COMMERCIAL SPACE

HEARING

BEFORE THE

SUBCOMMITTEE ON SPACE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED THIRTEENTH CONGRESS

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November 20, 2013

COMMERCIAL SPACE

WEDNESDAY, NOVEMBER 20, 2013

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

The Subcommittee met, pursuant to call, at 10:02 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Steven Palazzo [Chairman of the Subcommittee] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

EDDIE BERNICE JOHNSON, Texas
RANKING MEMBER

Congress of the United States
House of Representatives
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Subcommittee on Space

Commercial Space

Wednesday, November 20, 2013
10:00 a.m. to 11:30 a.m.
2318 Rayburn House Office Building

Witnesses

Panel I

The Honorable Kevin McCarthy, Member, Majority Whip, U.S. House of Representatives

Panel II

Ms. Patricia Cooper, President, Satellite Industry Association

Mr. Stuart Witt, CEO and General Manager, Mojave Air and Space Port

Mr. Dennis Tito, Chairman, Inspiration Mars Foundation

U.S. House of Representatives
Committee on Science, Space, and Technology
Subcommittee on Space

"Commercial Space"

CHARTER

Wednesday, November 20, 2013
10:00 a.m. – 11:30 a.m.
2318 Rayburn House Office Building

Purpose

At 10:00 a.m. on Wednesday, November 20, 2013, the Subcommittee on Space will hold a hearing titled "Commercial Space." The hearing will examine ways in which companies are utilizing federal support and government policies to grow their commercial businesses in space launch, communications, GPS, remote sensing, weather monitoring, suborbital tourism and science experimentation, and human spaceflight. The witnesses will also address what government policies would be helpful to U.S. commercial space industry. The witnesses have been asked to specifically address the policies contained in H.R. 3038, the Suborbital and Orbital Advancement and Regulatory Streamlining (SOARS) Act.

Witnesses

Panel I

- **The Honorable Kevin McCarthy** – Member, Majority Whip, U.S. House of Representatives

Panel II

- **Ms. Patricia Cooper** – President, Satellite Industry Association
- **Mr. Stuart Witt** – CEO and General Manager, Mojave Air and Space Port
- **Mr. Dennis Tito** – Chairman, Inspiration Mars Foundation

Background

Since the first FAA licensed commercial launch in 1989, the FAA Office of Commercial Space Transportation (FAA-AST) has issued 217 launch licenses[1] and there are 17 active launch licenses for the 2014-2018 timeframe.[2] While predicting the growth of the commercial launch

[1] Website for the Office of Commercial Space Transportation, retrieved on 10/23/2013 at http://www.faa.gov/about/office_org/headquarters_offices/ast/launch_license/licensed_launches/historical_launch/

[2] Website for the Office of Commercial Space Transportation, retrieved on 10/23/2013 at http://www.faa.gov/about/office_org/headquarters_offices/ast/launch_license/active_licenses/

market is notoriously difficult, the data demonstrates steady growth in the last decade with the potential for further growth in the coming decade.[3]

Every two years FAA-AST issues a report summarizing the economic impacts of Commercial Space Transportation and Enabled Industries (CST&EI). The most recent reported released in 2009 estimated the total economic activity generated by CST&EI to be $208.3 billion.[4] This includes satellite manufacturing, satellite services such as direct-to-home television and satellite data services, ground equipment manufacturing, satellite remote sensing, and distribution industries which are used to move parts to manufacturing sites.[5]

Some of the challenges facing by the commercial space industry include outdated regulations and federal laws, compliance with federal export control regimes, and international competition. Commercial space industry also leverages the investments made by federal government agencies, like various agencies of the Department of Defense, NASA, and NOAA, as part of their business plan. Future growth in the U.S. commercial space sector will be highly dependent on the federal government providing a legal and regulatory framework as well as a stable budget and program plans.

H.R. 3038 – The Suborbital and Orbital Advancement and Regulatory Streamlining Act
The SOARS Act was introduced by Representative Kevin McCarthy (CA-23) and Representative Bill Posey (FL-8). This bill seeks to update the Commercial Space Launch Act to reflect current and future trends in the suborbital and orbital space industry. The bill seeks to streamline the permitting and licensing process at FAA-AST and clarify the distinction between experimental and non-experimental vehicles.

Key Questions

- What is the proper government role in regulating the commercial space sector?
- What are the greatest challenges to the continued growth of a vibrant commercial space market?
- Does the current regulatory framework facilitate innovation?
- How do current agency processes affect the market (both interagency and interagency)?
- How does the U.S. compare with other nations when it comes to preserving its space industrial base and incubating the emerging commercial market?
- What are the most promising areas of economic growth in commercial space?
- How has the private capital market responded to shrinking government budgets, and how has this impacted the commercial space sector?
- What opportunities exist for public-private partnerships?

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[3] FAA Office of Commercial Space Transportation Annual Launch Forecast, May 2013, retrieved on 11/8/2013 at https://www.faa.gov/about/office_org/headquarters_offices/ast/media/2013_GSO_NGSO_Forecast_Report_June.pdf

[4] FAA Report "The Economic Impact of Commercial Space Transportation on the U.S. Economy in 2009", September 2010, retrieved on 11/12/2013 at http://www.faa.gov/news/updates/media/Economic%20Impact%20Study%20September%202010_20101026_PS.pdf

[5] *Ibid.*

Chairman PALAZZO. The Subcommittee on Space will come to order. Good morning. Welcome to today's hearing titled "Commercial Space." In front of you are packets containing the written testimony, biographies, and required Truth in Testimony disclosures for today's witnesses. I recognize myself for five minutes for an opening statement.

The Commercial Space Launch Act was passed nearly 30 years ago and was the turning point for the growth of the commercial space sector in our economy. The advent of the commercial space industry brought with it advances in space launch: communications; entertainment; position, navigation, and timing technology; weather monitoring; remote sensing; space tourism; science experimentation; and expanded human spaceflight.

The latest data available suggests the economic impact of the commercial space industry is approximately $208 billion. Congress has provided the Federal Government with various mechanisms to leverage the private sector, such as the Commercial Orbital Transportation Services Program and the Commercial Crew Program, FAA experimental permits, human spaceflight regulation moratorium, prize authority, and various public-private partnership authorities.

As Congress continues to look for ways to maintain the United States' preeminence in space and grow our economy, it is clear that the promise of the commercial space industry warrants additional attention.

We must ensure that export controls and International Trafficking in Arms Regulations are rational and productive. We need to provide stable, certain, and competitive regulatory environments at the Federal Aviation Administration, the Federal Communications Commission, and the National Oceanic and Atmospheric Administration that facilitate domestic investment.

There is no question that our commercial partners have a valuable role to play in our Nation's space flight and exploration in the coming years. But there will be trade-offs.

We must continue to weigh whether potential cost-savings come at the expense of overall capabilities, robustness, or safety. We must also recognize there are core, fundamental operations that will still need to be maintained by the Federal Government.

The witnesses before us today represent a variety of perspectives on the commercial space industry, and I look forward to hearing their testimony. We are also pleased to have or will have the Majority Whip, Representative Kevin McCarthy, with us today. Representative McCarthy, along with Representative Bill Posey, introduced H.R. 3038, the Suborbital and Orbital Advancement and Regulatory Streamlining Act or SOARS Act.

The Committee appreciates their leadership and willingness to work with us in developing policies that can grow our economy. Next year we hope to take up a comprehensive commercial space bill to address these issues, as well as many others.

The commercial space industry has been invaluable to our successes in the past, and the future continues to look very bright. I look forward to working with my colleagues on both sides of the aisle as well as with industry stakeholders to come up with com-

mon-sense policies that can help put people back to work, retain our skilled aerospace workforce, and protect our industrial base.

Finally I would like to address the perennial elephant in the room, commercial launch liability. This provision, which is so important to keeping our launch industry competitive in the international market, is set to expire once again at the end of the year. The NASA Authorization Act that passed this Committee over the summer included an extension for five years.

While I would have liked to see a long-term extension, it appears as though we have reached an agreement with the minority to only extend the provision for one year and take the issue up more thoroughly next year as part of a larger Commercial Space Launch Act.

I look forward to sponsoring this extension, along with Chairman Smith, Ranking Member Johnson, and Ranking Member Edwards. I hope we can discharge the bill and pass it under suspension of the rules on the House floor very shortly.

[The prepared statement of Mr. Palazzo follows:]

PREPARED STATEMENT OF SUBCOMMITTEE ON SPACE CHAIRMAN STEVEN PALAZZO

The Commercial Space Launch Act was passed nearly thirty years ago and was the turning point for the growth of the commercial space sector in our economy. The advent of the commercial space industry brought with it advances in space launch: communications; entertainment; position, navigation, and timing technology; weather monitoring; remote sensing; space tourism; science experimentation; and expanded human spaceflight.

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Chairman PALAZZO. With that yield the remainder of my time to my friend from Florida, Mr. Posey.

Mr. POSEY. Thank you very much, Mr. Chairman. Over a half-century ago Congress established the Federal Aviation Administration with the mission of ensuring the safety of the flying public. Today the FAA requires that new experimental vehicles designed to probe the fringes of outer space be as safe as a commercial airliner. Had the same stringency been applied to the automobile, Henry Ford's Model T might have never made it onto the streets. That is the situation that our country's space pioneers are faced with today.

Under current U.S. law, the experimental launch vehicles and experimental aircraft supporting them can be designed, built, and flown by our most innovative companies. But they can't charge for their services. Representative Kevin McCarthy and I introduced H.R. 3038, the SOARS Act, to change that.

There is a private company at the Kennedy Space Center which NASA hired and the FAA licensed to conduct astronaut training and payload testing. I should say was licensed. Two years ago the FAA decided they made a mistake in allowing the company to fly their FAA-defined "experimental" aircraft in support of NASA's launch activities and so the FAA grounded them. Now, obviously that was very bad news for the company, and that was a 100 percent safety record at NASA. It defies common sense that a long-standing NASA partner can be arbitrarily grounded by the FAA. We need to fix the problem by updating our laws so our space innovators have the freedom they need to innovate and regulators, such as the FAA, have the appropriate amount of flexibility to strike the right balance. Congressman McCarthy and I believe this bill will do that.

Thank you, Mr. Chairman. I yield back.

Chairman PALAZZO. Thank you, Mr. Posey. With that I yield to the Ranking Member, the gentlewoman, Ms. Bonamici.

Ms. BONAMICI. Thank you very much, Mr. Chairman, for holding today's hearing on commercial space, and welcome to our witnesses. Subcommittee Ranking Member Donna Edwards will join us shortly, and she asked me to take her place until then.

Mr. Chairman, the Ranking Member also asked that her opening statement be included for the record.

Ms. BONAMICI. As many of the Committee Members have stated, on several occasions, we see a strong link between the space program and the inspiration it provides to our younger generation through various STEM activities. Commercial space is an important component of that inspiration and a key source of jobs and innovation.

The commercial satellite industry has experienced strong and steady growth over several years. I hope to hear today about what factors have contributed to such growth and how other commercial space ventures might learn from their successes.

The audacious proposal from Mr. Tito and the entrepreneurial spirit overflowing at Mr. Witt's Mojave Space Port demonstrate that America's yearning for deep space exploration and thirst for innovation are alive and well. But maintaining such enthusiasm requires a well-oiled partnership between the Federal Government, states, private industry and academia.

