international consultations on the development or modification of domestic regulations. The U.S. and Europe should also jointly lead efforts in using space for tackling the global problems like climate change.

Before that background, space exploration—while leading the debate—can only be regarded as a potential field of trans-Atlantic cooperation. While first deliberations have to be made now, the priority has to be the full and successful use of the ISS as the basis for an international space exploration program.

In summarizing, I first of all would like to point out that the trans Atlantic relations should receive your high attention, since they are crucial in organizing the most important aspects of space activities: space for security and space as a strategic economic field. Dialogue and partnership in this field (with the European Union and the European Space Agency on the European side) should be intensified and institutionally strengthened. The single issues, I have mentioned in these areas, require roadmaps for implementing joint activities. This might be reflected in the ongoing space policy review in the U.S. A strong U.S.-European partnership can strengthen security and successfully tackle global challenges.

Chairwoman GIFFORDS. Thank you so much.

Last we are going to hear from Dr. Williamson.

STATEMENT OF DR. RAY A. WILLIAMSON, EXECUTIVE DIRECTOR, SECURE WORLD FOUNDATION

Dr. WILLIAMSON. Chairwoman Giffords, Ranking Member Olson and distinguished members of the subcommittee, I am pleased to have this opportunity to share with you Secure World Foundation's insights on the growth in world space capabilities and why these changes are important to U.S. interests.

One of the most important characteristics of the past decade is the rapid emergence of new actors in outer space. Since 1999, the number of states with space systems in orbit has increased from 27 to 37. Countries as diverse as Algeria, Iran, Nigeria, Venezuela, South Africa and Turkey have now become part of the so-called space club. The addition to the space environment of new players and spacecraft raises both opportunities and challenges for the governance of space activities, as you mentioned, Chairwoman Giffords. It also means a larger marketplace for U.S. products. Finally, it raises the important challenge that every space-faring state wants to own its own earth observation and communications satellite, leading to crowding in the orbits. This and the growth of space debris increases the need to establish effective governance of the global commons of outer space and raises the following concerns for the United States. Have the emerging space states instituted best operational practices in designing and operating their launch systems and spacecraft? Have they signed and modified the 1967 Treaty on Outer Space and the other space agreements? Do they adhere to the United Nations orbital debris guidelines?

In the view of the foundation, the United States could improve its own orbital security for commerce, science and national security and gain closer allies by engaging with the emerging space states in two key areas: first, assisting emerging space-faring countries to adhere to international best practices in space activities. Guaranteeing the long-term sustainability of outer space is one of the most important space issues the United States will face over the next decade. It is therefore important to assist emerging states to develop clear policies and laws that conform with international norms.

This February, the U.N. Committee on Peaceful Uses of Outer Space will begin work on a set of so-called best practices for space activities. The United States can continue to play a significant role in COPUOS by engaging with the small states as well as the larger ones in defining best practices.

Second is taking greater advantages of the opportunities that the emergence of these new space states present for U.S. policymaking. The space arena can provide a powerful platform for engaging in what has been called soft power, the use of U.S. technological and economic capabilities in policies to influence policymakers in other countries.

Through NASA, the U.S. Geological Survey and NOAA, the United States has long engaged with Latin America in space science and applications. It may time to increase that engagement in part to counterbalance the growing influence of China in the region. China has taken a strong interest in Latin America and has actively assisted both Brazil and Venezuela in their space efforts. China and Brazil jointly developed and operate the CBERS earth resource satellite system. Just a year ago, China launched into orbit a Chinese communications satellite that it sold to Venezuela under a technology transfer agreement. Some 90 Venezuelan engineers and technicians traveled to China to help build and launch the satellite. Satellite Simon Bolivar now provides communications for most of Latin America and has enabled Venezuela to extend its influence throughout Latin America and the Caribbean.

The United States could extend its own engagement with Latin America through additional teaching and cooperative space science and applications programs. However, the current onerous ITAR regulations impede our ability to cooperate effectively with space countries. ITAR reform would go a long way to fix this impediment. We need a regulatory framework that assists, not impedes the creation of new markets and enhances international cooperation and competition.

We at Secure World Foundation mostly see space developments among emerging space states as opportunities rather than as threats. In general, the United States can bolster the long-term security climate in space by working with these states to build space capacity, especially in space science and applications where current ITAR regulations are not large issues. Enhanced ability to make use of the benefits that space systems provide means a broader market for U.S. goods and services, especially high-tech consumer items.

Just as important, however, is the need to assist emerging space states to develop space policies with a global long-term sustainable approach. The U.S. range of policies, legal instruments and interagency practices can be instructive to emerging space states that are just developing their own space-related policies and law. Countries that gain an economic and political stake in the space environment are more likely to pitch in to preserve the space environment for the future.

Finally, these reflections lead to the overall need for the United States to develop an overarching space strategy that includes military, civil and commercial and international components. Such a strategy would go a long way to clarify the direction of U.S. invest-

ments in space and the nature and scope of U.S. involvement in the international community.

[The prepared statement of Dr. Williamson follows:]

PREPARED STATEMENT OF RAY A. WILLIAMSON

Chairwoman Giffords, Ranking Member Olson, and distinguished members of this Subcommittee, I am pleased to have this opportunity to share with you Secure World Foundation's insights on the growth in space capabilities throughout the world and why the changes this growth represents are particularly important to U.S. interests. From the emergence of China as a country with a significant human spaceflight program to the launch this September of South Africa's second indigenous remote sensing satellite, over the past decade the international space community has experienced many significant changes.

One of the important, but often overlooked, characteristics of the past decade is the rapid emergence of new actors in outer space. Since 1999, the number of States with space systems in orbit has increased from 27 to 37. Countries as diverse as Algeria, Iran, Nigeria, Venezuela, South Africa and Turkey have now become part of the so-called "space club." Eight States are now also capable of launching satellites into orbit. South Korea will likely soon make that a total of nine.

Countries wish to enter the space realm for a variety of reasons, not least of which is the desire to gain prestige in the international community. Rationales include the following, the priority of which varies depending on the needs of the State:

- **Advance scientific and technical capacity.** Emerging space States see space science and technology as assisting in the development of domestic scientific and technical capacity well beyond the space scene. Information, communication and imaging technologies, especially, have strong links to space science and technology. Even health technologies and the millennia old practice of agriculture are greatly enhanced by space technology. For example, as an article last week in the Economist highlighted, the data from remote sensing space systems and GPS can assist in improving crop yield, and reducing the overuse of fertilizer and seed.[1]
- **Improve the management and use of resources and provide better protection against the ravages of natural disasters.** The smaller states place an especially heavy emphasis on space applications. Hence, it is no surprise that Algeria, Nigeria and Turkey decided to enter the space realm by each purchasing a the satellite in the Disaster Monitoring Constellation (DMC),[2] which acquires a complete, medium-resolution data set of the globe every day. All participating States have access to data from the entire DMC, providing much more coverage and timeliness at lower cost than each State could achieve individually. Data from the DMC has helped those countries tackle the enormous challenge of managing forests, grasslands and waterways, and of responding to natural disasters. Having access to the DMC system has also spurred the creation of training in space technologies in these countries and development of new markets for data products.
- **Enhance access to education and health information throughout the country.** For many developing countries, especially, communication satellite systems can help spread access to educational programs and modem communications and information throughout a nation, especially those with poor infrastructure or vast geographical extent. Such systems also create opportunities for the development of tele-health and tele-education to serve extended remote areas. Canada and India have been particularly strong in providing tele-services to remote areas. Further, space activities are exciting to young people and help interest them in following careers in science and mathematics, which are needed to develop the country's industrial capacity.
- **Improve national security.** One of the primary drivers of a country's interest in space systems is their use in its national security apparatus. Space technology can especially assist in the improvement of border security. Furthermore, by monitoring potentially hostile activities in neighboring countries,

[1] "Harvest Moon: Artificial Satellites Are Helping Farmers Boost Crop Yields," *Economist,* 7 November 2009, p. 73.

[2] *http://www.dmcii.com/about us constellation.htm.* The DMC satellites were designed and constructed by SSTL of the United Kingdom. *http://www.sstl.co.uk.* DMC participants are: Algeria, China, Nigeria, Spain, United Kingdom, and the Spanish company, Deimos. Turkey was part of the original constellation but its satellite has reached the end of life.

space technology can help reduce tensions between States and preempt conflict.

- **Advance industrial capacity and the economy.** In order to participate more effectively in the global space economy, emerging space States use their entry to build the capacity to design and build space components. This upgrading of their economies can result in demand for products from the United States and other developed countries. In addition, as a recent study carried out by the Space Policy Institute of The George Washington University has demonstrated for GPS technologies, incorporating this space technology into the workflow of transportation services can markedly improve efficiency and reduce costs.[3]
- **Prestige in the international community.** We must not overlook the role that prestige plays in joining the space club. Identifying with other countries that are more advanced , technologically can be a powerful incentive because being part of the growing number of countries with space capabilities indicates a certain level of scientific and technological achievement. This achievement enhances the pride of citizens and augments the reputation of the country in the international marketplace.

The addition to the space environment of spacecraft owned and operated by emerging space States raises both opportunities and challenges for the space community and the governance of space activities. From the standpoint of increased opportunities, having more space players means greater chances for finding other space actors with which to cooperate in order to pursue space science and technology development. Doing so means pooling some resources and saving costs for each individual country.

Cooperation specifically means that States can create beneficial international agreements on space science and applications and on space exploration, allowing them to make advances that they might not achieve on their own. European countries have demonstrated the enormous value of such cooperation in the European Space Agency, a model that other regions have indicated they would like to emulate when conditions are right. Such cooperation can also lead to technological cooperation in other, non space disciplines.

A greater number of space actors means a larger marketplace for space products, of which both established and emerging actors can take advantage. Greater numbers can result in increased demand for a variety of commodities, everything from space launch vehicles to data analysis software and expert advice, all of which can benefit U.S. industry. More States involved in the pursuit of space science also potentially means greater and broader advances in our knowledge of the universe.

The increase in the numbers of space actors, coupled with the fact that the established space actors are increasing the numbers of their spacecraft in orbit also increases the need to establish effective governance of the global commons of outer space. Every spacefaring State tends to want its own Earth observing and communications satellite. As a result, we are beginning to experience crowding in certain orbits, such as in low Earth polar, sun-synchronous orbit where most Earth observation satellites are located and in the geosynchronous orbits (GSO) favored for satellite communications.

As this Committee knows, the increasing growth of orbital debris has also become an important concern in assuring the long term sustainability of space activities. For the emerging spacefaring States there is another set of issues related to sustainability:

- Have they instituted best operational practices in designing and operating their launch systems and spacecraft?
- Have they signed and ratified the 1967 Treaty on Outer Space and the subsequent Agreements on Liability, Registration, and Return of Astronauts?
- Do they adhere to the orbital debris guidelines agreed to and passed by the United Nations General Assembly?

Since its inception, Secure World Foundation has partnered with other institutions to pursue its mission of addressing space governance issues and the long term sustainability of space activities. For example, just one year ago, we, the European Space Policy Institute and the International Academy of Astronautics, held a work-

[3] Henry R. Hertzfeld, "Space as a Utility: An Exploration of GPS in Commercial Use," Report to Secure World Foundation, May 2009.

shop in Vienna, Austria focused on the fair and responsible use of outer space.[4] The workshop, which included analysts from emerging and established space countries, focused on the identification and analysis of key challenges to the achievement of fair and sustainable use of outer space for all space actors, including the newly emerging space States.

Among other things, the workshop emphasized the need for the established spacefaring States to establish appropriate practices to ensure that outer space remains available for the future use of emerging States and guarantees the fair and equitable use of the frequency spectrum for all space actors. By the same token, emerging States have the responsibility to ensure that they act as good citizens by adhering to the international space treaties and to resolutions such as the UN Guidelines on Orbital Debris.

In the view of the Foundation, the United States can improve its own orbital security for commerce, science and national security and gain closer allies within the international community by engaging with the emerging space States. The emergence of new space States raises two key questions for the United States:

1) **What can the United States do to assist emerging spacefaring countries in adhering to international best practices in space activities?**

It is important to assist emerging states as much as possible to develop clear polices that incorporate the elements of Outer Space Treaty and the other three international Agreements and to bring them into conformity with accepted space debris-reducing practices. Maintaining the benefits we gain from space systems through guaranteeing the long term sustainability of outer space is one of the most important space issues the United States and other spacefaring States will face over the next decade. It is a matter of ensuring space security, space commerce, and the economic and social benefits with which space systems provide us.

Over the past few years, the U.N. Committee on the Peaceful Uses of Outer Space, or COPUOS has made excellent progress on improving the international governance of space activities. The Committee has developed guidelines on limiting the creation of orbital debris which were passed in 2007 by the General Assembly. The U.S. delegation played a significant part in that effort.

This February the COPUOS Subcommittee on Science and Technology will begin serious work on a set of so-called "best practices" for space activities. U.S. delegates to COPUOS have played a strong role in both efforts. Committee membership includes many small states that had a major role in crafting the Space Debris Guidelines and they are likely to be helpful in reaching agreement on a best practices document. The United States can continue to play a significant role here by engaging with the small states as well as the larger ones in the work on best practices.

2) **Is the United States taking sufficient advantage of the opportunities that the emergence of these States as spacefaring entities present for U.S. policymaking?**

The space arena can provide a powerful platform for engaging in what has been termed "Soft Power" by analysts—the use of U.S. technological and economic capabilities to influence policymakers in other countries.

The case of Latin America might serve as a good example where the use of soft power could assist the achievement of U.S. goals. Two weeks ago, Secure World Foundation partnered with CRECTEALC, the Regional Center for the Teaching of Science and Technology in Space for Latin America and the Caribbean *[Centro Regional de Enseñnanza de Ciencia y Tecnologia del Espacio para Aménrica Latina y el Caribe]* to hold a workshop focused on sharing the space policies, programs and plans of Latin America.[5] This workshop specifically included presentations on space policy essentials, space security, international law of outer space, and the structure of U.S. space activities.

Participants expressed appreciation for the focus on policy and legal matters experienced in other countries that they might consider in drawing up space policies and designing national legal regimes that adhere to international space treaties. During the workshop representatives of several Latin American countries presented their countries' space policies and activities. They expressed just pride in what they had accomplished, despite the financial and political challenges of bringing a dedicated program of space science and technology into being.

Through NASA, the U.S. Geological Survey and NOAA, the United States has long engaged with Latin America in space science and applications, in a variety of

[4] European Space Policy Institute, Nov. 2008 conference, Fair and Responsible Use of Outer Space, *http://www.espi.or.at/*.