Thankfully there are many indications to show that this partnership is alive and well. Just yesterday the first high school developed CubeSat was launched along with other payloads aboard the Air Force's ORS–3 mission on a Minotaur 1 rocket from NASA's Wallop Facility. The Thomas Jefferson High School's CubeSat, known as TJ3Sat is a joint project between the high school and industry partners to design and build the CubeSat to increase interest in aerospace technology.

And a few weeks ago, I was pleased to see, from my home state the Oregon Space Grant Consortium, which promotes STEM education through cooperative and interdisciplinary programs while recruiting and training NASA's next diverse workforce announced its 2013–2014 scholarship recipients. This consortium, part of the National Space Grant College and Fellowship Program, is a statewide network of universities, colleges, museums, educators, researchers, students and science professionals. Each of the scholarship recipients has expressed an interest in seeking a future in the aerospace, science or education community and has attained the highest level of academic achievement.

Our partnerships among government, industry, states and academia need to match their goals, dedication and high achievement with challenging and engaging work.

So today I hope I get to hear our witnesses discuss their views on the state of the U.S. space workforce, how important STEM activities are to cultivating the skills that commercial space companies need, and what it will take to build the type of workforce that will eventually lead to our U.S. commercial space activities into the next century. Let us keep their inspiration alive by finding greater opportunities for partnership.

Thank you very much, Mr. Chairman, again for holding this hearing, and I yield back the balance of my time.

[The prepared statement of Ms. Bonamici follows:]

PREPARED STATEMENT OF REPRESENTATIVE SUZANNE BONAMICI

Thank you, Mr. Chairman, for holding today's hearing on "Commercial Space," and welcome to our witnesses. Subcommittee Ranking Member Donna Edwards will join us shortly. She has asked me to take her place until then. Mr. Chairman, the Ranking Member also asked that her opening statement be included for the record.

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Chairman PALAZZO. Thank you, Ms. Bonamici. I now recognize the Chairman of the Full Committee for a statement.

Chairman SMITH. Thank you, Mr. Chairman, and I thank you, too, for having this hearing today. And I want to thank our witnesses for being here as well to share their expertise on this subject.

It is appropriate, and I know he will be here momentarily, to have Representative McCarthy join us today to discuss his bill, H.R. 3038, the SOARS Act. This legislation seeks to streamline the regulatory process. It also amends parts of the Commercial Space Launch Act to provide clarity regarding new systems and how they are defined. Reducing red tape for our space entrepreneurs is a necessary step to ensuring their continued growth.

The commercial space industry offers improvements to the quality of life for every person on the planet. The discoveries and applications that have come from space technology number in the hundreds. The storied past of American ingenuity and exceptionalism is filled with examples of entrepreneurs who pushed the boundaries of the possible. The commercial space industry relies on this same creative spirit.

America has always been a Nation of innovators and explorers. We continue to remain on the forefront of new discoveries and technologies. This industry could yield results that blur the lines between science fiction and science fact. Students of tomorrow could go to college to study a whole new field that resulted from the development of private space exploration.

Perhaps in the next 20 years we will see new technologies and business models that result in private space laboratories. For example, advances in the suborbital space industry could yield the potential to send a package or people from New York to Hong Kong

in a matter of minutes. The applications of this type of travel are limitless.

And Mr. Chairman, I know you are going to more formally introduce our witnesses in just a minute, but I want to mention a couple of items about them as well.

One of our witnesses today is Mr. Dennis Tito, Chairman of the Inspiration Mars Foundation. This foundation is the type of private space endeavor we should encourage. Their mission to send humans to orbit Mars in eight years or less, using mostly existing technology, might well catch the public's imagination.

We are also pleased to have Mr. Stuart Witt, CEO of the Mojave Air and Space Port and a former test pilot and Top Gun with us today as well. There are exciting things happening in the Mojave Desert, and I have been there myself. The work of private companies and the space port add great value to our Nation's space assets.

Our final witness represents an often-overlooked part of the commercial space industry that has actually been around for a long time. Patricia Cooper is the President of the Satellite Industry Association, and the commercial satellite industry provides many of our modern conveniences and we are grateful for her perspective as well.

I look forward to today's hearing and to working with my colleagues on both sides of the aisle to develop policies that encourage the growth of the commercial space industry.

Thank you Mr. Chairman for the time, and I yield back.

[The prepared statement of Mr. Smith follows:]

PREPARED STATEMENT OF COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
CHAIRMAN LAMAR S. SMITH

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I look forward to today's hearing and to working with my colleagues on both sides of the aisle to develop policies that encourage the growth of the commercial space industry.

Thank you Mr. Chairman, and I yield back.

Chairman PALAZZO. Thank you, Chairman Smith. If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

Chairman SMITH. Mr. Chairman, may I asked to be recognized just for a second more? I want to apologize to the witnesses and express my regret that another committee that I serve on is having a mark-up, and I am going to have to leave soon for that mark-up so regret I won't be able to be here the whole time.

Chairman PALAZZO. Thank you, Chairman Smith. At this time we are just going to take a brief respite as we await the Majority Whip's arrival.

[Recess.]

Chairman PALAZZO. At this time I would like to introduce our first witness, The Honorable Kevin McCarthy, the Majority Whip of the House of Representatives and the Representative from California's 23rd District. Mr. McCarthy, your spoken testimony is limited to five minutes. Your written testimony will be included in the record of the hearing. I now recognize our first witness, Mr. McCarthy for five minutes.

TESTIMONY OF HON. KEVIN MCCARTHY, MAJORITY WHIP, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Hon. MCCARTHY. Well, thank you, Mr. Chairman, for holding this important hearing today and for allowing me the opportunity to testify in support of commercial space and the Suborbital and Orbital Advancement and Regulatory Streamlining, the SOARS Act. I want to also thank Congressman Posey for working with me to introduce this important legislation and his support for commercial space.

America is built on a strong heritage of exploration, discovery, and innovation. From President Thomas Jefferson's commissioning of the Lewis and Clark Expedition to exploring the American West, to the Transcontinental Railway linking east and west together, to the public-private partnership that helped the airline industry grow to become a safe mode of travel all over the world, to the internet, which has generated as much economic growth in 15 years as the Industrial Revolution did in 50.

Space, like the internet before the dot-com boom of the 1990s, was originally a government-run enterprise. Many believe that the commercial spaceflight is poised to have its own dot-com moment in the near future. NASA's Commercial Crew and Cargo program alone has already created thousands of high-quality jobs here in America, including many at the NASA Dryden Flight Research

Center, which I represent. My district is also home to Mojave Air and Space Port where many commercial spaceflight companies have located to research, develop, and test their hardware that will soon take Americans back to space.

This is why I support the commercial spaceflight industry: the creation of thousands of good paying jobs on U.S. soil and the continuation of America's legacy in space exploration and innovative technologies. Think about this: Over the last 50 years, about 500 humans have been to space. With the commercial space market, the number could double over the next ten years with the government only serving as a customer. The next U.S. astronauts to fly to space on American rockets will do so because of this new model.

The use of innovative public-private partnerships offers the government new ways of solving problems. A study shows these partnerships benefit the taxpayer, by providing space services at nearly 1/10 the cost of traditional contracting methods, getting results for less money, getting innovation, growth, and risk-sharing in the private sector. As NASA leads continued exploration missions and related technology development, entrepreneurs will follow, spending their own money and creating new industries.

However, it is up to us as legislators to ensure our current regulatory environment is appropriate for the needs of the 21st Century and to make sure safety is paramount in the commercial spaceflight industry's endeavors. This is why I introduced H.R. 3038 to ensure that the U.S. commercial spaceflight industry has a clear path ahead as it continues to innovate and generate high-quality American manufacturing jobs. A robust commercial space industry will also help attract students to the STEM fields of education by inspiring the next generation to literally reach for the stars.

The goal of this bill is to streamline the regulatory process for commercial spacecraft, ensuring that Americans remain a leader in commercial spaceflight, while providing the Secretary of Transportation the necessary tools to help the industry operate safely. The commercial spaceflight industry is one of our newest, fastest-growing, and most innovative industries, and I am proud that the Dryden Flight Research Center and the Mojave Air and Space Port are leading the way.

And if we take the right steps, we won't be just launching rockets, we will be launching new careers, new industries, and new economic opportunities. Whenever I visit these facilities—and I will tell you, when you hear from Stu Witt later—I go to Mojave Air more than any place else in my district because it is innovative, it is fast-moving and it is ever-changing. It is not just changing for California and the United States. It is changing the world. And we are doing it in a private-public partnership that has been seen no other place.

So the real possibilities will continue to grow. Again, you will hear from Mojave's Executive Director, Stu Witt, who is also testifying today. But this legislation, along with Congressman Posey is very simple. It is streamlining to make sure we keep the safety but also maintain the growth and the leadership for America in spaceflight.

Mr. Chairman, thank you for allowing me to testify today, and I yield back my time.

[The prepared statement of Hon. McCarthy follows:]

OPENING STATEMENT
Hearing on H.R. 3038, the Suborbital and Orbital Advancement and Regulatory Streamlining (SOARS) Act
Science, Space, and Technology Subcommittee on Space
Chairman Steven Palazzo | Ranking Member Donna Edwards
November 20, 2013
2321 Rayburn – 10AM

By Rep. Kevin McCarthy

Thank you Mr. Chairman for holding this important hearing today and for allowing me the opportunity to testify in support of commercial space and the Suborbital and Orbital Advancement and Regulatory Streamlining (SOARS) Act. I want to also thank Congressman Posey for working with me to introduce this important legislation and for his support for commercial space.

America is built on a strong heritage of exploration, discovery, and innovation. From President Thomas Jefferson's commissioning of the Lewis and Clark Expedition to explore the American west, to the Transcontinental Railroad linking east and west together, to the public-private partnership that helped the airline industry grow to become a safe mode of travel all over the world, to the internet, which has generated as much economic growth in 15 years as the Industrial Revolution did in 50.

Space, like the internet before the ".com" boom of the 1990's, was originally a government run enterprise. Many believe that the commercial spaceflight is poised to have its own ".com" moment in the near future. NASA's Commercial Crew and Cargo program alone has already created thousands of high-quality jobs here in America—including many at the NASA Dryden Flight Research Center, which I represent. My district is also home to the Mojave Air and Space Port where many commercial spaceflight companies have located to research, develop, and test their hardware that will soon take Americans back to space. This is why I support the commercial spaceflight industry – the creation of thousands of good paying jobs on U.S. soil and the continuation of America's legacy in space exploration and innovative technologies.

Think about this: Over the last 50 years, about 500 humans have been to space. With the burgeoning commercial space market, that number could double over the next 10 years with the government only serving as a customer. The next U.S. astronauts to fly to space on American rockets will do so because of this new model.

The use of innovative public-private partnerships offers the government new ways of solving problems. A study shows these partnerships benefit the taxpayer, by providing space services at nearly one-tenth the cost of traditional contracting methods; getting results for less money; and catalyzing innovation, growth, and risk-sharing in the private sector. As NASA leads continued exploration missions and related technology development, entrepreneurs will follow, spending their own money and creating new industries.