[5] The SWF–CRECTEALC workshop: *http://www.SecureWorldFoundation.org,* SWF Activities.

programs. It may be time to increase that engagement, in part to counterbalance the growing influence of China in the region.

In recent years, China has taken a strong interest in Latin America and has actively assisted both Brazil and Venezuela in their space efforts. China and Brazil jointly developed and operate the CBERS Earth resources satellite system. Data from this system are available for free to countries neighboring Brazil and to other countries who wish to build a ground station.[6] Other cooperative agreements in Earth and space science are underway. Just a year ago, China launched into orbit a DFH4 communication satellite that it had sold to Venezuela. The sales agreement included a technology transfer arrangement that resulted in some 90 Venezuelan engineers and technicians having direct involvement in China in the satellite's construction and launch. Satellite Simon Bolivar is now located at 78 degrees East Longitude over Uruguay and provides communications for most of Latin America with C band satellite communications. This satellite has enabled Venezuela to extend its influence throughout Latin America and the Caribbean.

The United States could extend its own engagement with Latin America through teaching programs, perhaps with the U.N.-affiliated CRECTEALC, which has campuses in Mexico and Brazil. It could also explore more vigorously than it has, cooperative space science and space applications efforts. However, the current onerous .ITAR regulations make certain types of technology cooperation extremely difficult. ITAR is a serious issue that impedes the U.S. ability to cooperate effectively with emerging and established space countries alike. ITAR reform would go a long way to fix this impediment. We need a regulatory framework that assists, not impedes, the creation of new markets and enhances international cooperation and competition.

One specific thing the United States might do with Latin America is to take an active part in the Space Conference of the Americas that will be held in Mexico in November 2010. This conference will bring together all of the major Latin American and Caribbean countries that are interested in outer space for several days of presentations, discussions and sharing of ideas. The United States could gain a lot not only from attending this important event but also from offering some specific science and technology initiatives for the countries attending.

In short, we at SWF mostly see space developments among emerging space States as opportunities rather than as threats. In general, the United States can bolster the long-term security climate in space by working with emerging space states to build space capacity, especially in space science and applications, where ITAR restrictions intrude relatively little. Enhanced ability to make use of the benefits that space systems provide also means a broader market for U.S. goods and services, especially high technology consumer items like GPS devices.

Just as important, however, is the need to assist emerging space States to develop space policies having a global, long-term sustainable approach. Since the beginning of the space age, the United States has constructed a range of policies, legal instruments and interagency practices to guide its space efforts. These can be instructive to emerging space States who are just developing their space-related policies and laws.

Countries that gain an economic and political stake in the space environment by having systems in orbit are more likely to be inclined to pitch in to preserve the space environment for their benefit. Nevertheless; it is important to work with all possible spacefaring countries to ensure that the space environment remains available for all for the many benefits space systems provide.

Finally, these reflections lead to the overall need for the United States to develop an overarching space strategy that goes beyond any necessary revisions to U.S. space policy and includes both

military, civil, and commercial components. Such a strategy would go a long way to clarify the direction of U.S. investments in space science, space applications, the human exploration of outer space, and the nature and scope of U.S. involvement in the international community.

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Secure World Foundation (SWF) is a private operating foundation headquartered in Superior, Colorado and with offices in Washington, DC and Vienna, Austria. The Foundation is dedicated to maintaining the secure and sustainable use of space for the benefit of Earth and all its peoples. SWF engages with academics, policy makers, industry, scientists and advocates in the space and international affairs commu-

[6] *http://www.imagingnotes.com/go/article__*free.php?mp__id=134.

nities to support steps that strengthen governance of outer space and delivery of the benefits of space to Earth. *http://www.SecureWorldFoundation.org.*

INTERNATIONAL EFFECT OF U.S. COMMITMENT

Chairwoman GIFFORDS. Thank you so much, Dr. Williamson, and to all of our panelists today, you really brought forward some fascinating aspects of this very complex situation. At this point we are going to begin our first round of questions. The Chair recognizes herself for five minutes.

I think a couple of points were clear across all of our witnesses. One is that the space environment globally is changing, that we have seen a tremendous amount of development in the last 50 years but particularly in the last decade. Also that U.S. leadership is in question and the lack of commitment that we have seen here in the United States and that the world has seen really changes the perspective of this economic, this defense aspect, exploration aspect, technological aspect that space brings with it. So my question, and I am going to begin with Dr. Pace, is a bit of twist. You know, you talked about your international experience and I am interested to hear from others as well, but what does this non-direct clear vision for the United States mean to other countries without a clear, precise vision for where we are going in space at this moment? How does that change other nations' commitment without having a U.S. strong lack of commitment to space?

Dr. PACE. Well, I think that it makes it difficult for advocates in other countries who want to work with us to make an argument that they will in fact be a partner. It also increases desires to look for other partners and alliances with other rising partners to make different arrangements as they pursue their own self-interest. As I said, the global exploration strategy is one which is a very collaborative effort. It is not a situation where the United States says we need to define everything and then you get to fit in in various places. The global exploration strategy is one which has been very inclusive to have other countries involved in defining the architecture and working together in a way that really I think is unprecedented. But if the United States appears not to be there or to be uncertain to be there, then what is there to talk about, and therefore people start looking at each other and going, you know, maybe we should be making other arrangements because we just don't know if the Americans are going to be there. As a result, it is not as if people are being hostile or anything to the United States; it is simply that we are making ourselves irrelevant to the discussions, and if we become irrelevant, then I think that does harm our interests as people will pursue their own self-interests in economic and commercial and international and security interests.

Chairwoman GIFFORDS. Thank you.

Dr. Schrogl?

Dr. SCHROGL. Yes. Thank you, Madam Chairwoman. The United States is still spending so much more money than all the other space-faring countries that U.S. leadership is present in your capabilities and in the activities you are conducting in outer space. The United States is leading through this engagement, and as I pointed out in my statement, Europe is very much interested in a strong relationship with the United States. The European countries have

recently started to come up with diplomatic initiatives of their own and we regard this as an opportunity to jointly develop issues in outer space where the United States could have taken leadership but where we as the Europeans have waited for such initiatives. We have seen a number of areas where Europe started debates like on space debris and now on safe conduct of space activities where it is absolutely necessary of course that the United States engages actively in such debates and we have seen that the United States is ready to cooperate in such fields with Europe in order to come up with joint global visions in these fields. So the United States certainly has to take an active role in the international field. You can do that, and Europe is certainly ready to work very closely with the United States in order to achieve common objectives.

Chairwoman GIFFORDS. Thank you.

I have more questions, but we have so many members, I think we want to make sure with votes and everything we get everyone's question in, so let me stop there and turn the floor over to Mr. Olson.

SPECIALIZATION IN SPACE

Mr. OLSON. Thank you very much, Madam Chairwoman. Thank you for your kindness, and gentlemen, I will be brief to make sure that all the members get to ask their questions.

I want to talk about collaborations and specialization. Going forward, exploration of space beyond low earth orbit either robotically or by human presence will most likely be done collaboratively between two or more nations. By limiting the role each partner might play in a future mission, does this necessarily mean that as nations become specialized in one of several capabilities they give up the capability of maintaining a full suite of capabilities and is necessarily bad—is it necessarily bad if a nation decides to cede a set of capabilities to another nation? Too much overspecialization. Mr. Hauser, you are on the left.

Mr. HAUSER. I think it depends on the nation's perspective and what they want to achieve and what their goals are for their own space program. You know, if you are a smaller country and you don't have the financial wherewithal to do, then maybe it gives you an opportunity to play where you might not have been able to play before. If you have grandioser dreams, then maybe overspecifying is a little bit too difficult. I would defer to my colleagues, who probably know more specifics about each of the nations, but I really—it does come down to the objectives of that nation and to their own psyche about what they want to achieve for their country and the status that they want their country to be perceived at, so I think it really comes down to them and what they want to do.

Mr. OLSON. Thank you for that answer.

Mr. Stevens?

Mr. STEVENS. I would tend to agree with what Marty said, and I would just add that I think for the United States, though, it is a totally different issue. I think we need to be capable in all areas of space. We are now and we should continue to be that way. I think it would be unsatisfactory for us to totally turn over one capability to another nation.

Mr. OLSON. Thank you very much. That is exactly what I was looking for. I appreciate that.

Dr. Pace.

Dr. PACE. I think, you know, keying off that, the capabilities that we have should be commensurate with what our responsibilities are. A relatively smaller country, a regional power may want to have space capabilities that are appropriate for it. If we want to see ourselves as a global power and global influence, then we need to have a full suite of those capabilities. So capabilities reflect what we think our role in the world is, and I think that as my colleague mentioned about strategic economic issues, if we are going to be cooperating with other countries, part of what we should be doing is being able to shape the ability of those countries to make it easier for them to work with us, so that is why we talk about open international standards, open markets. We protect the radio-frequency spectrum. We talk about global commons. Just as we are a maritime nation, we are a space nation and therefore things that are part of that space commons are of deep interest to us. I don't think there is a capability that we should unilaterally cede to depend on others because I don't think there is an aspect of our national security and foreign policy that we would want to cede to others, but at the same time, we should make it easier for others to work with us both by being a stable and trusted partner and making sure that our standards and markets are open to that cooperation.

ISS CONTINUATION

Mr. OLSON. And just to follow up on one of your comments, do you think that by deorbiting the International Space Station in 2015 that we sort of violate those promises we made to those countries and hurt our standing globally?

Dr. PACE. I think that the problem with 2015 date, and I agree with what has been said, that I think it should at least be sustained through 2020 so that we can make a data-driven, data-based decision on whether to continue it or not. I mean, the experiment has been set up but the experiment has not yet run so we should see whether we get value out of it. As I've said, I think the international collaboration we have achieved so far is already an outstanding value and a creation that is very impressive. Now we need to run the science experiment, see how that works, and then we make a decision based on real data and real results and so I think it would be wrong to preemptively deorbit that station. And if I might say, what I would have preferred is that we may have put something in the budget that said we are either going to deorbit it or we are going to extend it and not have left it ambiguous the way we did. But nonetheless, that is the decision now before this Administration.

Mr. OLSON. Yes, sir, agree on that comment as well.

Dr. Schrogl.

SPECIALIZATION

Dr. SCHROGL. Thank you. In Europe, we are used to the fact that our smaller countries are not able to cover the whole range of space activities so we are used to cooperation, cooperation in the Euro-

pean framework in order to achieve common objectives and then try to cover the whole field. Europe and other countries, space-faring countries, are certainly very much interested in getting into the position to have autonomous capabilities in various areas be it space transportation, be it now global navigation services, and as I said, it is, or it will be extremely important in the future that these systems will be combined and coordinated into systems of systems in order to achieve common goals like global change where we simply cannot have enough systems around the earth in order to achieve these common objectives.

Mr. OLSON. Thank you, Mr. Schrogl.

Dr. Williamson?

Dr. WILLIAMSON. It seems to me it is not just a matter of which technologies to focus on and so forth but what the capabilities you want are, and in my view, the United States should maintain a full range of technological capabilities but it may be, for example, that we depend on another country more for certain areas rather than others in order to achieve a greater common good for the international community. So it is a question of how—taking leadership to determine how we can best use the capabilities of others to achieve our goals as well as contribute to theirs.

Mr. OLSON. Yes, sir. Thank you very much for that answer.

I am over my time. Thank you, Madam Chairwoman.

Chairwoman GIFFORDS. Thank you, Mr. Olson.

We are going to hear from Representative Kosmas next.

MAINTANING AMERICAN LEADERSHIP

Ms. KOSMAS. Thank you, Madam Chairman.

Thank you all, gentlemen, for being here this morning. It has been quite enlightening to hear from you and I think encouraging as well for us to understand the significance of the opportunities before us to cooperate internationally in space exploration. However, I suspect that you feel the angst that we as members of this committee have and as representatives of communities that depend on space and consider it to be a very, very important issue for our Nation both in national security as well as in advancements of science and technology. I guess I would say "ambiguous" I think was a word just used as to where are we headed, and I guess my question is, what do you sense—some of you have made rather blunt assessments as to the aggressive way in which other countries are seeking to do the things that we have always considered our primary territory and our ability to continue to be a leader in space exploration. What do you consider to be the greatest impediment that we are—by which we are hindered at the moment in terms of our ability to continue to be leaders in space exploration and specifically manned space exploration? Mr. Hauser?

Mr. HAUSER. Finance is certainly one of the biggest impediments. You know, as we discussed already here, it is very difficult not only for us to plan with our budgets but then for other countries to depend on us and to engage in partnerships and cooperative efforts if they don't have reasonable comfortability that we are going to continue to be there as we go through that process. There are probably some regulatory issues as well. It is also a great impediment and certainly hurting our own marketplace because of the ITAR re-

strictions and in many ways we have been our own worst enemy. I am a retired Air Force colonel so I certainly believe in protecting national security but, you know, you have to protect what is important but you also have to find ways to work in the environment so that you are not so restrictive that you create other markets and other opportunities for everybody else which I personally believe we have, so we need to balance that out. I think those are the two big ones that really come to my mind.

Ms. KOSMAS. Mr. Stevens?

Mr. STEVENS. Well, once again, Marty took my two things, but I would like to add to it. The biggest concern I think we have is ITAR, and it really affects the companies that we represent, especially the small ones. Most of them need business. It is a global economy. They need to be doing business overseas to stay in business, and with the defense market starting to go down, a lot of them are losing money there and they need to be able to do business in a timely way. It drastically impacts our industrial base and we need to really watch that carefully.

Ms. KOSMAS. Thank you for that. I know that there have been some movements made by other jurisdictions, Foreign Affairs Committee, it is languishing perhaps in the Senate, but in terms of what we as a Nation need to continue to have that kind of inspiration and that kind of leadership, again, global leadership in this space exploration, your final answer would be finances and ITAR?

Mr. STEVENS. It would be.

Ms. KOSMAS. Dr. Pace?

Dr. PACE. I would say that again maybe as the policy guy, it is policy, programs and budgets, the alignment between those and there are a lot of disconnects between policies, programs and budgets that we are looking at, and that is really the core of instability. I think we need to have a clear statement that we are going to be going beyond low earth orbit and doing what the CAIB said we should do. I think we should have a program to execute that ability to go beyond low earth orbit and I think that there is one on the books, and I think we need to fund those programs. Now, if we don't like those answers in some ways, then we have a choice: we can change our goals, we can decide to, you know, add more money or we can decide to take on more risk. But I think that the fact that people are uncertain about what policies, programs and budgets we are going to be implementing is an ambiguous problem that makes other countries wonder if we are going to be there as a partner. So policy stability, I guess, would be my number one supported by the resources to carry that out.

Ms. KOSMAS. I think what you have all answered is consistent with the recommendations from the Augustine committee and those are of concern to us in terms of what will be the outcome of that report and where those policies, programs and funding will be established, so I think we are all saying the same thing.

Thank you, Madam Chairman. I yield back.

Chairwoman GIFFORDS. Thank you, Representative Kosmas.

Mr. Rohrabacher.

FUNDING PROBLEMS

Mr. ROHRABACHER. Thank you very much, Madam Chairman, and I appreciate your holding this hearing. I appreciate the witnesses today, stimulating our discussion of America's space program. One thing is clear. Although the complaint that funding is a problem, something else is clear by the testimony today is that we spend more money than any other country on space. Thus, if there is a problem, it is not necessarily that the money isn't there but the money that is being spent has not been spent wisely and that there has been a lack of discipline, prioritization and perhaps lack of professionality both inside our government and in the private sector. I understand that the Ares I was launched recently and I was just reading Buzz Aldrin's analysis of that, which is very interesting. I would submit that for the record at this point.

[The information follows:]

Why We Need Better Rockets

By Buzz Aldrin

Posted: November 9, 2009 04:56 p.m.

Well, it looked spectacular.

I'm referring to NASA's recent launch of the Ares 1–X, billed as the prototype of the Ares 1 as a crew launch vehicle, a fancy term for a manned space booster. The rocket is said to have performed as planned, and ushered in the era of the Ares rockets to replace the Space Shuttle next year. Only it won't. In fact, the much-hyped Ares 1–X was much ado about nothing.

Yes, the rocket that thundered aloft from NASA's Launch Pad 39B sure looked like an Ares 1. But that's where the resemblance stops. Turns out the solid booster was—literally—bought from the Space Shuttle program, since a five-segment booster being designed for Ares wasn't ready. So they put a fake can on top of the four-segmented motor to look like the real thing. Since the real Ares' upper stage rocket engine, called the J–2X wasn't ready either, they mounted a fake upper stage. No Orion capsule was ready, so—you guessed it—they mounted a fake capsule with a real-looking but fake escape rocket that wouldn't have worked if the booster had failed. Since the guidance system for Ares wasn't ready either they went and bought a unit from the Atlas rocket program and used it instead. Oh yes, the parachutes to recover the booster were the real thing—and one of the three failed, causing the booster to slam into the ocean too fast and banging the thing up. So, why you might ask, if the whole machine was a bit of slight-of-hand rocketry did NASA bother to spend almost half a billion dollars (that's billion with a "b") in developing and launching the Ares 1–X?

The answer: politics.

Technical problems, the kind that follow every new rocket's development, have haunted the Ares like leftovers from Halloween. The rocket as currently designed shakes so much during launch that shock absorbers are needed beneath its capsule payload. All of this takes time to fix—and money, money that NASA really doesn't have. To stave off critics, three years ago the Project Constellation managers conceived of the 1–X flight to supposedly show some progress. They could instrument the rocket with hundreds of sensors gathering information never before obtained during a booster use in a Shuttle mission. It would give the launch team some practice in the assembly of an Ares. And NASA would find out if something as ungainly as the Ares 1 design—a thicker top than the bottom booster—could survive during ascent through the Earth's atmosphere. Of course, all of the changes to the Shuttle launch pad to accommodate the Ares wouldn't be ready in time, so they decided to just leave all of the Shuttle hardware, such as the rotating tower that envelops the Shuttles there. A success might just buy more time for Ares to fix its problems.

And that's just what happened.

Meanwhile, the huge Ares V super booster is just a series of drawings. Unlike the plan used to send Neil Armstrong, Mike Collins and me to the Moon in 1969, whereby we used just one rocket to lift all of the elements of our Apollo spaceships, the current return-to-the-Moon plan requires not one rocket but two-one launch of an

Ares 1 carrying the astronauts in the Orion capsule, and an Ares V lifting a big upper stage, a sort of space tug, and the lunar landing craft called Altair. Together, the two ships dock in orbit and then the tug, called the Earth Departure Stage, fires up for the outbound trip to the Moon. Two rockets in development; two launching systems. And two price tags. Two ways for failure to occur. Or delays to develop.

Worse yet, neither rocket alone can accomplish a deep space mission. And deep space, such as Mars is, as our friends in the recent Augustine report stated, our destination in space. These rockets were originally supposed to all be derivatives of the Space Shuttle-using four segment boosters and Shuttle engines—but the designs were changed to save money and development time. Neither of which has proven to be the case today. Our Augustine panel colleagues stated flatly that some new heavy lift rocket would be needed no matter which direction President Barack Obama chose for the space program. But Ares 1 is too small, barely able to lift the crew space capsule. And Ares V is too weak to boost all of the elements together.

What do we need? One rocket for all our deep space missions. Save the taxpayer's money by canceling the Ares 1 *and* V. And go "back to the future" in designing the big beast. So how do we get to the space station without Ares 1? Let the commercial space firms develop their own crew launchers, and crew vehicles. Why should Uncle Sam be in the people hauling business?

Here's my plan—and yes, I *am* a rocket scientist—cancel Ares 1 now and the version of the Orion capsule that is supposed to fly astronauts back and forth to the International Space Station. Instead, unleash the commercial sector by paying them for transportation services to the station. Could be capsules. Could be winged ships like the Space Shuttle, capable of flying back to a runway with its crews and cargoes, not splashing in the ocean like a cannonball. With the money saved, start developing a true heavy lifter worthy of the Saturn V's successor. Could be a side-mount rocket like the Shuttles, with a tank-and-booster set flanked by a payload pod jammed full of cargo-or a space capsule with astronauts in tow. Or new upper stages capable of deep space missions. Let's open'er up to a true competition, with designs from inside—and outside—NASA. If we bypass a foolish Moon race and let the development of the Moon be an international affair, we will have time to refine the super booster to make sure it is compatible with our deep space goals, like missions flying by comets or asteroids—or to the moons of Mars. Such a rocket would be ready when the time comes to colonize Mars. No more false starts and dead end rockets.

Maybe use innovative elements like new upper stage engines, or entirely new propulsion systems. Or designs truly evolved from the Shuttle era. The idea is to get the best thinking from rocketeers before we start spending Uncle Sam's space bucks.

I confess I have a design in mind that I and my team have worked on for years. It's called Aquila, and it is a true offspring of the Space Shuttle. It makes maximum use of the existing Shuttle infrastructure—unlike the real Ares—and Shuttle boosters, engines and the side-mounted design where today the winged orbiter rides into space. If we need bigger rocket engines, Boeing's RS–68 behemoth is always available, flight proven and flight tested aboard the Delta IV commercial launchers. You see, heavy lifting doesn't need to be heavy spending, if we do the job right.

But let the designers take the field-and may the best booster win. To paraphrase David Letterman, we don't need any stupid rocket tricks. Just good sound engineering. For without good new rockets to carry our payloads and crews, nobody is ever going to follow in Neil, Mike and my footsteps into deep space. And that's where we are destined to go.

Mr. ROHRABACHER. And I understand that the Ares I actually cost us a half a billion dollars. Is that correct? Ares I–X cost us a half a billion dollars and it was—and if you take a look at the details of exactly what it was all about, it was probably the most expensive launch that we have had for a long time and was not really an entire—it wasn't a rocket in and of itself. But let us get to the subject at hand here.

ITAR RESTRICTIONS

When we talk about space cooperation, I personally believe that space cooperation is a prerequisite because of cost factors to future endeavors in space. We have got to have that because we can't afford to do it on our own but in-space cooperation, that doesn't nec-

essarily mean we need to cooperate with every country in the same way. The first complaint of the witnesses today was ITAR. I have heard that. And second was funding. But can we not cooperate with other countries like our European friends and things like space debris, which I think is a vitally important issue for us all to handle. It affects every one of the space-faring nations without having to have an elimination of the ITAR restrictions on dealing with vicious dictatorships like China. Can we not cooperate with the rest of the countries of the world, more democratic countries of the world without having to lift ITAR restrictions on China? That is my question to the panel. Go right ahead.

Dr. PACE. Well, I think that is a good question and I think that there are a number of areas, for example, in basic science, space science and earth science, where cooperation can happen without necessarily changing the export control rule because these are areas that we engaged with the Soviet Union during the height of the Cold War. We had science programs that went on and built relationships and so that is kind of a careful foundation that I think could be done also with China and may probably should be done with China. Issues of protection of spectrum, issues such as sharing information about space situational awareness standards, these are all things where cooperation could be extended without violating current export control rules. Regulatory reforms, open trade, these again are things where progress I think can be made. But at the end of the day, if you want to achieve the highest degree of cooperation and the degree of insight and trust that come only with flying together in space, you eventually do have to control the ITAR regulations and the burdens they impose but are there things that you can proceed with right now? Yes, there are, and I think my colleague in the European Space Policy Institute and I have tried to speak to that.

Mr. ROHRABACHER. Well, certainly, when we are talking about future space endeavors, I think that China is a country that we should look at and recognize, and by the way, the Germans had tremendous technological capabilities during the 1930s and it probably would have been a bad idea for us to enter into cooperative relationships then at the same standard for Germany that we had for our European, more democratic allies, and perhaps in China until we see some reform. We could be cooperating at the level that you are talking about within ITAR but loosen the restrictions for ITAR with our other more democratic countries. Isn't that a better strategy?

Dr. WILLIAMSON. Yes, sir. Well, I think we could certainly adopt a strategy like that. One of the reasons—with respect to China, one of the reasons that I focused as an example on Latin America—I could have chosen other regions, Africa or some other areas of the world—is that we see the increasing influence of China in Latin America, specifically in the space realm, and while I think that that has certainly assisted some of those countries there to develop their space capabilities, I am not sure we want to encourage that kind of activity with, say, Venezuela, which has extended its own influence over Latin America. So I think there are some concerns there and the United States becoming a bit more involved, especially in the space realm, because there is a great interest, a num-

ber of countries are now—in Latin America are now developing their own space policies and their own space programs, and—

Mr. ROHRABACHER. Well, that is a good thing. Let us just note—and I know my time is up, Madam Chairman. Just note for the end that a lot of these Chinese space capabilities, some of us believe that that came directly from America's irrational cooperation with the Chinese 15 years ago in which there were major transfers of technology that had been developed by American taxpayers. We need to make sure we focus and get our money's worth and not necessarily transfer those capabilities to our adversaries and competitors. Thank you very much, Madam Chairman.

ARES I

Chairwoman GIFFORDS. Thank you, Representative Rohrabacher. And also for the record, I just want to state that the Ares I–X launch not only was highly successful but also a very necessary key part of moving towards the Constellation program, which members of Congress have supported, and a new platform, a new vehicle and I for one am just particularly pleased with the results of Ares I.

Mr. ROHRABACHER. Are you pleased with the cost of the project for what we got out of it?

Chairwoman GIFFORDS. Congressman Rohrabacher, as you know, because you have certainly been the Subcommittee chair in the past, that what we do as a Nation with human exploration is very risky, it is very complicated. Obviously we have not seen it replicated in many different examples by many different countries or, you know, by individual standalone companies, and you know, there is a cost to greatness and I for one am willing to pay that cost.

Representative Fudge.

MITIGATING EFFECT OF GAP IN HUMAN SPACEFLIGHT

Ms. FUDGE. Thank you, Madam Chair, and thank you for being here today, all the panelists. I really just have one question actually.

Mr. Pace, I believe it was your statement, you indicated that China's human spaceflight experiences are training a new generation of technical specialists and raising the quality level of industrial suppliers. I know that I sit in these hearings all the time and most of the people I see in rooms, especially in this committee, are very young people. My staff is very young. I have people who are very interested in science who tell me that if we continue to go forward as we have with knowing that probably at least for the next five years that we are not going to have any human access to space, what do we do to keep our young people engaged? What is your suggestion? What do we do to keep our young people engaged and our supplier base capable so that as we go forward we can be where we need to be? Anyone can answer the question. I just happened to think it was Mr. Pace that said it. Thank you.

Dr. PACE. I will see what my colleagues suggest. I think the fundamental thing we have to do is, we have to do real missions. We have to have real hardware. We can't simply have programs where we have lots of view graphs and we say how great things are going

to be. They can be modest things. They can be small satellites. They can be balloons. They can be aircraft. They can be test flights such as the Ares vehicle. They can be things that take a long time. But there is a unique change that occurs when engineers see real hardware happening. You start figuring out who is actually really good in the field and who is, maybe they should stick to, you know, doing view graphs. And that lack of sense of reality, where is the real hardware going to be, I think is the thing that most deters people from pursuing longer-term careers because they don't see what is going to be built, and thank you for mentioning the Chinese case. I have to note there was just a press report this week that China had opened a 7,000-square meter plant outside Beijing that is used for design and development of the lunar exploration systems in orbit management of spacecraft and analyses. They are laying the groundwork now for a very long term. It may take them longer than expected but they have younger people coming. They are investing in the facilities. They have got a fairly logical program that is step by step going forward. They will do it with or without us, and again, I said we shouldn't fear them being out there but we should worry if we are not out there with them.

Ms. FUDGE. Thank you. Yes?

Dr. WILLIAMSON. I would like to pick up on something Dr. Pace mentioned and add to it a bit. It is the question for engineers, scientists to work with hardware, to work with experiments, to work with observations and so forth so we can do a lot in those realms, even with small satellites. I teach in the International Space University from time to time, and you find there some very, very great interest in space, even when the projects are small, where there are small satellites, but the point is that the students have a chance to get their fingers dirty soldering, you know, the circuit boards and so forth and actually putting together a small satellite, and it is wonderful when they work but there is still an excitement if the project fails at some point because they have actually had a hand in it, so I think that is very important.

Ms. FUDGE. Yes, go ahead.

Mr. STEVENS. This afternoon I have the pleasure of going to a commercial launch. It is my six-year-old son at St. Steven's model rocket club. They are launching rockets this afternoon and I hope that some day he participates in AIA's Team America Rocketry Challenge, which is a big event that I think you are aware of. The point I am trying to make is that we need to get to these kids early and we need to get them excited, and I know that the chairwoman mentioned you are going to be having a hearing on workforce and industrial base, and I know you will talk more about it then, but I think as has been said here, we really need to have stable funding and we need to have policies that cross Administrations. We cannot have each President that comes up every four or eight years changing the direction that we are going. We have to stick to something because to get to the moon, to get to an asteroid to do things is going to cross many Administrations and we can't keep on changing horses in the middle of the river.