However, it is up to us as legislators to ensure our current regulatory environment is appropriate for the needs of the 21st Century and to make sure safety is paramount in the commercial spaceflight industry's endeavors.

This is why I introduced H.R. 3038 to ensure that the U.S. commercial spaceflight industry has a clear path ahead as it continues to innovate and generate high-quality American manufacturing jobs. A robust commercial space industry will also help attract students to the STEM fields of education by inspiring the next generation to literally reach for the stars. The goal of this bill is to streamline the regulatory process for commercial spacecraft, ensuring that America remains a leader in commercial spaceflight, while providing the Secretary of Transportation the necessary tools to help the industry operate safely.

The commercial spaceflight industry is one of our newest, fastest-growing, and most innovative industries, and I am proud that Dryden Flight Research Center and the Mojave Air and Space Port are leading the way. And if we take the right steps, we won't just be launching rockets, we will be launching new careers, new industries, and new economic opportunities. Whenever I visit these facilities, I am awestruck by the technology the companies are developing there, and the incredible men and women who make it all possible, especially Mojave's executive director, Stu Witt, who is also testifying today.

Mr. Chairman, thank you for allowing me to testify today. I yield back my time.

Biography for Majority Whip Kevin McCarthy
Hearing on H.R. 3038, the Suborbital and Orbital Advancement and Regulatory Streamlining (SOARS) Act
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Congressman Kevin McCarthy represents the 23rd District of California, which spans Kern, Tulare, and Los Angeles counties. First elected in 2006, Kevin is a native of Bakersfield and a fourth-generation Kern County resident. He is committed to policies that give small businesses and entrepreneurs the confidence they need to hire, expand, invest and innovate. After the 2010 midterm elections, Kevin was elected by his colleagues to serve as Majority Whip of the United States House of Representatives.

Kevin started his own small business before the age of 21. He built Kevin O's Deli from the ground up, even enlisting his father's help in building the deli's counter in their garage. He worked hard, hired employees and enjoyed success in his community. That's also where he first encountered government overregulation. The countless frivolous and redundant rules, as well as the taxes small businesses like his were burdened with, spurred Kevin's interest in public service. When Kevin sold his business, he used the profits to put himself through college and graduate school. He received both his undergraduate degree and his Masters in Business Administration from California State University, Bakersfield.

During college, Kevin accepted an internship with then-Congressman Bill Thomas, and soon became a member of Congressman Thomas's staff. Kevin won his first election in 2000 as Trustee to the Kern Community College District. In 2002, McCarthy was elected to represent the 32nd Assembly District in the California State Assembly. As a freshman legislator, he was selected unanimously by his Republican colleagues to serve as the Assembly Republican Leader, becoming the first freshman legislator and the first legislator from Kern County to assume the top Republican post in the California State Assembly. Kevin worked with his colleagues in the Assembly and Senate and with the Governor to reduce California's budget deficit, overhaul the state worker's compensation system and enhance California's business climate to create more opportunities for California workers and businesses until he ran for Congress in 2006.

Kevin brings his personal experience as a small business owner and as an effective leader in the statehouse to Washington D.C. In his role as Majority Whip, Kevin leads the effort in Congress to advance common sense policies that will put America back on the path to prosperity. Since gaining control of the House in November 2010, Kevin and his Republican colleagues have blocked the largest tax increase in American history, cut out-of-control government spending by historic levels and passed numerous pieces of legislation that will help create jobs in America. These bills reduce the burden on small businesses, increase our nation's energy security by promoting domestic energy production, knock down barriers for small business owners to access capital and help increase certainty for the private sector.

Kevin will continue to fight to get Washington's fiscal house in order while promoting policies that empower the private sector to invest and create jobs.

When Kevin is not in Washington fighting for the constituents of California's 23rd District and for the future of America, he is home in Bakersfield with his wife Judy and two children Connor and Meghan.

Chairman PALAZZO. I thank Mr. McCarthy for his valuable testimony. The witness is excused, and we will move to our second panel.

Hon. MCCARTHY. Thank you.

Chairman PALAZZO. Our first witness is Ms. Patricia Cooper, President of the Satellite Industry Association. Our second witness is Mr. Stuart Witt, CEO and General Manager of the Mojave Air and Space Port, and our third witness is Mr. Dennis Tito, Chairman of the Inspiration Mars Foundation.

As our witnesses should know, spoken testimony is limited to five minutes each after which Members of the Committee have five minutes each to ask questions. Your written testimony will be included in the record of the hearing.

I now recognize our first witness, Ms. Cooper, for five minutes.

TESTIMONY OF MS. PATRICIA COOPER, PRESIDENT, SATELLITE INDUSTRY ASSOCIATION

Ms. COOPER. Mr. Chairman, distinguished Members of the Subcommittee, thank you for inviting the Satellite Industry Association to testify today on Commercial Space.

As the President of SIA, I am pleased to represent here the unified voice of the Nation's satellite industry including satellite operators, manufacturers, launch companies and service and ground equipment providers.

Our sector pioneered the commercialization of space. Just over 50 years ago, Telstar 1 was launched as the first privately owned satellite. Today, fleets of satellites ring the globe, owned and operated by private companies from around the world.

For the past 16 years, SIA has been tracking our sector's performance in an annual State of the Satellite Industry Report. Our most recent report, issued in October, showed global satellite industry revenues of nearly $190 billion last year, more than 60 percent of the world's entire space sector. The United States represents just under 45 percent of the global satellite industry, and U.S. satellite companies employ more than 225,000 Americans across all sectors.

Commercial satellites are used to deliver services to every ZIP code in the United States and every continent. Satellite services directly for consumers are the engine driving industry's overall growth. Satellite TV services alone earned nearly $90 billion in global revenue last year, joined with satellite radio, satellite broadband and new services like in-flight broadband for airline passengers.

Satellites also deliver hundreds of channels of media and broadcasting content everywhere as seen in the iconic tagline live via satellite and the ubiquitous satellite news truck.

Behind the scenes we also link far-flung businesses, extend cellular and telecom networks, power emergency communications for first responders and military communications for national security, and capture the Earth with remote-sensing imagery used for everything from agriculture to humanitarian assistance and Google Earth.

Satellites are an instant infrastructure that is reliably available every day, everywhere around the world, and we look to govern-

ments to maintain certain policy and market conditions to sustain our industry and pave the way for our growth and ongoing innovation.

I would like to highlight here four key aspects that drive the way we think about government policies. First, the satellite industry has particularly long business horizons. Satellite orders are typically placed two years before they are launched, and once on orbit last about 15 years.

While economic and competitive conditions shift, satellite companies thrive with consistent regulatory and business environments. We look for swift and effective licensing for satellites and ground terminals and stable regulatory fees. Dramatic changes in government regulations and policies simply put at risk the hundreds of millions of dollars required to finance the manufacture, launch and operation of a commercial satellite.

Second, the satellite industry is inherently international. We serve entire continents or hemispheres, and U.S. satellite manufacturers compete in a dynamic global marketplace. As a result, international policies and fair trade rules are essential. Congress recently took an important step to support U.S. satellite exports when it passed the 2013 National Defense Authorization Act which permits needed updates to the U.S. export controls on satellite technologies. These reforms, which are now being implemented by the Executive Branch, will assist the long-term competitiveness of U.S. satellite manufacturers, and for that we offer our appreciation.

Third, the satellite industry relies on radio frequency spectrum. Not only is spectrum used to fly our satellites but it is the lifeblood of the vast array of communication services provided via satellite. Without spectrum satellites simply would not function.

The telecommunications industry is currently being consumed by a debate over how to allocate spectrum, and satellite frequencies are among those targeted for sharing or wholesale repurposing. The satellite industry has long supported efficient and sensible satellite spectrum policies, but changes require respect for existing critical services and an understanding of the demands of communicating with spacecraft tens of thousands of miles away. Shifts in spectrum policy must be careful, objective and fact-driven to avert serious implications for satellite systems.

Finally, the satellite industry is keenly focused on managing risk. Satellites must be robust enough to navigate a technically challenging launch campaign and survive the harsh environments of outer space. We have close ties with the financial and insurance industries that allow us to mitigate these unique risks and meet the high, up-front costs of these satellite projects. While most financing is provided by the private sector and rightfully so, governments around the world have also stepped in to provide export credit financing for international sales of satellites. SIA encourages Congress to continue to support a strong U.S. Export/Import Bank to allow U.S. manufacturers to compete internationally.

Finally, governments have offered indemnification against lawsuits resulting from catastrophic launch failures. Although this protection has never been drawn upon, the U.S. Government should offer safeguards comparable to other leading space-faring nations.

SIA strongly supports extending this regime for a minimum of ten years if not permanently.

In our more than 50 years of experience the satellite industry has harnessed the power of space to serve national security, connect every corner of the globe and deliver entertainment to people on every continent. We fly 1/3 of the satellites on orbit and have posted ten percent average annual growth over the past decade, sustaining a robust worldwide space economy. The satellite industry is proud to lead the way for the safe, successful and sustained commercialization of space.

Mr. Chairman, distinguished Members of the Subcommittee, this concludes my testimony. On behalf of the members of the Satellite Industry Association, thank you for the opportunity to testify, and I look forward to your questions.

[The prepared statement of Ms. Cooper follows:]

Written Testimony for Patricia A. Cooper

President, Satellite Industry Association (SIA)

Before the House Committee on Science, Space, and Technology

Subcommittee on Space

Hearing on Commercial Space

November 20, 2013

Introduction

Mister Chairman, Ranking Member Edwards, distinguished members of the Subcommittee, thank you for inviting the Satellite Industry Association (SIA) to testify today on Commercial Space. I commend Chairman Palazzo and Ranking Member Edwards for their leadership, and thank the members of the Subcommittee for your continued focus on the commercial space industry.

As the President of SIA[1], I am pleased to represent here the unified voice of the nation's satellite industry. Our Association's members build and launch spacecraft for both commercial and government customers, operate hundreds of commercial satellites that connect the world with voice, video, and data, and manage satellite ground facilities across the nation and the world to link the communications network. Our customers range from the U.S. military, first responders, the world's entertainment industry, Fortune 500 enterprises, leading retailers and financial institutions, and individual consumers in every corner of the world.

The satellite sector pioneered the commercialization of space. Just over 50 years ago, Telstar 1 was launched as the first commercial satellite, marking the starting point for the commercialization of space. Today, fleets of satellites ring the globe, owned and operated by private companies from around the world. Commercial satellite operators control more than one third of all operational satellites on orbit. In fact, the members of the Satellite Industry Association collectively operate the largest fleet of spacecraft in the world.

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[1] SIA Executive Members include: Artel, LLC; The Boeing Company; The DIRECTV Group; EchoStar Satellite Services LLC; Harris CapRock Communications; Hughes Network Systems, LLC; Intelsat S.A.; Iridium Communications Inc.; Kratos Defense & Security Solutions; LightSquared; Lockheed Martin Corporation.; Northrop Grumman Corporation; Rockwell Collins Government Systems; SES Americom, Inc.; and SSL. SIA Associate Members include: AIS Engineering, Inc.; Astrium Services Government, Inc.; ATK Inc.; Cisco; Cobham SATCOM Land Systems; Comtech EF Data Corp.; DigitalGlobe; DRS Technologies, Inc.; Encompass Government Solutions; Eutelsat, Inc.; Globecomm Systems, Inc.; Inmarsat, Inc.; ITT Exelis; Marshall Communications Corporation.; MTN Government; NewSat America, Inc.; O3b Networks; Orbital Sciences Corporation; Panasonic Avionics Corporation; Row 44, Inc.; Spacecom, Ltd.; Spacenet Inc.; TeleCommunication Systems, Inc.; Telesat Canada; The SI Organization, Inc.; TrustComm, Inc.; Ultisat, Inc.; ViaSat, Inc., and XTAR, LLC.

For the past sixteen years, SIA has been tracking the performance of the global satellite industry in our annual State of the Satellite Industry Report. Our most recent report, updated in October, looked at 2012 trends, and showed a global commercial satellite industry posting nearly $190 billion in revenue. This figure represented more than 60 percent of all space spending worldwide. All four segments of the industry – satellite services, manufacturing, launch, and ground equipment – grew in 2012, as the industry as a whole posted growth of seven percent. Services provided directly to consumers, and in particular satellite TV, continued to be the engine driving the industry's overall growth. Satellite TV services alone earned nearly $90 billion in global revenue last year. The U.S. portion of the global industry continues to be substantial, as roughly 44 percent of global revenues can be attributed to the domestic U.S. market. Satellite sector employment also continues to be substantial, though it has declined slightly in recent years due to the effects of the recession. Private companies in the satellite industry employ more than 225,000 Americans, and this workforce is among the most technically skilled and well-compensated of any U.S. industry.[2]

At the outset of the space age, outer space was the provenance of only a handful of the most advanced countries. Today, more than 50 countries operate satellites, either on their own or as part of a regional consortium. Interest in joining the community of satellite operators has been particularly strong in recent years, with twelve new countries joining this fraternity since 2008. New entrants are attracted not only by the prestige of becoming a space player, but by the proven value of tapping space-enabled services to meet the real-world demands of citizens everywhere for more connectivity, more bandwidth, more entertainment, and more security.

Commercial satellite operators are driven to innovate by building new spacecraft, by delivering ever-more flexible and mobile applications, and by engineering more resilient networks. This drive is rooted in the explosion in demand for communications – on-demand and high-resolution media, more bandwidth for broadband to homes, cars, aircraft, ships, and phones, and more flexible and resilient enterprise networks for business and government. Satellite service providers are focusing on information assurance, managed services, and reaching consumers on the go. Satellite operators are continuing to update and expand their fleets to meet this surge in requirements. Satellite manufacturers are rolling out ever more capable technologies to reduce costs, enhance on-orbit operations and carry the high-throughput services demanded by today's communications environment. And satellite launch service providers are investing in next-generation launch capabilities to carry these satellites into orbit reliably and efficiently. The satellite sector's track record demonstrates that commercial space actors are innovative, adaptive, and driven to serve a competitive marketplace that has experienced tectonic shifts in demand and in technology.

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[2] Satellite Industry Association, "State of the Satellite Industry Report," October 2013, http://www.sia.org/wp-content/uploads/2013/10/2013_SSIR_Final_Oct.pdf

The essence of commercialization is the ability of private industry to deliver goods and services that are valued by another party. Private companies flourish when marketplace conditions encourage competition and growth. In the satellite sector, these conditions include a stable regulatory, financial, and policy environment, secure access to radiofrequency spectrum, and predictable methods for managing risk. Confidence in these conditions will allow commercial satellite companies to continue the success of the first half century of the commercial space age through the next 50 years.

Historical Trends in Commercial Space

At the outset of the space age in the early 1960s, commercial companies were expected to play a limited role in the nascent satellite sector. Satellites were seen as too expensive, too technically complex and too risky for any one country or company to pursue. So, in 1964, the United States and more than a dozen other countries established an intergovernmental organization tasked with providing international telecommunications links using satellites, mostly for the transmission of basic telephone calls and brief video feeds. This organization, which became known as INTELSAT, was joined in 1979 by a second intergovernmental organization, INMARSAT, established by the International Maritime Organization to provide communications and safety services to ships at sea. Together, these two intergovernmental organizations were intended to ensure that all countries were able to reap the benefits of space-based communications services by having their telecommunications networks linked in order to support international calling, including across the Atlantic, Indian, and Pacific Oceans.

By the 1970s, new private companies in the United States and elsewhere began to enter the satellite arena. The Federal Communications Commission (FCC) issued its first licenses to commercial satellite companies for domestic telecommunications services in 1973. By 1980, there were nine commercial communications spacecraft in orbit serving the United States, and by 1988, there were nearly five times as many privately-owned satellites over the United States. The private sector had established an abiding role to play in satellites, and by the end of 2001, both INTELSAT and INMARSAT had privatized, and commercial satellites were proliferating to meet the burgeoning demand for international telephone links, to carry television channels, and to provide capacity for the nascent data industry. Today, there are more than 330 commercial communications satellites ringing the globe in a highly competitive and creative environment. The meteoric rise of the commercial satellite industry was fueled by the proven ability of satellites to meet the explosive demand generated by the global telecommunications industry.

Throughout this period, satellite technology has continued to evolve and advance, while spacecraft, services and networks have become ever more cost-efficient. The first commercial satellite, Telstar 1, had solar panels capable of generating 14 Watts of power, handled roughly 100 transmissions a month during its four month lifespan, and required earth stations so large that shelters the size of a 16-story building were built to protect them. Today's satellites have solar panels that can generate one thousand times more power, can transmit as much as 140

gigabits of data per second, last fifteen years or more, and communicate with small ground terminals that are mounted on rooftops, embedded in the dashboards of cars, or installed as a chipsets in smart phones.

Today's Commercial Satellite Industry

These technological breakthroughs, when placed at the disposal of ever-growing numbers of commercial satellite companies, have allowed today's commercial satellite industry as a whole to triple in size over the past decade, and to remain at the cutting edge of communications, a far cry from the rotary phones and black and white television signals that were the norm in the 1960s.

Satellite Infrastructure

The manufacturers of satellite spacecraft and the companies that launch those spacecraft into orbit can be thought of as the satellite industry's "space infrastructure" segments. Satellite manufacturers build satellites for commercial and government customers. Once delivered by a launch vehicle to the required orbital location, these spacecraft provide the platforms used by satellite operators and service providers to connect the world.

The United States' satellite manufacturers are global leaders in producing satellites used for communications, earth observation, navigation, and intelligence functions. Their technical merits and track record of reliability have won about half of the global marketplace for satellites in the past few years, even with robust competition from European satellite manufacturers, and, to a lesser extent, their Asian counterparts. Between 2001 and 2010, prime U.S. manufacturers produced 264 spacecraft, with half sold to commercial customers and the other half produced for military or civil government clients. This trend continues today, as 61 percent of U.S. satellite manufacturing revenues in 2012 came from U.S. government contracts. Given the prominence of the government in this market, it's worth noting the significant role it has played historically in developing advanced satellite capabilities and in establishing acquisition and regulatory policies that support the industry.

The launch services segment has also seen shifts in the international diversification and customer mix over time. Government customers worldwide continue to represent the major driver for global launch revenues, accounting for 64 percent of revenues earned by the sector in 2012. For the past decade, the bulk of U.S. launches have been for U.S. government payloads, and most commercial satellites have been launched by European or Russian vehicles. This is changing, with the unparalleled reliability of existing U.S. launch vehicles, notable innovation over the past five years, and several U.S. companies winning orders to launch commercial satellites in the near term.

Combined, the cost of manufacturing and launching a satellite represents a significant, up-front, fixed investment for both established and new satellite operators. Because this

investment must be made years before the satellite is launched and before any revenues are realized, commercial satellite operators and their financial backers demand exacting quality control and reliability standards from their suppliers in the satellite manufacturing and launch services sectors. More than in other industries, reliability and flight heritage are often as important as price and delivery schedule for commercial satellite operators. U.S. satellite space infrastructure companies have long historical involvement and deep expertise in satellite manufacturing and space launch technologies. These characteristics, along with the ability and talent to innovate, help American companies remain in the forefront of the satellite infrastructure business.

Satellite Services

The commercial satellite industry is recognized as a critical piece of the world's communications backbone, and satellite-delivered services reach every corner of the globe. The industry provides consumers with broadband internet, satellite radio, and direct-to-home television; delivers media and broadcasting content everywhere; links businesses, and cellular and telecom networks; provides weather and early warning information; and powers emergency communications for first responders and military communications for national security.

Broadband internet: Today, satellites deliver high-speed internet services directly to consumers across America, at speeds of up to 15 megabits per second and at cost-effective rates. These direct-to-consumer satellite broadband providers are increasing competition for customers in populous ex-urban areas, putting pressure on terrestrial competitors to improve service quality and reduce prices. Additionally, satellites allow internet service providers to push their coverage areas out to include the most rural and remote portions of the country, extending internet access to customers that terrestrial wired or wireless networks may never reach. For example, Alaska's largest telecommunications company relies on satellite to connect Alaskans in the farthest reaches of American soil. Satellite is now taking broadband mobile, allowing in-flight internet for passengers on commercial airlines and enabling Wi-Fi for cruise ship passengers.

Direct-to-home Television and Radio: Since the early 1990s, satellite has been delivering subscription television and radio services to millions of consumers across the United States, creating competition with cable and other TV service providers at cost-effective prices. Today, there are more than 33 million U.S. subscribers to satellite TV, about one third of all American pay-TV subscribers. Outside the United States, an additional 130 million consumers in the Americas, Europe, Africa, and Asia also choose satellite technology to deliver TV directly to their homes. Another 24 million Americans subscribe to satellite radio.

Video transmission: Since the late 1960s, satellites have emerged as the most efficient technology to deliver television content, first carrying TV programming to local network affiliates. With the cable age, satellites carried even more media content, capturing breaking

news and live sports "live via satellite," delivering thousands of channels of programming to cable companies in every corner of the globe. Satellite technology made the proliferation of hundreds of channels and pay-TV platforms possible – which is one of the reasons why the *Financial Times* recently listed "Satellites" as one of the "Fifty ideas that shaped business today."[3]

Private business networks: Satellite technology has long linked far-flung offices of private enterprises, offering a reliable, cost-effective approach to carrying business data among business locations across the country and between countries and continents. Satellite-based corporate communications networks are integral to all kinds of retail, corporate, natural resource and transportation businesses, as well as government organizations. For example, satellite-linked corporate networks are used to transmit inventory, back office and accounting data, allow credit card transactions at rural gas stations or remote hotels, link the U.S. Postal Service's offices, and keep the maritime shipping industry connected at sea.

Public safety voice and data: Satellite technology has come to the rescue during the country's worst days – when terrestrial infrastructure is damaged or disabled or when emergencies happen away from communications hubs. From Hurricane Katrina, to the earthquake in Haiti, to Hurricane Sandy, to the tragic impact of last week's Typhoon Haiyan in the Philippines, the satellite industry has supported the efforts of first responders and humanitarian organizations by providing mobile health care and in-field communications for recovery efforts. During the times when our nation needs communications most – satellite is on the spot and always reliable.