Ms. FUDGE. Thank you very much. I just want to thank all of you for your answers and just say for the record that what I am hearing today from a panel of experts is that it is worth the money to

do what we need to do to keep us where we need to be as a Nation, where we need to get young people engaged in science early, and it is worth it. Sometimes we fail, sometimes we succeed, but the dollars are necessary to keep us as the premier country in this world, so I thank you very much.

Chairwoman GIFFORDS. Thank you, Representative Fudge.

We have noticed that votes are going to be called between 11:15 and 11:30, but I think we have time for another round with the members, and it is a long round of votes so we are going to have to adjourn when the votes are called and we have to leave.

GLOBAL SPACE MARKET

I have another couple of quick questions. Specifically, we talked about growing international capabilities and what is happening with space products in the global market. Specifically, I would like to hear in what exact products or which types of services are we seeing increased competition, I mean true, real competition with what we have been able to produce here in the United States. Let me start with Mr. Stevens, so that way you can't blame Mr. Hauser for taking your answers.

Mr. STEVENS. Well, the two issues that come to my mind are launch capability, and I mentioned that, and COMSATS. These are two areas that are being undercut, and it is difficult to compete with nations that have a labor force and don't pay them what we pay people and take care of people that way. So that is very tough, and the ITAR adds to that type of thing. It makes it very difficult for us to do business with people overseas and, as I mentioned, that is why we are coming up with—other countries are coming up with satellites where they don't have to do business with us. It makes it much easier, so—

Chairwoman GIFFORDS. Thank you.

Other people? Dr. Pace.

Dr. PACE. Well, I think I would like to point out, the launch vehicle and the communications satellite industry are the two areas where you see U.S. market share drop off fairly seriously over the last decade or more, and particularly in the case of space launch. One of the problems there is that there is a relatively small number of launches that are competed every year and they are competed with other countries that have different industrial policies. In some cases, as is said, it is because of differences in what they pay people. In some cases they are inheriting material that was left over from the Cold War, or in other cases other countries have decided we are simply going to produce a certain production run of vehicles and then simply going to then make those vehicles available, so it is not a commercial market in a pure sense. It is, we are going to have X numbers of vehicles, we will produce those. We want to keep a production line open. We want to maintain a certain size industrial base and then we will allocate those vehicles. That is not, you know, a commercial market and so it is really hard, I think, for private U.S. firms who are trying to compete against state enterprises or against foreign industrial policies that are there for other purposes to compete in that kind of market. It is a very hard question. I don't know that I would want to emulate or replicate that policy for the United States but I think it is fair

to recognize that we are not competing on the same terms and conditions that other countries are, and that has an effect on our industrial base and our competitiveness since we have to ask okay, now what should we do given that reality. As I say, the globalized market means not only are there more competitors in terms of products but there are more competitors in terms of alternative policies that affect our companies.

SELLING SPACE TO THE PUBLIC INTERNATIONALLY

Chairwoman GIFFORDS. I have been thinking about other countries that certainly have financial constraints in this day and age just like the United States yet other countries while they don't spend the dollars that we exactly spend in terms of their budgetary priorities are making significant inroads. How is it that other global leaders or other governments are justifying to their people the benefits or, you know, the rewards or the sacrifices being made to fund new space innovation? Dr. Schrogl?

Dr. SCHROGL. In fact, Europe has recognized space as a lead market. The European Union has set out a number of particularly important areas for the economy and one out of six has been space, and this was a clear signal that space does comprise a number of benefits, be it in manufacturing, but even more so in the services, and Europe wants to grow, of course, in this area and its strategy is in particular also in view of Galileo as a global system which will certainly provide a new setting and create competition in particular also for the services which are provided in the manufacturing which is related to GPS and where Europe intends to grow considerably. So the European governments say the economic impact of space will be raising and it is also doing its best to make the right framework conditions on the regulatory level as well as on the policy level, which is a straightforward European space policy to make that really become to the benefit of the people. On the other hand, I should mention that as well the European leaders have recognized the high potential of space as a symbolic issue area and that the prestige you can get in the international field should not be underestimated by the Europeans. So far we haven't really went into that but now we are recognizing it, also vis-&-vis the other countries which are competitors in this field, attractiveness as a high technology part like China or India. So Europe is putting together a whole set of arguments in order to invest in space and make it known to the public that this is money well spent.

Chairwoman GIFFORDS. Interesting.

Dr. Williamson.

Dr. WILLIAMSON. I might add to that that Europe has invested time and effort into developing a kind of strategy for its space efforts in Europe, and I think as I mentioned in my testimony, I think it would be very helpful for the United States not just to develop policies but also a strategy going forward to guide our space efforts. One of the things that Europe and a lot of the small countries have done is focus a lot on earth observation services in addition to the technology and the science. We have tended to focus more in earth observations on the science side of it and a lot less in the service side of it for public sector, and the difficulties there are enhanced or made more difficult by the fact that it is very dif-

ficult to make a shift from the science side that NASA funds into, say, for earth observations either U.S. Geological Survey taking over systems or NOAA taking over systems, which tend to be very expensive systems to develop and maintain. So that is one area that we could work on, it seems to me is fixing that. I am not sure how to do it. I know it has been around for a long time but I feel the need to point that out once again.

Chairwoman GIFFORDS. Thank you, Dr. Williamson.

Congressman Olson.

ALTERNATIVES TO ARES

Mr. OLSON. Thank you very much, Madam Chairwoman.

I have one question. It will be very brief. It is for you, Dr. Pace. In your testimony, you state that the human spaceflight review has "created an air of uncertainty over U.S. intentions." Now, I am concerned that any changes to the program at this point will extend the gap, and I know that I am going to step on the territory and I am going to incur the wrath of my colleague from California here but I thought the Ares I–X launch was an extremely successful launch, and my question for you is, how are the alterations of the path we have planned for the Ares I affect your ability as a partner, an international partner, particularly if we assume that we are going to extend the space station to 2020 and we are going to have to have some access to it?

Dr. PACE. Well, thank you. You know, I have to say in one area I will certainly agree with Congressman Rohrabacher in that the Ares I did not demonstrate brand-new physics. I mean, it was an engineering achievement, it was a test achievement. It was not something that you would consider technologically groundbreaking, and that is a good thing because the shuttle program is ending and we need to have a vehicle that we can rely on for access to space. It is time to really, I think, put aside a lot of the really pretty view graphs and make sure that the U.S. government and this Nation has the capability that it is going to be able to rely on. Now, if it turns out that other commercial activities are able to take over the burden of getting to LEO, I will be thrilled. I think that will be absolutely wonderful. But the question is, I don't want to bet on that happening unless I know that I have got something else to back it up. So to me, the Ares I vehicle is absolutely necessary as insurance and as a way of making sure I can get to space so I can place considered bets on the commercial community. It in fact is enabling of those bets on the commercial community. And the other thing is, it helps me bring forward that capability, that strategic capability in this country for doing human spaceflight farther in the future. So it is a crucial bridge, if you will, to the future, because if it turns out that we don't have Ares I, if it turns out that the commercial options take longer and are more expensive than maybe people expect, the result is, we will be reliant upon our ISS partners, in particular Russia. Now, Russia has been an excellent partner. If it was not for Russia after the loss of Columbia, we would not have been maintaining the station. But a strategy going forward that is willing to place maybe a decade worth of bet on relying on a foreign country for access to our facility to me is not a

great idea. I want to encourage commercial but I want to have a backup option in case it doesn't show up on time.

Mr. OLSON. Yes, sir. Thank you for those comments.

Madam Chairman, I yield back my time.

Chairwoman GIFFORDS. Thank you, Mr. Olson.

Representative Kosmas.

Ms. KOSMAS. Thank you, Madam Chairwoman.

I was going to ask a different question but in light of the comments that were just made, I think it is an excellent place to round out this conversation today. I think Dr. Pace said much of what we have been saying as a committee and as a group of members who strongly support manned space exploration and the continuation of our ability to maximize the use of the International Space Station with our partners but also to continue and look for what you all had suggested, which is policy, programs and budgets that will work going forward and a consistency of programs, and I think we are all most interested in seeing that occur and we appreciate your conversation with us today. Thank you so much.

Chairwoman GIFFORD. Thank you, Representative Kosmas.

Congressman Rohrabacher.

Mr. ROHRABACHER. Well, here I am again. Let us just note that as we progress with this discussion that there is no doubt in my mind that space investment is worth the money. There is no doubt about that, and I am a strong supporter of making sure—and space cooperation is essential if we are going to achieve the potential that we have and all of humankind has in terms of utilizing space for the benefit of the people here on earth but also to explore in the areas beyond. The question isn't whether or not it is worth the money. The question is, are we getting our money's worth that we are spending. We are spending more than any other country of the world yet we are falling behind. What does that tell you? We have got to do some things better than what we are doing and we are not going to do it by simply excusing inefficiencies when we see them.

Now, let us note that in the private sector and the commercial space business, you have SpaceX out there, and from what I have seen, SpaceX has spent less money and developed a whole new rocket system, the Falcon system, and everything that they spent is less than the cost of a design test of Ares 1–X that has not even tested any new hardware. Now, this test that we just had was a test of design but not a test of hardware but yet you have a commercial endeavor that is able to spend less money and develop a whole new rocket system. Now, we can't go on like that. What we have here is not a lack of money. We have a lack of discipline, a lack of focus, a lack of prioritization and a lack of demand by Members of the United States Congress on more-effective use of the resources that we are spending, and I would suggest that we do need to cooperate. That is one of the things that we can maximize it but we also have to keep in mind that when we cooperate with nondemocratic countries like China, there is a payback and in the end it is a brutal payback for the people of the United States who have upgraded, which we did 15 years ago with our cooperation with China. We upgraded their capabilities and now they are coming back as our competitors and our adversaries. So it seems to me

that we just have to be responsible and we have to be self-disciplined and we have to try to be as realistic as we can, and sorry to shoot that out but maybe some of the panelists or the chairman would like to comment on that. Thank you, Madam Chairman.

Mr. STEVENS. What a softball. I would rather talk about the times when I went to UCLA and used to surf down at Huntington, but I guess I will take this one on.

Mr. ROHRABACHER. I never cut you off when you were down there.

Mr. STEVENS. I represent all the companies you mentioned, SpaceX, and all the companies that are building Ares I, and I would say that having been a program manager over on the aircraft side of things, it is hard to tell exactly what the costs are and what it costs to do something these days. I would agree with you that any time there is acquisition, there are ways to do things better, and we need to take a look at that. I don't think there is competition between companies like SpaceX and the other companies that are building Ares I. They are two different missions. One is designed to go up in a commercial way, supply the International Space Station. The other one is already looking at human spaceflight and it takes a lot of money to do that type of thing, and it is supposed to go beyond that. It will provide us the capability. And as I said earlier, I don't think we should be changing horses in the middle of the stream right now or we will never be able to get up there. We will have to extend the space station to 2030 by the time we start—we get something—the government gets something. I hope you are right about SpaceX. They are a very good company and I think they will do great in the commercial world, and as I mentioned, it is good both ways to have two different systems to get up there.

ITAR

On the ITAR side of things, I agree with a lot of what you are saying but it is impacting us. I think we need to take a look, as you mentioned earlier, at different countries and how we treat them. Scott mentioned that we are working with the Chinese on different things. We are members of the Global Earth Observation Systems. Eighty countries are involved in that. We are sharing climate data and things like that and that is a good thing to do, and one would think that if we had an accident of some sort up on the International Space Station and the Chinese had the capability of rescuing our astronauts, we would like to take that into account, but we do not want to be in a position of handing over important data, and as I said earlier, the two questions you need to ask whenever you are thinking about doing cooperation with other countries is, number one, how does it impact national security, and number two, how does it impact the industrial base.

Chairwoman GIFFORDS. Great. Thank you, Mr. Rohrabacher.

As we all know, votes have been called. I have one final question, and certainly if there is anyone else that wants a final question, please let me know. We have a few minutes here. A couple of nights ago I had the pleasure of listening to a lecture on Hubble by Dr. John Grunsfeld over at the Smithsonian, and the images of course from Hubble are absolutely phenomenal but more so than

that, having spent a lot of time watching a lot of space station videos, as we all have a chance when the crews come back and at home too, get a chance to watch these videos, it really, I mean, just piques the imagination there of how large the universe is and all the questions that we have about the universe that are really unanswered, and I think it touches too this human exploration part of getting out of lower earth orbit and moving back to the moon and then going on and exploring this vast, vast tract of sky that we have. There have been a lot of questions, and I think as members of this Subcommittee and Members of Congress, we take space very seriously but in some respect, in terms of the growth of global space capabilities, the problems and the opportunities it presents, that this also needs to be shouldered by the private sector and also by the nonprofit community, all of these NGOs out there, these groups that also have an interest in space.

ROLE OF PRIVATE ADVOCACY

So I guess my final question to the panelists is that obviously you can hear a strong commitment by members of this Subcommittee, the Committee and the vast majority of Members of Congress. You can see that and certainly in the past budgets that we have supported. But really, what is the responsibility and what are the actions that the private sector and folks out there in the nonprofit world—I mean, what are all of you willing to do to make sure that the United States continues to lead in this area? Mr. Hauser?

Mr. HAUSER. I will take the first stab at it. I would like to think we are attempting to do our job fairly well. Certainly in the Space Foundation we have a very active education program and based on the question earlier, I had wanted to share that we have a partnership with Charles County, Maryland, which is quite a fabulous partnership. A very forward-leaning school superintendent wanted to build a planetarium for our students and he realized the only way to do that was to leverage it across all of the disciplines. So every grade level and every discipline has to integrate space and science into their education program, which is pretty fascinating. You find the teachers are thrilled with what they are doing because the English teacher is teaching mythology, you know, based on space. You find, I can't think of the right word, but teachers, shop teachers talking about mining asteroids and things like that.

So I think part of what we do is the education process. The other thing we do at Space Foundation obviously is come to hearings like this. We publish the Space Report. We thank you for the plug earlier today to help educate and inform America, and we spend a great deal of time trying to make sure that this works for not only the technical person but, you know, grabs my mom's interest as well too. And then I would say that we do a lot of things to partner with industry, provide networking forums and things like that again to get our message out and to interest more people in space and in science and all the things you just mentioned. So thank you for the opportunity.

Chairwoman GIFFORDS. Mr. Stevens?