Military products and services: The satellite industry builds and launches communications, intelligence, navigation, and weather satellites for the U.S. national security community. Commercial satellite companies also provide communications services linking military units and nearly every type of military platform, from satellite manpacks for warfighters, to small Unmanned Aerial Vehicles (UAVs), to Humvees, to aircraft carriers. The most recent available Department of Defense figures indicate that the U.S. military purchases more than $1 billion worth of commercial satellite communications a year. Government and industry are also working together to find innovative ways to meet the unique requirements of the military and to develop new capabilities, including through the use of hosted payloads.

Remote sensing imagery and products: Beyond communications, commercial companies are also providing remote sensing and imagery, taking advantage of the long heritage of satellite manufacturing capabilities built for military and intelligence users. With imagery archives capturing billions of square kilometers of the surface of the earth, commercial remote sensing companies provide rich data sets used for environmental monitoring, natural resource

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[3] Lionel Barber, ed., "The fifty ideas that shaped business today," June 2013, p. 22, http://www.ft.com/reports/50ideas.

management, and humanitarian assistance, as well as by companies in the agriculture, insurance, mining, and engineering sectors.

Across the board, U.S. consumers, families, businesses, first responders, and government agencies rely on satellites to meet their communications and information requirements across the United States and its territories. It is an instant infrastructure that is reliably available every day, everywhere around the world.

The Role of Government

The commercial satellite sector has unique features that require certain policy and market conditions to provide a firm foundation on which to build their businesses. The commercial satellite industry looks to the U.S. government to help maintain these conditions in order to continue providing the services we offer today, to pave the way for future innovation, and to allow the further development and growth of the industry.

The first notable characteristic of the satellite industry is its long business time horizons. Business cycles in the satellite industry are often measured in terms of decades, and therefore benefit from a stable regulatory and policy environment over a longer time arc. An order for a satellite is typically placed at least two or three years before launch and, once in orbit, the satellite is typically expected to be operational for about fifteen years. Therefore, when a company considers ordering a satellite, it is planning for the future. While economic and competitive conditions shift constantly, satellite companies look for stable regulatory and business environments for a longer duration than most other types of companies. In particular, swift and effective FCC licensing processes for satellites and ground terminals and stable regulatory fees are important for ensuring stability and predictability in the long term. Should government regulations and policies, tax rules, or service conditions change dramatically in the intervening time, the combination of changing competitive conditions and policy shifts could put at risk the hundreds of millions of dollars required to finance the manufacture and launch of a commercial satellite.

The second unique characteristic of the industry is its inherently international nature. Most satellites can serve an entire continent or hemisphere, and so the satellite services environment is inherently reliant on international policies and market access rules. Additionally, satellites are regularly manufactured in one country with parts and components sourced both domestically and internationally, are launched in another country, and are insured by yet another. This international collaboration requires pro-competitive trade and export control policies to operate effectively and efficiently. We note that the Congress took an important step to safeguard the U.S. satellite sector's competitiveness in passing the 2013 National Defense Authorization Act, which included provisions that enable and encourage needed reforms to U.S. export controls for satellites and related technologies. These reforms, which are now being implemented by the

Executive Branch, are a crucial step towards ensuring the long-term competitiveness of the U.S. satellite manufacturing industry, and for that we offer our appreciation.

We expect this action to directly support the U.S. space industrial base, which has recently become a well-documented national security concern. Numerous studies by government agencies and private entities dating back to 2005 have linked satellite export control policies to erosion of the U.S. industrial base, and particularly the third, fourth and fifth tiers of the industry. These suppliers of input materials, parts, and components are relied upon by manufacturers of commercial, military, civil space, and intelligence spacecraft alike, and their health has been of increasing concern to the U.S. national security community. Once the reformed regulations for satellites and related components come into effect, likely in mid-2014, U.S. companies will once again be able to compete on a level playing field for international contracts.

The third key characteristic of the commercial satellite industry is our reliance on radiofrequency spectrum. It is the lifeblood of satellite-based communications services and is essential to control and operate the satellites themselves. Spectrum-based command and control links are essential for ensuring that the space platform remains stable and correctly positioned. Spectrum is also used to transmit data gathered by space-based sensors back to ground stations for analysis – the days when photographs from reconnaissance satellites were returned to earth on a parachute have long since passed.

Spectrum is perhaps most important to the communications delivered by the satellite industry. Communications satellites bring in a vast majority of all revenues earned by the satellite industry and represent a majority of all operational satellites. Without spectrum, these satellites simply could not function. The telecommunications industry, with which the satellite industry intersects, is currently being consumed by high-profile discussions about how to allocate radiofrequency spectrum, and frequencies that are relied upon by the satellite industry are increasingly being considered for possible sharing with or wholesale repurposing for use by terrestrial communications providers. While the satellite industry supports efficient and sensible allocations of spectrum, the unique technical requirement of communicating with spacecraft tens of thousands of miles away and the long-term design implications of satellites require careful analysis and respect for existing critical services. Experience has taught the satellite industry that shifts in spectrum use could have serious implications when applied to satellite spectrum, thus requiring objective and fact-driven analysis. The satellite industry continues to be strongly focused on working with the FCC, non-U.S. regulatory agencies, and the International Telecommunications Union to maintain the viability of satellite spectrum for delivering today's reliable, high-performance satellite services as well as to continue to innovate and evolve new applications.

Finally, the satellite industry is keenly focused on managing risk. The deployment and operation of satellites in space is more challenging than is the case for terrestrial infrastructure. Deployment requires a robust spacecraft, significant expertise, and a technically intricate and

challenging launch campaign. Once deployed, satellites must survive in the harsh environment of outer space, operating safely adjacent to other satellites and among orbital debris. The satellite industry has been successful because of its ability to navigate these challenges, largely because of its exacting focus on quality control and reliability. As prudent risk management demands, the industry has close ties with the financial and insurance industries, allowing the industry to mitigate risk and meet the high up-front investment costs of satellite projects. Having guarantors of risk is vital to the maintenance of the satellite business model. While most financing is provided by the private sector, and rightfully so, governments around the world have also stepped in to provide export credit financing for international sales of satellites. SIA urges the Congress to continue to support a strong U.S. Export-Import Bank that will allow U.S. manufacturers to compete internationally. Governments have also offered launch indemnification against the possibility of certain damages stemming from launch failures involving both government and commercial satellites. The U.S. commercial launch indemnification regime expires at the end of this year, and SIA strongly supports making this regime permanent or extending it for a minimum of 10 years. This regime has allowed U.S. commercial launch service providers to more effectively compete with foreign providers, and has never been drawn upon.

The satellite industry has more than fifty years of experience in commercializing the world's most advanced technologies. We have harnessed the power of space to serve national security, to connect every corner of the world, and deliver entertainment to people on every continent. We have grown at an average annual rate of ten percent over the past decade, sustaining a robust worldwide space economy. The satellite industry is proud to lead the way for the safe, successful, and sustained commercialization of space.

Mister Chairman, Ranking Member Edwards, distinguished members of the Subcommittee, this concludes my testimony. On behalf of the members of the Satellite Industry Association, thank you again for the opportunity to testify, and I look forward to your questions.

PATRICIA A. COOPER
President

Patricia Cooper has served as President of the Satellite Industry Association since November 2007. As President, Ms. Cooper is SIA's lead advocate for regulatory, legislative, export control, government services, public safety, and trade issues of critical importance to the Association's diverse membership. She also manages the day-to-day operations of SIA, including member communications, staff leadership, and SIA-sponsored events.

SIA is a U.S.-based trade association providing worldwide representation of the leading satellite operators, service providers, manufacturers, launch services providers, and ground equipment suppliers. The Association is the unified voice of the U.S. satellite industry on policy, regulatory, and legislative issues affecting the satellite manufacturing, launch and services business. For more information: www.sia.org

Patricia brings more than 20 years of experience in the satellite industry and in government. She joined SIA following a five-year tenure in the Federal Communications Commission, where she managed the FCC's bilateral relationships with regulatory agencies across the world and, as Senior Satellite Competition Advisor to the International Bureau, served as lead author of the FCC's inaugural satellite competition report to Congress. Before joining the FCC, Patricia directed the international regulatory strategy for CoreExpress, a start-up intelligent data delivery company. For six years prior, she directed the international market access at PanAmSat Corporation during its transformation from a start-up single-satellite communications company to a global satellite system. From 1989 to 1994, Patricia counseled U.S. satellite companies on international business opportunities for the U.S. Commerce Department's International Trade Administration and monitored telecom liberalization in the Americas. She began her communications career with Motorola's U.S. Federal Government Affairs office in Wiesbaden, Germany.

Patricia holds a Master's Degree in International Economics from the School of Advanced International Studies at Johns Hopkins University (SAIS) and graduated summa cum laude from Kansas State University with a Bachelor's Degrees in Political Science and German.

Chairman PALAZZO. Thank you, Ms. Cooper. I now recognize our next witness, Mr. Witt.

TESTIMONY OF MR. STUART WITT,
CEO AND GENERAL MANAGER,
MOJAVE AIR AND SPACE PORT

Mr. WITT. Chairman Palazzo, Representative Bonamici, Chairman Smith, Mr. McCarthy, Members of the Subcommittee, I want to thank you for the opportunity of addressing you this morning and the invitation to Congress.

My name is Stuart Witt, and I am the CEO of the Mojave Air and Space Port located in southeast Kern County, California. Today our topic is America's commercial space industry, and my message to you from the high desert is that American engineers and entrepreneurs in Mojave and other places across this great Nation are successfully revolutionizing America's future in space. My story today is 100% a good news story that didn't just happen. This Committee enacted into law a Commercial Space Launch Amendments Act in 2004 sponsored by Mr. Rohrabacher that created an informed consent regime for commercial human space flight. By giving us permission to take risks, you enabled us to create a new industry which is freeing up NASA and others to pioneer deep space exploration.

I personally want to thank Committee Members Takano, Mr. Rohrabacher, Mr. Bridenstine and Chairman Smith who have made visits to Mojave on multiple occasions and witnessed firsthand the private sector innovations I am addressing today.

Chairman Palazzo has requested my attention to four specific questions which I will answer in summary here, but I have gone into far greater detail in my written testimony.

Question number one. Please summarize the work underway by commercial space companies at Mojave Air and Space Port. There is enormous interest in what we offer. Many have asked me, how did I manage to attract firms to Mojave over the past 12 years doing orbital research, suborbital research and development, deep space propulsion system development, and specifically demonstrated by entrepreneurs and high net-worth investors. My response is simple. In a word, I offer permission. We don't advertise. We just deliver, just as our tenants deliver. We set reasonable constraints, provide value-added services to test operators and allow the developers to conduct and manage their own programs with remarkable results. What sounds incredibly simple is actually in practice somewhat complex and very rigorous. But again, the results speak for themselves.

Mojave Air and Space Port currently has 17 firms engaged in commercial space research leading to production of manned and unmanned space systems with 19 separate rocket test sites. Mojave now hosts 156 separate business contracts employing nearly 3,000 professionals. Specific emphasis is centered on green, non-toxic, liquid and hybrid rocket propulsion systems. Privately funded complete launch systems to orbit and suborbit and components for such systems are in development for commercial and government clients.

Question number two. The potential future suborbital space market? To your question, Mr. Chairman, Mojave is far more than suborbital. Mojave entered this game in the orbital market and found a way to back in to the suborbital market. I view this discussion similar to the discussion the world had about steam 175 years ago. Obviously investors knew it had potential, but they didn't know the answer to the basic question you ask. Today the majority of the world's power systems are based on steam. We all know the investment in suborbital tourism. It is in the press every day. But beyond that is an emerging new interest being led by the world's high net-worth investors who are visiting Mojave because they know investment in hypersonic, high mach business travel, is ripe for suborbit. This is where I see the needle moving, and my written testimony goes into far greater detail on the subject.

Question three. The challenges and opportunities faced by the suborbital space market. A. The industry needs regulatory certainty, but the learning period restriction on unsubstantiated safety regulations expires in less than two years and the risk-sharing indemnification regime expires at the end of next month. For regulatory certainty, extension of both is required now.

The Administration's proposed changes to ITAR pose a restriction to extending the peaceful exploration of space to a thirsty world market seeking suborbit vehicles. ITAR as it currently stands is more than a speed bump to expanding the markets internationally.

Question four, your thoughts on H.R. 3038, the Suborbital and Orbital Advancement and Regulatory Streamlining Act. I strongly support two elements of H.R. 3038 contained in Section 2, but the third element, contained in Section 3, to me is ambiguous and requires further discussion and clarity.

From my 44 years as a professional aviator, test pilot and business executive if taken at current words, it may take the FAA and the industry into that mysterious land of unintended consequences if we don't spend just a little time and get it right.

Again, I thank you for your invitation to present the good news coming out of Mojave, and I look forward to your questions.

[The prepared statement of Mr. Witt follows:]

MOJAVE
AIR & SPACE PORT

Prepared Statement of

Stuart O. Witt
CEO and General Manager
Mojave Air and Space Port

Hearing on "Commercial Space"
Wednesday, November 20, 2013

Subcommittee on Space
Committee on Science, Space, and Technology
U.S. House of Representatives

Chairman Palazzo, Ranking Member Edwards, Chairman Smith, and members of the subcommittee, thank you for giving me the opportunity to address the subcommittee this morning. My name is Stuart Witt, and I am the CEO and General Manager of the Mojave Air and Space Port, which is located in southeast Kern County, California.

Many of my tenants call Mojave the Silicon Valley of Commercial Spaceflight. I'm just proud to lead the nation's only private experimental flight test center, a place where Innovation Takes Flight.

Our topic today is America's commercial space industry, and my message to you from the high desert is that American engineers and entrepreneurs in Mojave and other places across the country are successfully revolutionizing America's future in space. This is a 100% good news story. What my Mojave tenants require from elected representatives in Washington is continued permission, and modest encouragement, rather than obstacles.

I personally want to thank committee members Takano, Rohrabacher and Chairman Smith who have visited Mojave on numerous occasions, witnessing firsthand the private sector innovations I'm addressing today.

Chairman Palazzo has requested my attention to four specific questions which I will answer in detail.

Question 1. ***Please summarize the work underway by commercial space companies at Mojave Air and Space Port.***

There is enormous interest in what we offer. Many ask me "how did you manage to attract the firms and growth in Mojave over the past twelve years, including orbital research, suborbital development and operations, and deep space propulsion, specifically demonstrated by entrepreneurs and high net worth investors?" My response is simple. In a word, we offer them "Permission". We don't advertise. We just deliver. Just as our tenants deliver. We set reasonable constraints, provide value added services to test operations, and allow the developers to conduct and manage their own programs... with remarkable results. What sounds incredibly simple is actually in practice somewhat complex and rigorous. But again, the results speak for themselves. I'm convinced that daily development activities by the commercial space entrepreneurs at Mojave and other locations in Washington State, Nevada, New Mexico, Florida, Maryland and Virginia and Texas to name a few will yield remarkable outcomes to the nation. The emerging industry has certainly captured the investment eye of the high net worth community.

Specifically, Mojave Air and Space Port has 19 rocket test sites and 17 firms engaged in commercial space research, development, ground and flight test and evaluation, leading to production of manned and unmanned space systems. A major focus of development work at Mojave is on basic and applications-driven R&D in advanced aerospace propulsion and power systems. Specific emphasis is centered on green, or non-toxic, liquid and hybrid rocket propulsion systems. Privately funded complete launch systems to orbit and sub-orbit, and components for such systems, are in development for commercial firms and government clients. But this work also has huge spin off potential beyond aerospace. For example, some of their discoveries are being applied to conventional internal combustion engine efficiency and are yielding demonstrated >20% MPG increases on current commonly in service production automobiles.

From this work, over 27 patents have been filed in the U.S. and over 50 abroad in just the last three years. Patent protection and respect of patent law (both in the U.S. and abroad) is a very important aspect of ensuring rapid and successful infusion of advanced technology in the commercial marketplace.

As many of you and your staffs have pointed out during your visits, "you can see the future from Mojave". Current space-related developments include:

1) Reusable rocket development/Re-startable rocket development
2) Sub-orbital human rated tourist experience vehicle development x 2
3) Sub-orbital RLV piloted scientific payload system development x 2
4) Full scale LEO/GEO system delivery developments x 4
5) Subsystem component development and operations
6) Liquid and hybrid rocket engine/propulsion development
7) Vehicle control & monitor room development and deployment

Included in this technology portfolio, the Spaceport is the home of NOFBX™ green propulsion technology. NOFBX™ is one of the three competing technologies to eventually displace the current "gasoline" of the satellite community. (Europe has recently issued a 2016 ban on hydrazine due to its safe handling and disposal issues.) Due to its much higher performance than competing options, NOFBX™ technology has been selected for development for next generation, low cost, tactical launch systems like DARPA's Airborne Launch Assist (ALASA) program. NOFBX™ is also in development for a flight experiment on the International Space Station.

Commercial Space doesn't mean just aerospace. In the process of solving hard aerospace problems, inevitably new solutions for how to do things emerge that eventually find themselves into the commercial market place.

For example, SonicExhaust is a technology accidentally derived from developing extremely fuel efficient, extreme altitude unmanned aerial vehicle engine technology funded under DARPA. The SonicExhaust technology has been consistently demonstrating >20% improvement in fuel economy (miles per gallon) during extensive road test trials on standard size personal vehicles and has recently passed the California Air Resources Board (CARB) certification.

Likewise, composite material manufacturing solutions for endo- and exoatmospheric vehicles are in development by numerous firms at Mojave. What began under the watchful eye of Mr. Burt Rutan and the Rutan Aircraft

Factory in the 1970's has grown into a full industry with many spinoff firms designing and developing vehicles and components for current aircraft, new aircraft and spacecraft and subsystems. Spin-off firms designing coatings for fasteners which blend metallic and composites structures are in production at Mojave. Laser manufacturing processes have recently been accelerated by >100x from work initiated at the Spaceport enabling an emergent revolution in micro-fluidics and advanced optics much like circuit board lithography did for electronics. Ongoing work is going to accelerate these advanced manufacturing processes by another 100x. Ongoing work in next generation energy and power systems is in development at the Spaceport to reduce the U.S. demand on foreign energy supplies and help reduce the impact of emissions on the environment. Cost effective, advanced test beds and commercial test support for customers with new advanced development projects is also in development at the Spaceport.

To bring it down to a bottom line, Mojave now hosts 156 separate business contracts employing nearly 3,000 professionals. Annual aerospace revenue from rents and leases alone to our Air and Space Port District is $3,076,000. Total client commerce at the Spaceport is well in excess of $1B annually, not including commerce through our on-property rail yard supporting the renewable energy market.

Question 2. The potential future suborbital space market.

First of all, as I point out above, Mojave is not just the home of three suborbital vehicle developers. All of these companies, plus others, are actively working on systems and major components for orbital launch, all the way up to EELV-class missions. Some are also pursuing capabilities for deep space exploration. Innovations coming out of Mojave are likely to stimulate significant growth in the more established orbital launch marketplace, as well as the new suborbital market.

In essence, if someone asked the question over two centuries years ago - "what can we do with steam"... We wouldn't know WHAT the future was but it would be logical to assume it had potential. Sub-Orbit is there and we have largely failed to utilize this band of the upper atmosphere, which we refer to as the "ignorisphere". It will be up to future generations to further develop "how and

why"– but it's there and cannot be ignored. One near certain use will be for long range point to point intermediate or hypersonic human travel. These concepts are being explored in many corners of the globe now. Sub-orbit is there, it's accessible, costs are coming down... future generations will fully exploit it for research, space access, tourism and point to point travel and other uses...who knows. Any futurist who tries to answer this question is nearly sure to underestimate the potential of the discoveries and their applications to increasing flight safety, efficiency and general quality of life on earth.

However, I would just restate what I said earlier: the emerging spaceflight industry has certainly captured the investment attention of the high net worth community. They believe there is potential.

Question 3. The challenges and opportunities faced by the suborbital space market.

a) This industry needs regulatory certainty. But the learning period restriction on unsubstantiated safety regulations expires in less than two years and the risk-sharing (indemnification) regime expires at the end of next month. That regulatory uncertainty is difficult for many companies. I ask Congress to make Indemnification permanent, and also extend the Learning Period to a full eight years of R&D and operational flights to provide regulatory certainty to firms developing passenger carrying vehicles.

b) The Administration's proposed changes to ITAR[1] pose a restriction to extending the peaceful exploration of space to a thirsty world market. As you may know, I have personally been to numerous friendly countries with long standing space exploration agreements with the United States who seek access to our emerging commercial space industry products. ITAR as it currently stands is more than a speed bump to expanding our markets off shore to countries seeking sub-orbit space tourism and sub-orbit scientific experiment access to space by developers currently operating at Mojave. I strongly urge this Congress to take action to identify and find meaningful

[1] The State Department's proposed revision to Category XV ("Spacecraft") of the United States Munitions List explicitly places any human spaceflight vehicle, whether suborbital, orbital, deep space, or a habitat, under ITAR, whether or not it contains sensitive technology.

relief for the investments of XCOR and Virgin Galactic so their product line can be operated worldwide. Actions you take to provide such relief will assist all other domestic space systems providers and developers.
The Kingdom of Sweden, through Spaceport Sweden, has been actively seeking access to US Space Sub-Orbit vendors to operate commercial flights through the aura-borealis from Northern Sweden but the obstacle continues to be ITAR. This specific issue was raised by Sweden during the President's recent visit to Stockholm.

Question 4: **Your thoughts on H. R. 3038, the Suborbital and Orbital Advancement and Regulatory Streamlining Act.**

I strongly support two elements of H.R. 3038 contained in Section 2. But the third element, contained in Section 3, is ambiguous and requires further discussion. From my 44 years as a professional aviator, test pilot and business executive it may take the FAA and industry into that mysterious land of unintended consequences and requires further review.

First, Section 2 of the bill allows companies to flight test a vehicle under a permit even after that class of vehicle has received a license. It's very important to allow companies to test each new copy of a spaceship they make, even if previous ones are operating commercially. And if a vehicle requires a repair, the operator should be able to test that repair under the flexible permit regime before returning to revenue flight under their license.