Mr. STEVENS. One of the things that the Aerospace Industries Association on the space side is ramping up and really doing a big

campaign, I think. We are talking to our members about doing this right now but we really to focus and get the public involved. If you look back at the public approval of going to the moon back when we did that, it was only about 40 percent, but if you talk to people now and you look at surveys and Gallup polls and what is going on, it is close to 77 percent. So people like space, they want the United States to remain a leader in space and, you know, we just need to stay involved. We need to keep the funding stable and robust, as I mentioned, so that would be my answer.

Chairwoman GIFFORDS. Thank you.

Dr. Pace?

Dr. PACE. Well, I think the most important way I think we contribute at George Washington University of course is the education of people and the people over the many, many years who come through the program, you find them all over the world. We have students who are in every space agency around the world, we have visiting scholars from all over the world, and so that there is a community that has been built up that on one hand recognizes deep differences that other countries have their own subjective objectives and interests and needs but also the commonality that you describe as we sort of look beyond, you know, our immediate needs and we recognize this broader horizon that we can be moving toward.

So one of the things I think that we try to do is try to connect space to these sort of broader interests of national security, foreign policy, economic development, international trade development, that is not simply about a bunch of engineers having a good time with their own particular project but it is about serving a sort of broader, really more transcendent interest in our societies, and I think that is one of the privileges in the institute that I have is being able to see that in generation after generation of students who come through that program.

Chairwoman GIFFORDS. Thank you.

Dr. Schrogl, could we have the European perspective?

Dr. SCHROGL. Yes, indeed, Madam Chairwoman. I cannot exactly respond to your question because I am working for the purpose of having Europe maybe in the future being a leader in outer space, at least a small leader. Now, we are trying to convey the message that space is useful for a number of policy areas, and this is I think a theme that Scott Pace has already mentioned as well. In Europe is it very complicated with all the levels we have for the member states at the European level to also educate the decision makers that space is a tool, a powerful tool to achieve results in these policy areas ranging from security to knowledge, mobility, resource management and the environment in particular. And so this is one of our main tasks to show the benefit of space and space applications in these policy areas, and of course then to try to convince the decision makers as well as all the users, the potential users to reap the benefit from utilizing space capabilities to this extent.

Chairwoman GIFFORDS. Thank you.

Dr. Williamson.

Dr. WILLIAMSON. Well, yes. The Secure World Foundation, it is a small foundation with offices in Colorado, United States, and Vienna. We have focused heavily on space sustainability and edu-

cating people not only in the United States but also in other countries about the importance of focusing some effort on sustainability so that we reduce the issues with space debris and also with this orbital crowding that I mentioned in my testimony. One of the things we do is partner with an organization in Canada, Project Plowshares, to produce this Space Security Index every year, and which is available online and in paper copy, so that we educate people about space policies and about the importance of maintaining the space environment for all the benefits we obtain from the space environment.

Chairwoman GIFFORDS. Thank you. I just want to thank all of our witnesses today. Any additional questions? No? Okay. Again, I mean, I think we covered a lot of ground, and this is something during a very difficult time of competing budget priorities that we need to continue to be vigilant about and we need to continue to focus on, so again, for our witnesses, thank you so much for being here.

Before we bring the hearing to a close, also I want to make sure that the record will remain open for 2 weeks for additional statements from the members and for answers to any follow-up questions that Subcommittee members may ask of our witnesses. The witnesses are now excused and the hearing is now adjourned.

[Whereupon, at 11:38 a.m., the Subcommittee was adjourned.]

Appendix:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Marty Hauser, Vice President for Research And Analysis, Washington Operations, the Space Foundation

Questions submitted by Chairwoman Gabrielle Giffords

Q1. What does the changing global space arena and the increasing capabilities of space players mean for our national security interests?

A1. It means that a domain we are accustomed to operating in with complete freedom is more constrained. This limits our options and we must take more third parties into consideration when we select a course of action related to space.

Q2. You indicate in your statement that China and the Europeans, though not spending more, are getting more out of their investments than we are. What is your basis for saying that? In your opinion, what investments in NASA would give us a greater bang for the buck?

A2. Estimates of Chinese spending vary, but the administrator of the Chinese National Space Agency stated in 2006 that they had spent $2.8 billion on developing human spaceflight capabilities over the years. This is less than the amount spent on the Space Shuttle in a typical year (approximately $3 billion). Even accounting for fewer Chinese flights, and assuming that the administrator's statement was accurate, this is a very low price for developing human spaceflight capabilities (partly due to collaboration with Russia). On the European front, in spite of a lower level of overall space spending the Europeans developed a launch vehicle, the Ariane 5 that is the only booster capable of delivering two large communications satellites to geosynchronous orbit at a time. This capability has made the Ariane 5 a world leader in the commercial launch industry. Investments in NASA that are intended specifically to produce or enhance commercial applications may give the United States a greater return.

Q3. The Space Foundation organized a private delegation to China and visited space facilities and infrastructure for China's human space flight program. What, during the visit, was most striking? How, if at all, did the visit change perceptions of China's space capabilities on the part of those who went on the trip?

A3. I was not on that trip but I am told what was most striking is that they have a program of record that they are committed to. They are not trying to "leap frog" ahead of the United States in terms of manned space, but they are making steady incremental progress. While here in the U.S. we are making programmatic and funding starts and stops. This focusand commitment by the Chinese will allow them move ahead of us in space.

Q4. What is the impact of U.S. export controls, particularly ITAR, on the United States' ability to reach out to emerging spacefaring nations? What would you recommend be done?

A4. It is crippling for the aerospace industry. It dramatically affects our business opportunities and operations. The loss of business due to unnecessary export controls creates a long term national security issue for us. We must protect critical national security technology without question but we must also find a balance and loosen unnecessary restrictions. This would allow our companies to compete internationally and to build and rebuild necessary partnerships and collaborative efforts with other countries. The administration and emerging congressional efforts at export modernization should be applauded.

Q5. To what extent does cooperating on space activities improve domestic national capabilities in science and technology? Does that apply to emerging space powers as well as to the United States?

A5. Ideally, if a partner has a core competency, for example Canada and their telerobotics, it allows the partner to focus on their strengths, reduces demand on the US to develop such capabilities, and allows the US to devote resources to other critical path systems. I believe this is true when dealing with emerging space powers as well. In some cases it is even more beneficial because they are starting with a clean slate and can focus their investment in new areas of expertise that have not been fully explored.

Q6. While several new participants have entered the global space arena and others are demonstrating increasing capabilities, what do we know about the ability of these nations to sustain their space programs and investments?

A6. Not surprisingly it is not easy to garner complete and concrete data on how other nations are explicitly funding their programs. What we have seen is that other nations are doing two things when prioritizing and allocating scarce resources:

#1. Identifying near-term, pragmatic needs and requirements that can be addressed via space assets/capabilities

#2. Where appropriate, they are making their contributions to any collaborative space effort with other nations.

In addition, the model for space is changing daily. It used to be countries like the U.S. and Russia built their own launch vehicle and satellite, launched it, and operated it. That paradigm has changed and now has numerous possibilities. Now that more nations with smaller budgets have recognized the value of space and using space assets and products, there are all kinds of unique arrangements. For example, one country could pay another to build their desired satellite, pay another to launch and operate it for them. This a la carte way of purchasing hardware and support comes in just about any type of arrangement one could want. And in some instances, like China, there is a package of agreements and services that extend beyond space, i.e., building and operating a country's satellite in exchange for rights to oil or other resources or land use. These are the arrangements that turn countries into partners and potentially threaten the long term security of the United States.

Questions submitted by Representative Pete Olson

Q1. Talking about other space-faring nations, you stated that, "(T)hey are not outspending us, but they are certainly getting more out of their investments." Could you expand on that statement? How are other space-faring nations able to exploit their investments to greater effect?

A1. Over the past decade and across both civilian and national security space, US government programs have seen programs start, have their requirements change, costs increase, schedule delays, get restructured and cancelled. Billions are wasted because of poor management, unrealistic expectations and funding uncertainty. Other nations are not immune from these problems, but they seem more judicious in how they allocate funds.

Q1a. For what period of time does the US typically hold on to newly developed space technologies—whether talking about launchers, sensors or other related capabilities—before these technologies are replicated by other countries?

A1a. Unfortunately I am not a technology expert and I don't think I am qualified to answer this question. That said, I will take a stab at it.

There is no simple answer—it depends on the technology and the capabilities of the other countries that are involved. In some cases, it is enough to know that a capability exists. Once that is known, it is possible to determine how it is accomplished and how it can be duplicated. Other technologies require significant empirical testing to perfect, and substantial resources must be dedicated to the research process before the capability can be replicated.

Q2. What capabilities are the emerging space-faring nations working hardest to develop, and why? Should we be concerned?

A2. Many emerging spacefaring nations, particularly developing nations, are focusing on capabilities that are Earth-oriented and show direct benefits for education, communications, agriculture, and other public services. The greatest concern may be when these emerging space nations do not seek assistance from the United States for their programs, as it is a lost opportunity for us to use "soft power" to form useful connections with them for the long teen.

Q3. What are the long-term effects and strategic implications on our country's economy, our ability to engage in international collaborations, and our ability to exploit space, if we are reduced to launching a relative handful of civil missions each year?

A3. There will be all sorts of unforeseen ripple effects through the aerospace industrial base, and the number of talented young Americans who choose space as a career.

This will eventually spill over into how the US develops cutting edge technology and capabilities in both civilian and national security communities. Costs per flight will increase as well.

Q4. How closely coupled are our commercial and civil space programs, including human spaceflight, to our national security space posture? Would a reduction in civil space R&D and infrastructure imperil the technology base and capabilities on the military side?

A4. They inexorably linked. Most companies that comprise our space industrial base perform work in both civil and national security space. An easy example is ATK. The lion's share of their work with solid rocket boosters (SRBs) is with NASA. Due to economies of scale it reduces the costs for the Department of Defense (DOD) usage of SRBs. If NASA ends their use of SRBs or dramatically reduces their use of SRBs, the costs for ATK and DOD will increase.

Additionally, in many cases space technology and equipment is provided by smaller, second tier suppliers. Many of them are the only supplier of a specific piece of necessary space equipment. Today, many of them exist on the margins when it comes to profitability. If demand and requirements decrease, many could not afford to stay in business, thus causing problems for the entire production chain and potentially create an unrecoverable affect in the industrial base.

Questions submitted by Representative Parker Griffith

Q1. Regarding space dominance, my question for the panel focuses on Human Space Flight Exploration. I would like to remind everyone, we currently have a capable and recently tested Constellation program intended for low earth orbit, which is managed in my district at Marshall Flight Center in Huntsville Alabama. Could you talk about the geopolitical perception of the United States if we walked away from the current national exploration initiative and further extended the human space flight gap by turning over the mission to a commercial industry that is yet to have a human rated space exploration vehicle?

A1. In the past several days we are starting to see that reaction to such a scenario. We ourselves have had interactions with foreign space officials who are somewhat dismayed and saddened by such a move. While a move to a commercial launch marketplace may be a good long term solution, no doubt in the short term it weakens the perception of the U.S. being the global space leader we are known to be. It also begs the question, what is the true commitment of the United States to human spaceflight, and when will we make a decision and stick to it?

Q2. How can the United States maintain its space dominance when we are reassessing the goals of human space flight exploration with presidential administration and continuing to underfund our NASA programs? What is needed for the United States to maintain its space dominance and inspire America's youth?

A2. Programmatic and funding starts and stops hurt development of vehicles and systems as well as failing to get the public enthused about space. I think a sustained commitment to the program by successive Congresses and Presidents will help. This commitment needs to be aggressive in spirit and in effort. It must be well developed and installed in programmatic goals and provide increasing long term, reliable national funding to achieve those goals.

Q3. While the United States is attempting to maintain space dominance, the financial and public support is waning as we get past 2010. How do we work to reverse this trend?

A3. NASA and its contractor partners need to execute as best they can. Overruns and delays reduce enthusiasm. Nothing builds support more than mission success. A new vision must be developed quickly, communicated and then funded long term without wavering commitment. As they say in the movies, "If you build it, they will come."

ANSWERS TO POST-HEARING QUESTIONS

Responses by J.P. Stevens, Vice President, Space Systems, Aerospace Industries Association

Questions submitted by Chairwoman Gabrielle Giffords

Q1. What does the changing global space arena and the increasing capabilities of space players mean for our national security interests?

A1. Space is a 'high ground' in national security and a resource currently available to only a few other nations. As the use of space increases, new and potentially unfriendly nations will secure these capabilities. Increases in foreign communications satellites could support foreign troops and unmanned vehicles. Other nations are developing GPS systems which could be employed for targeting and military navigation. Remote sensing will provide other nations a global view of military and industrial capabilities and even deployments.

It is incumbent upon the United States to remain vigilant about these foreign space capabilities while we continually maintain -. and advance—our own capabilities. We are risking our national security should we become complacent about these capabilities.

Q2. In your prepared statement, you mentioned increasing competition in the satellite manufacturing industry and the decline in the U.S. share of revenues in this market. What are the implications of the U.S. market position in these and other industries for our national space capabilities?

A2. In 2007, the satellite market provided the U.S. 257,000 jobs (services—84,000; manufacturing—27,000; launch services—50,000; and ground equipment—96,000).

The U.S. had 47 percent (4.6 billion dollars) of satellite manufacturing revenues in 2003; this number sank to 29 percent (3.1 billion dollars) by 2008. This loss of market share has a major impact on U.S. aerospace companies and continues to be of concern.

The satellite industry is a 144 billion dollar industry worldwide; with satellite services providing 58 percent of these revenues, ground equipment providing 32 percent, satellite manufacturing providing 7 percent and launch services providing 3 percent. Services and ground equipment alone represent 130 billion dollars worldwide each year. As foreign satellite use grows, the U.S. share of the overall satellite industry will continue to decline.

Due to an overly restrictive export control system for commercial satellite and related technologies, U.S. firms are becoming increasingly reliant on government contracts for business sustainability. As the U.S. market share declines and government programs remain flat or decline, many U.S. companies—particularly small firms or component manufacturers—are faced with hard choices, including whether or not to exit the market altogether.

Further erosion of the U.S. market share has far reaching implications to our nation's space industry, especially our second and third tier suppliers. These suppliers are necessary for more than just commercial satellite customers, as many produce components needed for our national security community. Losing these companies puts our national security at risk, can increase the cost of major space programs, and impacts the ability of industry to meet the needs of our military and intelligence community.

Q3. What is the impact of U.S. export controls, particularly ITAR, on the United States' ability to reach out to emerging space nations? What would you recommend be done here?