Second, companies should be able to get one stop shopping at FAA for a Single license or permit for all flights of their system, not just ones that launch a spacecraft into space. This will streamline paperwork and oversight business operations but will come with some geo-operations constraints under FAA AST, which I also support. Implementation of this provision under FAA/AST is proper for the industry and AST is the proper location within the FAA.

Section 3 of the bill may require further thought and discussion, especially depending on how this provision, or a modified form, is implemented. If implemented as proposed, Section 3 could have an adverse impact on the industry. Having said that, there is certainly a need for providing realistic training for passengers seeking a space experience in unusual attitudes and varying g-force load and a confined environment. Ways to provide this training include

centrifuge, aircraft of varying types and classroom or a combination of all. High performance former military aircraft have the potential of providing this training and may serve a highly beneficial purpose to aeronautically adapt people with no background or reference point on high g-force flight, confined space and potentially disruptive ride environments. The question arises as to whether this should be under "Informed Consent" space licensing or a new regime under FAA's aircraft side. I would be happy to provide further testimony as I further consider options to provide for proper aeronautical adaptability training.

Again, my opinion is that Section 3 under H.R. 3038 requires further review but that should not hold up passage of Section 2.

MOJAVE
AIR & SPACE PORT

Stuart O. Witt
Chief Executive Officer
Mojave Air & Space Port

Stuart O. Witt is the Chief Executive Officer of the Mojave Air & Space Port (MASP). Since joining in April 2002, he has transformed MASP from a small general aviation test airport to the nation's first inland spaceport.

Witt is the force behind the Mojave Desert's primacy in the space business, as home to Virgin Galactic, The Spaceship Company, Scaled Composites, Stratolaunch Systems, Masten Space Systems, Firestar Technologies, XCOR Aerospace, Orbital Science's L1011 Stargazer, Interorbital Systems, as well as the National Test Pilot School and Flight Research Inc. In 2004, under his leadership, MASP played host to the world as Scaled Composites qualified and won the $10M Ansari X-PRIZE and received its designation as the America's first inland spaceport. Witt recently has been credited with crafting and seeing through to Governor Brown's signature, California Bill AB2243 – Space Flight Liability and Immunity Act.

Prior to joining Mojave Air & Space Port, Witt served as Executive Vice President of CTA, Inc, where he directed engineering projects from New York to Hawaii. Before that he served as an Engineering Test Pilot on numerous DoD and civilian test programs for Westinghouse Electric Corporation.

Witt served in the United States Navy both as an active duty member and reservist from 1976 to 1996. He was an F-14 Tomcat Pilot on the USS JFK and later a FA-18A project pilot at the Naval Warfare Center, China Lake, California.

In September 2012 Witt was elected Chairman of the Board of the Commercial Spaceflight Federation (CSF), whose members span the industry. The mission of the CSF is to promote the development of commercial human spaceflight, pursue ever-higher levels of safety, and share best practices and expertise throughout the industry.

A native of Onyx, California, Mr. Witt is a graduate of California State University at Northridge, the Naval Aviation Schools Command, the Naval Fighters Weapons Schools (TOPGUN) and University of Maryland's Center of Creative Leadership. He is married to the former Susan Etoch and they have three grown sons.

Chairman PALAZZO. Thank you, Mr. Witt. I now recognize our final witness, Mr. Tito.

TESTIMONY OF MR. DENNIS TITO, CHAIRMAN, INSPIRATION MARS FOUNDATION

Mr. TITO. Thank you very much, Mr. Chairman and Members of the Subcommittee. I can't think of a better way to begin today's discussion—

Chairman PALAZZO. Your mike, please, if you can turn it on?

Mr. TITO. Thank you. I can't think of a better way to begin today's discussion on the public-private ventures in space than to propose one.

At the Inspiration Mars Foundation, we have designed the architecture for a mission carrying two astronauts to the far side of Mars and back. It would be a voyage of around 800 million miles around the Sun in 501 days. We propose to do this in collaboration with NASA as a partner in a NASA mission in the name of America and for the good of humanity. The endeavor is not motivated by business desires but to inspire Americans in a bold adventure in space that reinvigorates space exploration. In fact, the capabilities developed through private funding belong to NASA for this and future missions. The partnership is a new model for a space mission. It is not the model of traditional contracts or subsidies for vehicle developments, although these models are imbedded in the NASA programs to be leveraged for this mission. It is a philanthropic partnership with government to augment resources and achieve even greater goals than is possible otherwise. Philanthropy has historically benefitted society beyond what governments can afford or justify. What better use is there for private funding than to challenge the imaginations of people all over the world by providing the spark that invigorates the space program to further human destiny, to learn more and improve our civilization. Just as exciting times in the space program have motivated young people to study math, science and engineering in the past, benefitting all parts of U.S. industry, this mission will surely provide that benefit.

No longer is a Mars flyby mission just one more theoretical big idea. It can be done, not in a matter of decades, but in a few years. Moreover, the mission might just show the way for a new model for joint effort and financing. It would attract significant private funding, while enabling NASA to do what it does best, and to confirm that the United States is the unquestioned leader in space.

The work of this Subcommittee has helped to prepare the way with the 2010 authorization. That gave NASA the Space Launch System, the Orion program, and new commercial capabilities. We propose to combine all of these elements, as we have explained in the Architecture Study Report released this week.

We can accomplish this flyby within a set launch schedule using rockets, systems, hardware already in testing and meeting established objectives that is a part of space policy for sending people to explore Mars.

But if the technology, the rockets, and the systems are all virtually there, why not move this mission to the here and now and not wait until the '30s?

There is a compelling reason to do that—in a word, opportunity. Every 15 years or so there is a rare planetary alignment relying on the gravitational forces of Mars, Sun, and Earth. An American spacecraft would have to be on its way in the first days of 2018. Otherwise, we are looking at another 15 years before that alignment happens again.

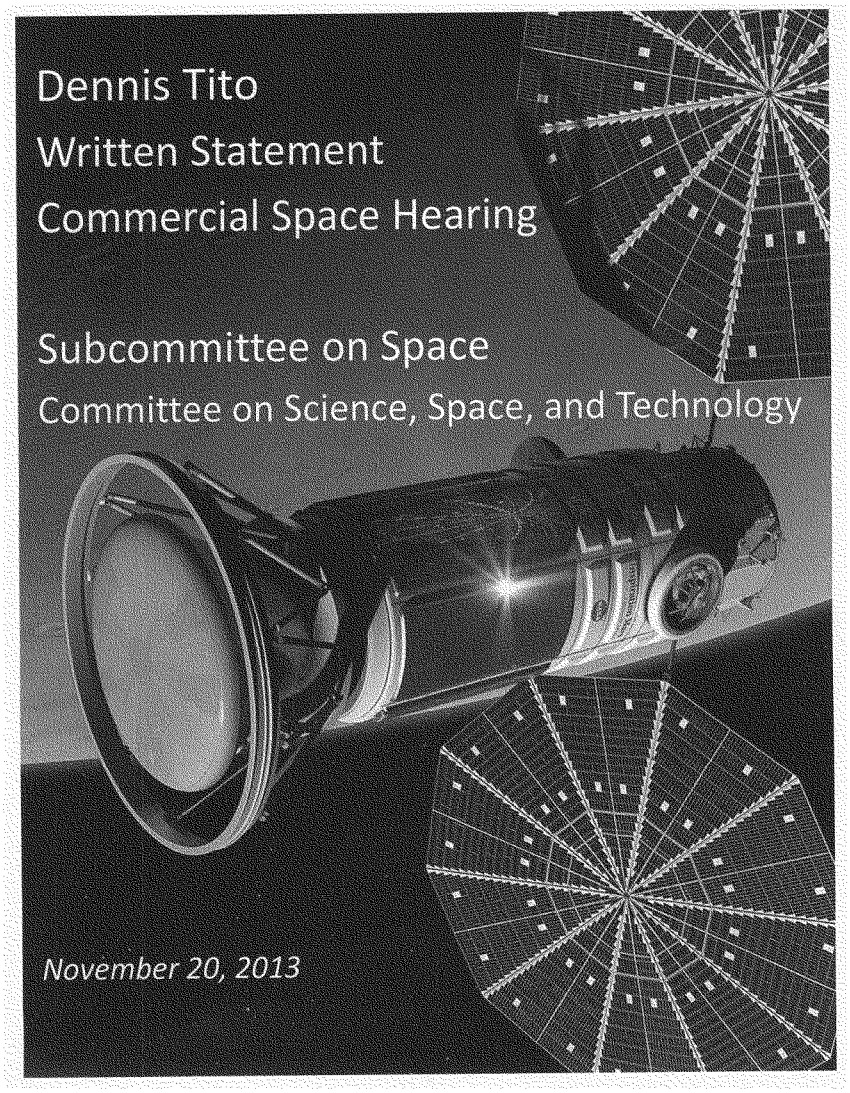
If we need a Plan B, there is a mission 80 days longer that flies behind Venus before going to Mars, being a unique trajectory that could be flown in 2021. However by then, another country, almost surely China, will have seen our missed opportunity and taken the lead for themselves.

May I offer a frank word to the Subcommittee? The United States will carry out a flyby mission or we will watch as others do it. If America is ever going to do a flyby mission of Mars then we are going to have to do it in 2018. Given the Russian recognition and value of accomplishments in human space exploration, they have announced that they will recommercialize the Energia rocket and make that available. They also have upgrades to their capabilities which would allow them to fly in 2017.

We feel it is our civic duty to bring this attention to the executive and legislative branches of government.

In 2019, it will be 50 years since we landed on the Moon. Let us hope that we can look back and say that we have accomplished something in that 50 years. Thank you very much, Mr. Chairman and the Subcommittee, and I would be happy to answer your questions.

[The prepared statement of Mr. Tito follows:]


Dennis Tito
Written Statement
Commercial Space Hearing
Subcommittee on Space
Committee on Science, Space, and Technology
November 20, 2013

Testimony of Dennis Tito
Executive Director of Inspiration Mars Foundation
Hearing on Commercial Space
Subcommittee on Space
November 20, 2013

Thank you very much, Mr. Chairman and members of the subcommittee.

I can't think of a better way to begin today's discussion on public-private ventures in space than to propose one.

At the Inspiration Mars Foundation, we have designed the architecture for a mission carrying two astronauts to the far side of Mars and back. It would be a voyage around the sun of more than 808 million miles in 501 days. We propose to do this in collaboration with NASA, as a partner in a NASA mission, in the name of America, and for the good of humanity. The endeavor is not motivated by business desires, but to inspire Americans in a bold adventure in space that reinvigorates US space exploration. In fact, the capabilities developed through private funding will belong to NASA for this and future missions.

This partnership is a new model for a space mission. It is not the model of traditional contracts or subsidies for vehicle developments, although those models are imbedded in the NASA programs to be leveraged for this unique mission. It is a philanthropic partnership with government to augment resources and achieve even greater goals than is possible otherwise. Philanthropy has historically benefitted society beyond what governments can afford or justify. What better use is there for private funding than to challenge the imaginations of people all over the world by providing the spark that invigorates the space program to further human destiny, to learn more and improve our civilization. Just as exciting times in the space program have motivated young people to study math, science and engineering in the past, benefitting all parts of U. S. industry, this mission will surely provide that benefit.