A3. Outdated export barriers affecting U.S. companies have prompted other countries to develop their own indigenous capabilities, and have promoted the ability of other nations to trade in space technology globally. In light of the current export control system, U.S. firms have become increasingly dependent on government contracts to remain in business and are not able to compete on a level playing field globally. These restrictions make it harder for the U.S. government and industry to partner with our friends and allies internationally.

Our export control system is currently under review by the administration, and also requires legislative action to move control of commercial satellites and related components to the Department of Commerce. A system must be developed that keeps sensitive technologies out of the wrong hands while facilitating technology trade and cooperation with our friends and allies in a timely manner.

Q4. I am concerned about continued U.S. competitiveness in the global economy. What does the increase in global space capabilities among other space nations mean for our U.S. aerospace industry and our economic competitiveness? Are any of the emerging space nations able to compete with space products and services on the global market? In what areas are we likely to see increased competition due to growing space capabilities?

A4. As demonstrated in question two, the global satellite industry is increasingly leaving U.S. companies behind. Another key area of concern is commercial launch services. In 2008, U.S. companies launched only six of 28 worldwide commercial payloads. Currently, Russia and Europe have around 60 percent of the global launch market. In addition, our GPS system will be facing competition in the next several years with systems being developed or deployed by Russia, the European Union, China, India, and Japan.

The increased competition worldwide is of serious concern to the U.S. aerospace industry. Fostering a business environment that rewards innovation and risk, while removing barriers that exist with our current export control regime, is what is needed to ensure we remain competitive into the future.

Questions submitted by Representative Pete Olson

Q1. For what period of time does the U.S. typically hold on to newly developed space technologies—whether talking about launchers, sensors or other related capabilities—before these technologies are replicated by other countries?

A1. Four variables to consider are (1) the cost of pursuing the specific technology, (2) which areas of expertise a nation chooses to pursue, (3) the capacity of each nation for R&D of the new technology, and (4) a willingness to invest. For example, space launch is a very expensive program requiring long lead times and a steep learning curve, while sensors for remote sensing are a relatively easier project.

Willingness to fully invest in a project helps reduce technology development times, allowing nations to catch up with the U.S. With the Cold War funding enjoyed by the Apollo program, the U.S. was able to develop the Saturn V moon rocket in just eight years. The proposed Ares V heavy lift rocket, which has a less robust funding profile projected, is estimated to take the U.S. at least twice as long to develop.

Nations such as China, however, have both the capacity for R&D and the willingness to invest. Utilizing the technology development of the U.S. and Russian space programs, the Chinese were able to meet major space milestones at a significantly accelerated pace. Their first three manned flights have included flights with multiple crews, orbital maneuvers, and extra-vehicular activity. India and Japan have both orbited probes around the moon, Europe and Japan have launched remote control cargo vehicles to the International Space Station, and India has developed a remote sensing system.

As space technologies increase their presence in the global marketplace, it is reasonable to expect that emerging space countries will be able to make sizable improvements to their technological capabilities at a much faster pace than the U.S. needed for developing technologies from scratch. Other countries are able to build their development upon existing systems.

Q2. What capabilities are the emerging space-faring nations working hardest to develop, and why? Should we be concerned?

A2. The U.S. has competitors in every aspect of space technology. The area which nations are most likely to prioritize for technology development is remote sensing. This is comparatively simple, inexpensive and can have commercial, civil, and national security applications.

Two other areas of rapid growth are GPS and human space flight. Europe, China, India, and Japan are developing GPS systems (Russia is currently deploying one). China has a

human space program and India is expected to have a human spaceflight in this decade. Europe and Japan have developed unmanned cargo delivery systems to the International Space Station; these projects have developed technologies which can directly support human spaceflight.

The development of new capabilities by emerging players is an area of major concern. It represents not only commercial competition, but also has national security implications because many civil and commercial capabilities (remote sensing, communications satellites, and GPS) can serve dual purposes.

Q3. What are the long-term effects and strategic implications on our country's economy, our ability to engage in international collaborations, and our ability to ex-

ploit space, if we are reduced to launching a relative handful of civil missions each year?

A3. The U.S. has been in the enviable position of being the leader in both civil and commercial space ventures. However, the increase in players in commercial space and the businesses supported by commercial space (communications, remote sensing, launch, and soon GPS), means a loss of the U.S. global share.

This decline not only affects businesses but also the perception of the U.S. as the global leader of space. This leadership gives us an advantage when we cooperate internationally. If our leadership continues to erode so does our voice in cooperative international efforts.

Q4. How closely coupled are our commercial and civil space programs, including human spaceflight, to our national security posture? Would a reduction in civil space R&D and infrastructure imperil the technology base capabilities on the military side?

A4. Our space efforts are deeply intertwined between commercial ventures, civil programs and national security space programs. Many of the same companies support all three ventures, sometimes with the same equipment. For example, the GPS program is administered by the Department of Defense, yet countless civilian and commercial applications render the system indispensable. Similarly, commercial, civil and national security payloads are often placed in orbit by the same types of launchers. Therefore, when one program is canceled or delayed, the impact can easily spread across our space industrial base.

Reducing our civil space R&D effectively reduces the overall investment in our space industrial and technology base. Even though the space industry has the ability to move talent between programs, and to share resources (such as components for satellites, launchers or the solid fuel for launch systems which is provided by a single company for commercial, civil and national security projects), a reduction in any one aspect of R&D ultimately affects the entire resource pool

NASA's R&D is largely driven by developing or improving human rated systems. A reduction in human exploration R&D would significantly reduce the overall pool of space R&D that benefits the nation.

Questions submitted by Representative Parker Griffith

Q1. Regarding space dominance, my question for the panel focuses on Human Space Flight Exploration. I would like to remind everyone, we currently have a capable and recently tested Constellation program intended for low earth orbit, which is managed in my district at Marshall Flight Center in Huntsville Al. Could you talk about the geopolitical perception of the United States if we walked away from the current national exploration initiative and further extended the human spaceflight gap by turning over the mission to a commercial industry that has yet to have a human rated space exploration vehicle?

A1. Other nations recognize the value of space programs as innovation drivers, for increasing world stature and as a source of national pride. It is imperative the United States maintain our stature as the world leader in space. Developing the next generation of launch and human spaceflight capabilities is a necessary component toward this end. Supporting the civil space program, while also encouraging commercial development, is critical toward ensure a robust space industry able to support the United States' goals in the future.

Q2. How can the United States maintain its space dominance when we are reassessing the goals of human spaceflight exploration with presidential administration and continuing to under fund our NASA programs? What is needed for the United States to maintain its space dominance and inspire America's youth?

A2. Despite recent advancements from other space faring nations, the United States remains at the forefront of human space exploration. However, unless NASA receives an increased investment, the U.S. risks falling behind as other countries continue to invest in their human space exploration missions. Periodic reassessment of our programs is prudent; however, it is imperative that the U.S. demonstrate resolve and commitment toward our human spaceflight goals. The impact of indecision is felt across the entire U.S. space industrial base and speaks volumes to America's youth. Increasing investment in NASA sends a direct message to our youth that they should pursue science, engineering, technology and mathematics (STEM) education, and that an exciting aerospace career can be theirs.

Q3. While the Untied States is attempting to maintain space dominance, the financial and public support is waning as we get past 2010. How do we reverse this trend?

A3. The primary way the U.S. can maintain space dominance in this era of growing global competitiveness is by greater investments in NASA and in our space industrial base.

The industrial base designs, develops, produces and supports our spacecraft, satellites, launch systems and supporting infrastructure. These systems are often produced in small, even single, numbers. Production interruptions or cancellations can negatively impact large companies and can be catastrophic to smaller firms—often the only entities with the unique abilities to produce small but critical components on which huge portions of our economy, infrastructure and security depend.

NASA and the space industrial base also drive significant technological development. The need for better composites, smaller components, more sensitive instruments and more robust systems must be constantly addressed. These developments most commonly occur with the design and production of next generation systems.

It is critical, especially in these times of tight budgets, that the administration and Congress prioritize and support this industrial base. It is also important to take every opportunity to engage and educate the general public as to the importance space systems and technology play in their everyday lives.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Scott Pace, Director, Space Policy Institute, The George Washington University

Questions submitted by Chairwoman Gabrielle Giffords

Q1. Recently, President Obama was in China meeting with Chinese President Hu Jintao. One of the areas they discussed was space. According to a U.S.-China Joint Statement released by the White House, the U.S. and China plan to expand discussions on space science cooperation and begin dialogue on human space flight and exploration. What are your thoughts on how we should approach this dialogue? What are appropriate issues for the agenda? What areas of space science and human space flight might serve as a starting point for U.S.-China engagement?

A1. As with the Soviet Union, the first steps in space cooperation should be modest, science-driven projects that create confidence through their reciprocity and transparency. China is unlike the situation of the Soviet Union in that a high degree of scientific cooperation already exists in many fields so extending cooperation to new fields of Earth and space science should be easier. However, China's space efforts are like the Soviets in that the military plays a leading, if not fully dominant, role. Thus cooperation in human space flight needs to be consistent with the state of U.S.-Chinese military-to-military dialogs. A breakdown or suspension in mil-to-mil exchanges, for example, would necessarily call into question NASA dialog with the PLA.

Initial pilot efforts in Earth and space science could be followed by biomedical data exchanges relevant to human space flight. In close consultation with the partners, small Chinese experiments could be flown on the International Space Station and reciprocal experiments flown on future Chinese manned facilities. There is much in the way of multilateral technical work that the United States an China could cooperate on, such a protection of space frequencies, standardization of communications and navigation protocols, and sharing of space situational awareness data relevant to both man-made and natural objects in space. Such standardization would increase the opportunities for communications cross-support for unmanned scientific missions.

Finally, consideration could be given to flying cargo to both International Space Station and a Shenzhou-based Chinese station. Interoperable docking and rendezvous procedures would be needed to accomplish this. Such a capability would have to be thoroughly reviewed by the ISS partners, but may be attractive in order to diversify logistics support to ISS after the end of the Shuttle program. One might even imagine using a commercial U.S. resupply launch for the U.S. contribution.

Q2. What is the impact of U.S. export controls, particularly ITAR, on the United States' ability to. reach out to emerging space nations? What would you recommend be done?

A2. U.S. export controls, particularly ITAR, are a significant barrier to U.S. engagement with emerging space nations via direct and indirect reasons. Such controls bar the transfer dangerous technology but they also create additional burdens on U.S. government employees and contractors even on approved international cooperative projects. NASA may have State Department approval to conduct a cooperative project with certain technology transfer boundaries but its contractors still need export licenses with their foreign counterparts. Contractors with the best expertise are often unwilling to risk potential legal liability in meeting with foreign nationals to resolve technical issues that necessitate lengthy workarounds through government employees who are not as expert. This creates additional mission risk.

The fundamental problem is not export control or even 1TAR per se, but the legislatively mandated lack of flexibility in the current system. The solution would be to return responsibility for the U.S. Munitions List (specifically Category XV) to the Executive Branch, with continuing legislative oversight, and have the Executive Branch rationalize and update the USML to better reflect current global and market realities. The State Department should further delegate, on a case-by-case basis, the responsibility for oversight of export control compliance to agencies engaged in approved (e.g., via Circular-175 process) international cooperative space activities.

Q3. Many of the challenges that we face as a society-climate change, ensuring the availability of clean energy and water, and protection from potential near-Earth objects that might be headed toward Earth-will require multilateral solutions. To what extent will these societal issues influence the development of global

space capabilities? What is the appropriate means by which to engage emerging and established space-faring nations on such issues?

A3. There are several useful models for the engagement of emerging and established space-faring nations on issues requiring multilateral cooperation. Some of them already exist as voluntary associations among space agencies, such as the Consultative Committee on Space Data Standards, the Committee on Earth Observation Satellites (CEOS) and the International Space Exploration Group under the Global Exploration Strategy. Others, in areas such as space situational awareness and near-Earth objects, are just forming. These organizations tend to be more pragmatic and flexible than "top-down" approaches such as a single international space agency and thus gain wider participation from nations at differing levels of space development.

The United States can best promote engagement by being a technical leader in these groups and building community networks that align with our broader national interests. For example, the SERVIR initiative by NASA and USAID in Latin America and Africa helps forecast environmental changes and to improve response to natural disasters. Cooperative networks like this have been beneficial in sectors such as satellite communications, remote sensing, weather, and global positioning. It will hopefully be the case in space weather, space situational awareness, and future explorations of the Moon and beyond.

Q4. In your prepared statement, you say that "We need friends and allies to help secure the global commons of space upon which we depend, to ensure that the space environment remains free of interference and open to peaceful uses by all." How should we be engaging both the new and established space players in ensuring the peaceful use of the global commons?

A4. The United States should engage new and established space players on the peaceful use of the global commons through the "bottom-up" networks described in the previous answer. The focus should be on the creation of measurable and verifiable norms of behavior, such as "rules of the road" on satellite approaches and space debris generation. Effort should be put into creating treaties limiting ill-defined capabilities (e.g., bans on "space weapons").

The United States should also be proactive in creating a more stable and predictable international regime for private investment, for example, by clarifying property rights in space that can impact space debris (e.g., salvage and removal rights) and extraction of local resources (e.g., lunar oxygen and water). Such efforts must necessarily engage our international space partners since unilateral statements

cannot create a predictable investment environment. On the other hand, not all space-faring nations should be accorded equal treatment. Countries like North Korea and Iran may have emerging space capabilities and aspiration, but nuclear and missile proliferation issues should accord them few benefits from being in the "space club." The degree to which we cooperate with other nations in space will varying by the degree to which we hold common political interests in space and other areas.

Q5. To what extent does cooperating on space activities improve domestic national capabilities in science and technology? Does that apply to emerging space powers as well as to the United States?

A5. Space cooperation can benefit domestic and national capabilities in science and technology directly and indirectly. Direct benefits can come from technology transfer, training, and education. Indirect benefits can come from a stronger political and economic basis of support for challenging space activities. For example, the International Space Station has benefited U.S. national. capabilities, not so much by technologies acquired from others (although there were lessons from Russian experiences) as from the international political support that enabled the project to proceed.

International cooperation creates challenges for technical and political coordination, but realistic awareness of those challenges also forces more conscious deliberation on the purpose and structure of a space mission. Such pre-commitment thinking typically improves the chances for mission success if there is decision to cooperate.

Q6. The International Space Station the ISS has become an orbiting symbol of global space cooperation, with many nations involved in its creation and sustainment. How best can the role of the ISS be expanded to become a tool to foster cooperation with emerging space nations?

A6. With the completion of the International Space Station, cooperation with emerging space nations can be fostered by encouraging utilization of this unique facility. ISS partners would need to be consulted, but one could imagine multiple opportunities for sponsoring payloads and experiments on the ISS. Depending on the quality of the experiments, resources contributed, and confidence established, invitations to be formal ISS partners on the ISS could be extended. These invitations would carry utilization rights and would have to be consistent with the foreign policy interests of the current partners. Thus invitations to India, South Korea, and possibly Brazil would be more likely than invitations to China. The latter has significant resources and expertise, but political and technical insight into the Chinese space program is lacking.

Emerging space nations could also utilize commercial launches and potential commercial facilities in orbit to build up expertise prior to or in parallel with ISS activities. While some nations, such as Iran and North Korea, would still be barred from using U.S. suppliers, other countries would be able to without the same level of political sensitivity and symbolism of being on the ISS itself.

Questions submitted by Representative Pete Olson

Q1. For what period of time does the US typically hold on to newly developed space technologies—whether talking about launchers, sensors or other related capabilities—before these technologies are replicated by other countries?

A1. A lead in space technology can be created and maintained by innovating faster than competitors and/or by trying to slow the competitors down through restricting the spread of technical innovations (e.g., export controls, classification, proprietary protections). Depending on the resources and incentives of competitors, a technical lead may persist for more than two decades (in the case of some space launchers and satellites) to less than 2 years (in the case of space-based information technologies.)

U.S. funding for space technologies have declined and export controls have limited foreign markets so the U.S. space industrial base has consolidated and shrank. Even where necessary, export controls and other restrictive decisions create incentives for others to develop indigenous capabilities that, in the long run, further erode the ability of the U.S. to innovate faster.

Q2. What capabilities are the emerging space-faring nations working hardest to develop, and why? Should we be concerned?

A2. The primary capability others are working hardest to develop and which cause the greatest concern are space launchers that can be used for ballistic missiles. The obvious concern is that such missiles could be used to carry weapons of mass. destruction,

At the same time, U.S. commercial launch providers have largely been driven from the international competitive market in the face of European and Russian competition. Given the strategic important of space launch, it may be necessary to treat at least the larger vehicles as we do Naval shipyards—as a industrial capability that will be sustained at a certain size necessary to meet national needs.

Q3. What are the long-term effects and strategic implications on our country's economy, our ability to engage in international collaborations, and our ability to exploit space, if we are reduced to launching a relative handful of civil missions each year?

A3. A prolonged low launch rate leads to the deterioration of the skilled work force necessary to routinely operate in space. This is the core reason why a prolonged gap in human spaceflight is bad for the country. A gap of a few years is not permanently harmful, but going beyond 6 years is harmful since experienced workers leave and new ones don't have opportunities to learn.

At low flight rates, the ability of the United State to engage in international cooperation, much less lead in space, deteriorates as the intellectual capital in both government and industry retires and leaves without projects to attract new talent. The United States will still rely on space for its national security and economy, but it will become more reliant on others who remain active, such as Europe, Russia, and China. This is not a situation we should welcome or accept.

Q4. How closely coupled are our commercial and civil space programs, including human spaceflight, to our national security space posture? Would a reduction in civil space R&D and infrastructure imperil the technology base and capabilities on the military side?

A4. U.S. commercial and civil space programs, including human spaceflight, are inextricably linked to our national security posture. With the end of the Cold War and the dramatic consolidation of the defense industrial base in the 1990's, it is not possible to talk about separate civil and defense industrial space capabilities. The human capital, facilities, technologies, and finances are intertwined. The U.S. loss of international market share in space launch and satellites has intensified the importance of the U.S. government as a primary customer.

Current defense budget pressures will mean that national security space projects will be hard pressed to execute on time and on-schedule, much less create innovative technical breakthroughs as in the past. This means the lower civil space spending and fewer challenging projects (in science or exploration) will mean less technical innovation in the space sector as a whole. Such pressures can be partially offset through international cooperation and burden sharing, but ultimately, one cannot be good at a skill if you don't practice it yourself.

Questions submitted by Representative Parker Griffith

Q1. Regarding space dominance, my question for the panel focuses on Human Space Flight Exploration. I would like to remind everyone, we currently have a capable and recently tested Constellation program intended for low earth orbit, which is managed in my district at Marshall Flight Center in Huntsville Alabama. Could you talk about the geopolitical perception of the United States if we walked away from the current national exploration initiative and further extended the human space flight gap by turning over the mission to a commercial industry that is yet to have a human rated space exploration vehicle?

A1. The current Global Exploration Strategy, developed by 14 space agencies, is developing a lunar architecture involving humans and robots as well as a robotic Mars Sample Return architecture. This unprecedented level of cooperation was driven by the United States on the assumption that it would have a robust space transportation capability beyond Low Earth Orbit. Even if commercial industry were to field a human-rated launch vehicle, that does not imply a human-rated heavy-lift launch vehicle or a vehicle of carrying humans beyond LEO.

If the commercial industry is not able to field human-rated vehicle in a timely manner—and many international space agencies are skeptical—then the United States has much less to contribute to the Global Exploration strategy. U.S. influence on international space developments, technically, militarily, legally, politically, and economically, will decline as a result. States will have less reason to accept U.S. leadership in space if the U.S. is reliant on Russia, Europe, and possibly China, even for access to the International Space Station. U.S. scientific leadership will likely remain unchanged, however, due to the on-going strength of U.S. Earth and space science communities.

Q2. How can the United States maintain its space dominance when we are reassessing the goals of human space flight exploration with presidential administration and continuing to underfund our NASA programs? What is needed for the United States to maintain its space dominance and inspire America's youth?

A2. The United States needs to show persistence and ability to execute long-range goals while still allowing for flexibility and innovation. There is no fundamental incompatibility between the potential use of commercial firms for access to LEO and Constellation—in fact they are synergistic with each other. However, it's important to have a known option in hand like Constellation, in order to take risks such as betting on undemonstrated commercial suppliers. The alternative of not having an assured capability and betting completely on commercial launchers is—in effect—a decision to acceptance dependence on foreign launchers should the commercial options be delayed or fail.

Q3. While the United States is attempting to maintain space dominance, the financial and public support is waning as we get past 2010. How do we work to reverse this trend?

A3. Space is a deeply symbolic activity as well as one that is crucial to national security and economic competitiveness. Space achievements are a very positive reflection on the United States while space failures are negative indictments. In order to maintain U.S. space leadership, clearer links much be drawn between space and the geopolitical and economic standing of the United States as well as the symbolism of being a world power. These linkages were important during the Cold War and are still important today in environmental of rapid globalization and rising space power. In addition, and unlike the Cold War, there are new opportunities for

space to touch people more directly—whether though everyday technologies like GPS or even space tourism in the future.

In order to strengthen financial and public support for space, tangible demonstrations are needed that the United States is determined to lead exploration missions beyond Low Earth Orbit, that there will be opportunities for young people to be part of such missions, and that these missions will have a purpose that justifies that risks and costs. As I testified, determining whether and what kind of future humanity has in space is the kind of strategic question that can drive human space exploration, as well as technical innovation and international leadership here on Earth.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Kai-Uwe Schrogl, Director, European Space Policy Institute

Questions submitted by Chairwoman Gabrielle Giffords

Q1. How does Europe view the changing global space arena and what are Europe's plans for engaging new and emerging space nations?

A1. More actors are regarded by Europe as an enrichment and an opportunity to reach joint goals and objectives of global relevance and concern.

Cooperation in science and Earth observation application areas for common goals and goods (e.g. Africa will be a focus for 2010 in the EU) are of high priority. The new focus for NASA on issues like climate change is a most welcome complement to Europe's strategy.

Europe also envisages industrial partnerships wherever possible (e.g. with countries like South Korea).

But Europe is at the same time careful about proliferation of critical technologies.

Europe also encourages the development of an international regulatory framework which is good for economic and industrial development and space applications but which at the same time prevents "flags of convenience".

Q2. Recently, a number of European nations met in Prague to discuss Europe's future plans for human and robotic exploration. What was the outcome of that meeting, and what impact will U.S. decisions on its human exploration program have on Europe's plans?

A2. The Prague conference put Exploration on the agenda of the high political (ministerial) level.

Europe intends to be a major actor in this field and will foresee the provision of the necessary funds in its future space budgets,

A follow-on ministerial conference is already scheduled for 21 October 2010 under the Belgium EU Council Presidency.

Exploration is regarded as a global task; to be conducted in close partnership with the United States. The United States decisions will strongly affect European long-term plans, in particular regarding human exploration (mid-term plans for robotic exploration might be less but will still be affected).

Q3. Many of the challenges that we face as a society-climate change, ensuring the availability of clean energy and water, and protection from potential near-Earth objects that might be headed toward Earth-will require multilateral solutions. In your view, to what extent will these societal issues influence the development of global space capabilities?

A3. They are already influencing programmatic developments in Europe, in particular visible in GMES (the flagship program "Global Monitoring for Environment and Security") which covers issues related to sustainable development in Europe and in the global context.

"Visionary" issues like energy from space and NEO are not on the current political agenda (nor are they on the agenda of the public or the media). The European policy is strongly focused on concrete benefits from space, accepts exploration as an important stimulus for long-term perspectives but is reluctant to lead political debates on utopian technologies

Q4. Europe has developed The European Draft Code of Conduct for Outer Space Activities. What are the major elements of that draft code of conduct? Has Europe broached the issue of a code of conduct with emerging space nations?

A4. The major elements of the Draft Code of Conduct are information sharing on space activities and space situations, the notification rules for space activities and through that the establishing of confidence-building measures; it also contains provisions for organized implementation.

The Draft Code of Conduct intends to establish first elements of traffic rules in outer space, which shall benefit all operators and raise the security and safety of space operations (for civilian as well as military uses).

The Draft Code of Conduct expressly responds to United States interests in safeguarding its military as well as civilian space activities and assets.

Presenting the Draft Code of Conduct can be regarded as the so far major diplomatic initiative by Europe in the field of international space policy. Consultations have started immediately after the presentation and are conducted with all States (major space powers, emerging space powers as well as other States and inter-

national organizations) throughout this year until a decision on the further procedure (most possibly an inter-governmental conference for agreeing on a Code; but not as a international treaty) is taken.

Q5. In your testimony, you noted that Europe is working to "educate the decision makers that space is a tool, a powerful tool to achieve results in these policy areas ranging from security to knowledge, mobility, resource management and the environment in particular." What specific approaches does Europe use to educate decision makers? Could you provide examples of how Europe conveys to the public the benefits of its investments in space?

A5. In the parliamentary field, the Committees of the European Parliament as well as the national parliaments are regularly briefed on space applications for their respective fields of competence. This is either done from inside the parliaments (there exist space groups in numerous parliaments) or from the outside through agencies, lobbyists or think tanks (like the European Space Policy Institute).

The space groups in the national parliaments as organized in the European Interparliamentary Space Conference (EISC), which meets on an annual basis in order to assess the optimum use of space applications in policy areas and the development of the space sector as a whole. It invites relevant actors (agencies, industry, users) to inform its members in a comprehensive way.

In the governmental field in particular the space agencies actively promote space applications vis-a-vis organizations, institutions and agencies (in all sectors like security, transport, resource management etc.) which are potential users; for that purpose, the space agency heads lead these "marketing" efforts vis-a-vis the heads of these actors.

There are also numerous European bodies, whose competences range from decision-making to coordination (to mention on the highest level is the European Space Council and its informal meetings). They do encompass elements of "education/awaress building through coordination/decision-making."

Questions submitted by Representative Pete Olson

Q1. From Europe's perspective, what actions should the U.S. take to strengthen our trans-Atlantic relationship in space-related capabilities and programs?

A1. The recent announcements for increasing international cooperation have been received a thoroughly positive reaction on the political as well as the agency level in Europe.

Increasing cooperation should happen in all issue areas of space activities, civilian as well as security related.

The field of space and security should be one particular focus for cooperation. In concrete terms: for jointly improving Space Situational Awareness, jointly develop space for Internal/Homeland Security and for technology developments (especially sensors). Space and climate change could be another prime focus.

The United States should be truly ready to open its market for European space components and the participation of European companies in the enlarging commercialization of United States government funded space programs.

Other areas for cooperation and coordination could be:

- Protection of the radio spectrum used by space services from harmful interference.
- Protection of the space environment and mitigation of orbital debris.
- Promotion of open, interoperable standards for space systems.
- Promotion of open international markets in space goods and services, and preventing the proliferation of ballistic missile technologies.
- Encouragement of international consultation on the development or modification of domestic regulations affecting any Commercial space sector.
- Encouragement of international cooperation through space projects that benefits all mankind, such as better understanding of the global environment and explorations beyond low Earth orbit.

Questions submitted by Representative Parker Griffith

Q1. Regarding space dominance, my question for the panel focuses on Human Space Flight Exploration. I would like to remind everyone, we currently have a capable and recently tested Constellation program intended for low earth orbit, which is managed in my district at Marshall Flight Center in Huntsville Alabama.

Could you talk about the geopolitical perception of the United States if we walked away from the current national exploration initiative and further extended the human space flight gap by turning over the mission to a commercial industry that is yet to have a human rated space exploration vehicle? How can the United States maintain its space dominance when we are reassessing the goals of human space flight exploration with presidential administration and continuing to underfund our NASA programs? What is needed for the United States to maintain its space dominance and inspire America's youth? While the United States is attempting to maintain space dominance, the financial and public support is waning as we get past 2010. How do we work to reverse this trend?

A1. These questions are addressed to United States institutions on the panel. Here a general remark from the European perspective is provided.

Seen from Europe, the United States dominance is not primarily based on its role in exploration but on its military capabilities and in general the dominating space budgets. Europe understands the recent announcements regarding enlarging international cooperation in a way that the United States does not simply want to dominate is open to a fair partnership, in which Europe is most vividly interested.

The American Youth might also be inspired by issues like the contribution of space to manage climate change and other issues of global concern.

Seen from Europe, it is difficult to understand, how dominance in the field of space exploration can be maintained without autonomous human spaceflight capabilities.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Ray A. Williamson, Executive Director, Secure World Foundation

Questions submitted by Chairwoman Gabrielle Giffords

Q1. Earlier this year the Subcommittee held a hearing on Keeping the Space Environment Safe for Civil and Commercial Users. Dealing with the issues of orbital debris and minimizing any chances of in-space collisions are critical for maintaining our activities in. space. The growing number of nations active in space certainly adds to the importance of ensuring a safe space environment. How can the United States get more countries engaged in terms of responsible space behavior? What can be done to encourage newer space nations to engage in safe space practices?

A1. One of the most important actions the United States can take in encouraging other countries to develop responsible behavior in space is to take an active part in the discussions within the UN Committee on the Peaceful Uses of Outer Space (COPUOS) and other venues where these matters are discussed. In 2009, C99UOS established the Working Group on Space Sustainability, of the COPUOS Subcommittee on Science and Technology. That Working Group will be actively working on a set of "best practices" in space that would, in the experience of experts in space operations, contribute greatly to a sustainable space environment. It is chaired by Dr. Peter Martinez of South Africa, an astronomer and key player in the development of S. Africa's space policy and young space agency.

Newer space nations are generally hungry for information and policies that would improve their changes of operating safely in outer space. The United States can help emerging space entities improve their safety of operations without jeopardizing the U.S. control of sensitive technology by informing emerging spate states about responsible space behavior and demonstrating what responsible space behavior consists of. This could be done by participating in international workshops on safe operational practices. Secure World Foundation is doing what it can by cosponsoring and taking part in workshops designed to foster adherence to the international treaties on space, establish constructive. space policies, and discuss the importance of national regulation in emerging space nations.

Q2. Recently, President Obama was in China meeting with Chinese President Hu Jintao. One of the areas they discussed was space. According to a U.S.-China Joint Statement released by the White House, the U.S. and China plan to expand discussions on space science cooperation and begin dialogue on human space flight and exploration What are your thoughts on how we should approach this dialogue? What are appropriate issues for the agenda? What areas of space science and human space flight might serve as a starting point for U.S.-China engagement?

A2. It is important for the United States to cooperate in a meaningful way with China, both to gain from China's growing scientific and applications prowess and also to establish better relations between the two countries. There are many areas of science of interest to scientists and applications experts both in China and the United States. These include terrestrial and space weather, climate change, and many areas of space exploration and human spaceflight. One way to start this process is to share scientific data and then as confidence is gained, it could be possible even to do some joint missions. Human spaceflight is more difficult because of the technology transfer issues that arise in a joint mission, but here again, dialog and sharing of data on the in-flight experiments and tests on human reaction to the space environment provide an avenue for cooperation at little risk to unwanted technology transfer. Both countries have a lot to learn in human health-related disciplines and cooperation could help.

Q3. What is the impact of U.S. export controls, particularly ITAR, on the United States' ability to reach out to emerging space nations? What would you recommend be done?

A3. U.S. export controls can certainly impede the U.S. ability to reach out to emerging space States by preventing these countries from purchasing U.S. systems and components. Meanwhile, our economic competitors, including China, are selling systems to these States and even engaging in the transfer of technology and know-how to them. This not only assists emerging space States develop indigenous capabilities, it undercuts U.S. industry. For example, as mentioned in our testimony, Venezuela purchased a communications satellite and launch from China. As part of the ar-

rangement, Venezuela sent a large team of engineers to work with Chinese engineers in the construction of the satellite and to be trained in operations. China has offered similar arrangements to other countries, including Nigeria, as part of a soft power strategy to increase its influence in regions with important strategic resources.

Because a number of countries in Latin America, Asia and Africa are planning to create their own space programs, the United; States has an opportunity to work closely with them in developing their capabilities and to guide them toward incorporating safe practices in their space activities. In order to do so, however, the terns of ITAR will need to be restructured to make it possible for countries friendly to the United States at a minimum to have access to those U.S. space technologies for which there are equivalent competing technologies in the world market. Other more sensitive technologies could be considered on a case-by-case basis.

Q4. Many of the challenges at we face as a society—climate change, ensuring the availability of clean energy and water, and protection from potential near—Earth objects that might be headed toward Earth-will require multilateral solutions. To what extent will these societal issues influence the development of global space capabilities? What its the appropriate means by which to engage emerging and established space-faring nations on such issues?

A4. All of the challenges you mention in the question will require the use of satellite technologies to understand and tackle fully. Earth-orbiting satellites alone have the capability to assess both harmful and beneficial changes in Earth's environment, no matter which country is experiencing them. Further, their synoptic view of the atmosphere, land, oceans and ice fields makes them ideal for monitoring large scale, subtle processes on Earth. However, the scale of observations needed and the cost require international cooperation both in space and on the Earth. Further, only sovereign States environmental measurements on their own soil and in order to measure climate change with accuracy and precision; scientists need local measurements.

The U.S. practice of making most civilian satellite data openly available has gone a long way to support international cooperation on these important environmental matters. Some countries, however, will need additional capacity building in the form of training and assistance to make the most effective use of those data, and they can in return make local environmental data available to U.S. researchers. Established space faring States can therefore contribute instruments and satellites and the emerging space states can contribute local data and the manpower to collect data needed by scientists. The new communication tools, such as smart phones, netbooks, and digital cameras and analytic software available in the consumer marketplace can be put to use to assist data gathering and analysis at relatively low cost.

Q5. To what extent does cooperating on space activities improve domestic national capabilities in science and technology? Does that apply to emerging space powers as well as to the United States?

A5. Scientists and engineers have discovered that cooperating on research projects with their counterparts from other countries can spur innovation in both countries because scientists from different cultures tend to approach problems from different directions even though they are working from the same basic scientific laws and data. Further, no country has the financial resources or personnel to tackle every aspect of science and engineering. As a result, countries develop specialties that contribute to diversity in scientific approaches to problems. Even emerging space powers can take a substantial part in research and development because they often specialize in areas of Earth science that are of local interest and in terrestrial and space weather research. Space weather research and monitoring, especially, depends on dispersed measurements of magnetic field intensity and direction at Earth stations located around the globe. Many countries with only modest research budgets can therefore contribute to science by taking these measurements, which require a high level of scientific sophistication but relatively small investments, and in doing so, take part in a worldwide scientific endeavor. It is a matter of fitting their contributions to their specific circumstances.

Q6. In your prepared statement you note that "It is important to assist emerging states as much as possible to develop clear policies that incorporate elements of Outer Space Treaty and the other . . . international agreements." What are your thoughts on how the U.S. should go about helping newer space States to develop space policies?

A6. Here again, continuing the U.S. constructive active involvement in UN COPUOS demonstrates to other members of COPUOS, many of whom are emerging space States, the U.S. interest in supporting the development of safe space practices and adherence to the space treaties. The United States has been very supportive of the new Working Group on Space Sustainability and has contributed several elements to the initial working document that was developed under France's leadership. In addition, U.S. involvement, through NASA, NOAA and the Department of State, in the Space Conference of the Americas in Mexico in November 2010 will go a long way toward demonstrating U.S. interest in the development of beneficial and constructive space policies. Other regions hold similar conferences that are attended by high-level officials from emerging space States and they can be influenced positively by the U.S. experience in developing policies and legislation that supports the international treaties.

Questions submitted by Representative Pete Olson

Q1. For what period of time does the US typically hold on to newly developed space technologies—whether talking about launchers, sensors or other related capabilities—before these technologies are replicated by other countries?

A1. This is an extraordinarily difficult question to answer, primarily because it differs almost on a technology-to-technology basis. There is also the challenge of classification—most often, these technologies are first developed by classified military programs and eventually make their way into commercial and civil programs. This question would best be answered by elements of the US intelligence community in a classified setting. This also assumes that work being done in the United States is not being done independently elsewhere. Europe, for example, now manufacture ITAR-free satellites that compete quite successfully with U.S. systems. This gives Europe companies far more flexibility than U.S. companies have on the world market for contracting with launch companies. Further, in certain technological arenas, such as high speed data processing, commercial technology developed for the consumer market is being inserted into the space realm in many different ways. These technologies are by their very nature available on a worldwide basis commercially.

Q2. What capabilities are the emerging space-faring nations working hardest to develop, and why? Should we be concerned?

A2. Very few emerging space-faring nations are working on capabilities that are specifically for military benefits. However, since many space capabilities have dual military and civil uses, there are likely to be at least minimal military benefits from practically any space capability. Emerging space-faring nations are developing, instrumentation, payloads and launchers. Most of the payloads tend to be spacecraft like earth-observation satellites or communications satellites, and are used primarily for civilian applications. Launchers—and very few countries are actually working to develop their own launchers—are of concern because many of these technologies can be used to create a long-range ballistic missile program. One does not necessarily lead into the other, but there is a dual-use nature to the capability needed.

The specific technologies that emerging space-faring nations concentrate on is usually a function of their overall strategy and goals for their use of space. For example, India initially focused on using their space program to provide socioeconomic benefits for their citizens, including telemedicine, communications, education and resource utilization. However, in recent years as their space program has matured, the focus has shifted toward military and defense applications, such as surveillance and imaging and even anti-satellite capabilities, and prestige applications, such as exploration of the Moon.

Q3. What are the long-term effects and strategic implications on our country's economy, our ability to engage in international collaborations, and our ability to exploit space, if we are reduced to launching a relative handful of civil missions each year?

A3. The vast majority of national security and economic benefits that the United States derives from space are a product of the non-human spaceflight programs. However, human spaceflight is a significant source of jobs; furthermore, it is a primary means by which the United States engages in cooperation in space by using space collaboration as a soft power tool of international outreach.

Q4. How closely coupled are our commercial and civil space programs, including human spaceflight, to our national security space posture? Would a reduction in

civil space R&D and infrastructure imperil the technology base and capabilities on the military side?

A4. Commercial space is a significant part of the U.S. national security space posture. In addition to providing the industrial capacity to produce the space capabilities that the U.S. military requires, the commercial space sector has also become a sort of "emergency reserve" for certain capability shortfalls. For example, 80% or more of the U.S. military's satellite communication traffic for the Middle East and Afghanistan currently travels over commercial satellite networks, because the military satellite networks cannot provide the necessary bandwidth. Remote sensing imagery is another example.

Civil space programs have less of a direct impact on the US national security space posture. There are concerns that cancellation of the human space flight program would depress the U.S. solid-rocket motor industrial base, and thus have a negative effect on US security space posture, but this would be difficult to quantify.

Questions submitted by Representative Parker Griffith

Q1. Regarding space dominance, my question for the panel focuses on Human Space Flight Exploration. I would like to remind everyone, we currently have a capable and recently tested Constellation program intended for low earth orbit, which is managed in my district at Marshall Flight Center in Huntsville Alabama. Could you talk about the geopolitical perception of the United States if we walked away from the current national exploration initiative and further extended the human space flight gap by turning over the mission to a commercial industry that is yet to have a human rated space exploration vehicle?

A1. The geopolitical perception would have more to do with the end result of such a change in policy rather than the means of doing so. The inability of the United States to continue to place humans into space and be at the forefront of space exploration could be seen globally as a sign of the weakening of American leadership in space and technology. The policy decision concerning the direction in which the American human spaceflight program proceeds should be seen in the light of which strategy is most likely to produce a successful result and strengthen the American lead in technology and space industry. The strategy should also link U.S. space goals and activities to other issues in the international arena. The problems and concerns countries have about other political and technological issues could affect how much they would be willing to cooperate with the United States on space activities.

Q2. How can the United States maintain its space dominance when we are reassessing the goals of human space flight exploration with presidential administration and continuing to underfund our NASA programs? What is needed for the United States to maintain its space dominance and inspire America's youth?

A2. Proper funding is essential for success of any major undertaking, and human spaceflight and space exploration are no different. However, the United States continues to be the preeminent space power, despite changes in our human space flight exploration program: a majority of the satellites on-orbit is owned/affiliated with the United States, and the U.S. government is a major buyer of space capabilities. It also spends more on its civil and classified military program than the spending of all other countries combined.

Inspiring America's youth is critical, but it is only part of the problem—many in recent generations are proud of NASA's accomplishments but still do not seek degrees or jobs in the scientific and technical fields. This perhaps has more to do with economics than inspiration—youth with aptitude in mathematics are likely to find the career economic opportunities in the financial or Silicon Valley world to be more alluring than those in the aerospace engineering or scientific world.

Q3. While the United States is attempting to maintain space dominance, the financial and public support is waning as we get past 2010. How do we work to reverse this trend?

A3. The United States needs a defined strategy for what it hopes to achieve in space, and then give the programs defined by the strategy sufficient resources (funding, people, high-level support) to carry it out. Otherwise it is uncertain what the United States wishes to accomplish and as such, the public, focused on economic uncertainty at home and other more tangible issues, is reluctant to throw its support behind an amorphous program.

Appendix 2:

Additional Material for the Record

THE PLANETARY SOCIETY

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November 17, 2009

Rep. Gabrielle Giffords
Rep. Pete Olson
U.S. House of Representatives
Committee on Science and Technology
Subcommittee on Space and Aeronautics
Washington DC 20515

Dear Rep. Giffords and Rep. Olson,

On behalf of the members of The Planetary Society, in both the United States and other countries, we thank you for holding a hearing on "The Growth of Global Space Capabilities: What's Happening and Why It Matters."

Global Space Capabilities help enable U.S. space interests. Human space exploration is already dependent on international space capabilities. Increased ambitions for exploration of the Martian surface and the outer planets' satellites are making robotic exploration dependent on international partners as well.

Science and exploration are intrinsically global interests, requiring global capabilities. Popular interest in space is focused on extending our human – not just our national – presence into the solar system. This is readily apparent in the positive public support for international cooperation in space.

In addition to exploring other worlds, understanding our own world demands global resources. Coping with the enormous environmental questions related to climate change on Earth requires international data and international assets.

Commercial space activities also benefit from global space capabilities. The expanded space market and expanded space resources enable American aerospace industry to develop and grow. Such opportunities encourage American entrepreneurs to develop new products and services.

The Planetary Society has extensive experience in international space cooperation. We have worked with Russian, European and Japanese space organizations. Currently, we are participating on the Russian Phobos-Grunt mission and are working cooperatively with the Japanese on their Venus Climate Orbiter/ IKAROS Solar Sail venture. We are a consultative member of the UN Committee on Peaceful Uses of Outer Space and hold membership in the International Astronautical Federation and COSPAR. We also have in depth experience with the International Traffic in Arms Regulations (ITAR), including with several Technical Assistance Agreements and export control licenses. We know first-hand the inhibiting effect of ITAR on American space interests.

Looking to the future, The Planetary Society advocates even closer international collaboration, including creating an international lunar outpost or way-station for human and robotic development, an international Mars sample return mission and a human exploration of Mars.

We thank you again for holding these hearings and offer our support to the Committee to advance considerations of international cooperation in space.

Sincerely,

Louis Friedman
Executive Director

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