No longer is a Mars flyby mission just one more theoretical big idea. It can be done – not in a matter of decades, but in a few years.

Moreover, the mission might just show the way for a new model for joint effort and financing. It would attract significant private funding, while enabling NASA to do what it does best, and confirm the Unite States as the unquestioned leader in space.

The work of this subcommittee has helped to prepare the way with the 2010 authorization. That gave NASA the Space Launch Systen the Orion program, and new commercial capabilities. We propose t combine all these elements, as we have explained in an Architectur Study Report released this week.

We can accomplish the flyby within a set launch schedule; using rockets, systems, and hardware already in testing; and meeting an established objective that is a part of U. S. Space policy for sending people to explore Mars. It's currently expected sometime in the 2030's. But if the technology, the rockets, and the systems are all virtually there, why not move this mission into the here and now?

There is a compelling reason to do just that – in a word, opportunity Every 15 years or so, there is a rare planetary alignment that makes a Mars journey relatively less complex, relying on the gravitational forces of Mars, the Sun, and Earth. An American spacecraft would have to be on its way in the first days of 2018. Otherwise, we're looking at another 15 years before that perfect alignment occurs again.

If we need a Plan B, there is a mission 88 days longer that flies by Venus before going by Mars, a unique trajectory that could be flown in 2021. However by then, another country – almost surely China – will have seen our missed opportunity, and taken the lead for themselves.

If I may offer a frank word of caution to this subcommittee: The Unit States will carry out a Mars flyby mission, or we will watch as others do it – leaving us to applaud *their* skill and *their* daring. If America i ever going to do a flyby of Mars – a manned mission to another wor – then 2018 is our last chance to be first.

This week Americans are thinking of President John F. Kennedy wit special feeling, among other reasons for the fire he lit under the

Apollo program to make America first to the moon and six years later, there they were.

In 2019, it will be 50 years since those first footprints were left in lunar dust. On that anniversary, we will have to ask how we have used the time, where we have journeyed since, why our best-known spacecraft are all in museums.

We can reply that in this half-century, human space flight never went farther than where the Eagle landed; that we had plans and ideas to journey beyond the Moon, but we never did and we never tried.

Or, if Congress and the president will give NASA this great mission, we will be able to say in 2019 that two of our countrymen have just traveled the distance of Mars and back – the longest journey ever made – and that they were the first.

I thank the members of the subcommittee for your kind attention, and I welcome your questions.

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Answers to specific questions:

(1) Your work on the Inspiration Mars project and the promise of public and private sector partnerships to advance space exploration;

Philanthropic support for science is a long standing tradition, patrons of the arts and sciences predate Columbus. Philanthropic support for space exploration is a part of that tradition and I think it is due in part to a growing recognition that space exploration plays a critical role in America's future economic competitiveness.

On the occasion of being invited to provide this testimony the Inspiration Mars Foundation is releasing the Architecture Study Report, demonstrating the technical feasibility of the free return Mars flyby mission with two crew members. A summary of the Architecture Study Report is provided with this written testimony.

The mission takes advantage of a rare planetary alignment occurring at the end of 2017. One interesting result of the study is a clear demonstration of the need for the Space Launch System (SLS) as well as advanced reentry capsule technology. As shown in the attached data sheet, the architecture calls for launching the unmanned spacecraft into low Earth orbit using SLS. The crew is subsequently delivered to the spacecraft loitering in low Earth orbit by one of the commercial crew transportation providers. With the crew on board and spacecraft checkout complete, the commercial crew vehicle undocks and the SLS with Dual Use Upper Stage performs the burn sending the spacecraft and crew on their way to Mars and back. A summary of the report has also been provided to the committee, the full report can be provided as well.

A Plan B, if we need one, is a mission longer by 88 days that flies by Venus before going by Mars, a unique trajectory that could be flown in 2021. The downside is that by then, another country – almost surely China – will have seen our missed opportunity, and taken the lead for themselves.

(2) The proper government role in regulating and fostering growth in the commercial space sector;

The proper government role in fostering growth in the commercial space sector begins with moving the entire industry forward by having NASA do the really hard deep space exploration missions for which there is no business model. This cutting edge role for government is the catalyst for the private sector to follow behind.

Possibly the most important regulatory issue that needs to be addressed is permanently controlling liability exposure for the emerging commercial suborbital space tourism industry.

(3) How the private capital market has responded to shrinking government budgets, and how this has impacted the commercial space sector; and

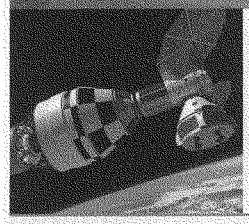
The commercial space sector covers a broad range of products and services however one way to think about it to look at sectors in which the government is the principal enabling customer, and those sectors in which the market demand does not require the government. At risk investments in which the government is the prospective customer appear to require government subsidies to the investment, whereas purely commercial markets do not, that reality speaks for itself.

(4) Your thoughts on H.R. 3038, the Suborbital and Orbital Advancement and Regulatory Streamlining (SOARS) Act.

In general regulatory streamlining of launch licensing is beneficial; however I have not looked into this bill and the issues surrounding it enough to give an opinion.

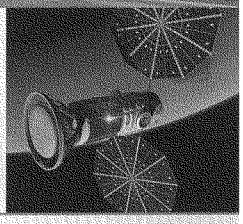
inspiration mars

Fact Sheet
Rev. NC



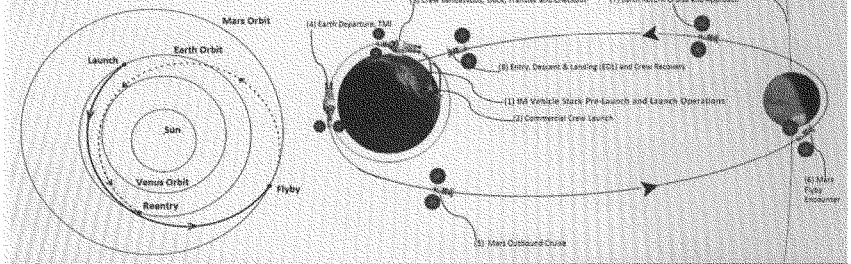
Inspiration Mars Goals

- An American crew – a man and a woman – on an historic journey to fly within 100 miles of the Red Planet and return safely to Earth
- Inspire a sea change in the U.S. Space Program and maintain leadership in space exploration
- Demonstrate feasibility of human missions to Mars and retire risks of human deep space exploration
- Foster knowledge, experience and momentum for space exploration



Mission Design

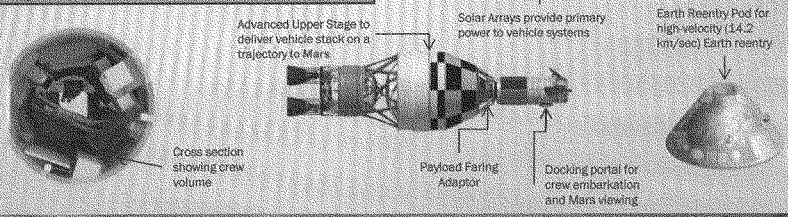
- An unique opportunity in Jan 2018 for a fast 500-day free-return trajectory that minimizes risk to the crew



Vehicle Systems

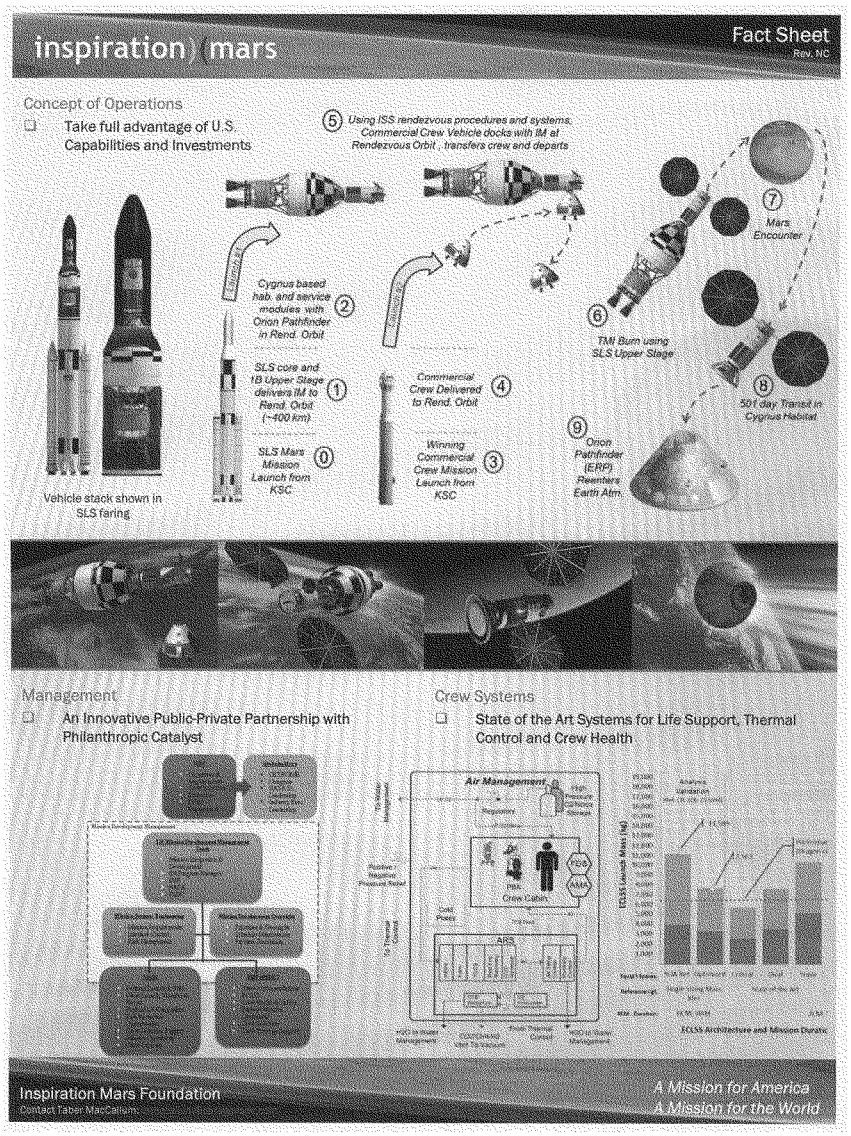
- Leverage existing systems combined with custom new developments

Mass Margin Approach		
SLS TMI limit with performance margin reductions	19,000 kg	
SLS Performance over Margined Estimated Value	469 kg	3%
Margined Estimated Value	18,531 kg	
Average Contingency Margin	2,764 kg	17.5%
Current Best Estimate	15,767 kg	
Estimated Average Mass Growth Allowance	2,628 kg	20%
Base Mass Estimate	13,139 kg	
Total of Margin over Base Estimate	5,861 kg	45%



Inspiration Mars Foundation
Contact Taber MacCallum

A Mission for America
A Mission for the World


inspiration)(mars
Fact Sheet
Rev. NC
Concept of Operations
Take full advantage of U.S. Capabilities and Investments
Vehicle stack shown in SLS faring
SLS Mars Mission Launch from KSC
0
SLS core and 1B Upper Stage delivers IM to Rend. Orbit (~400 km)
1
Cygnus based hab. and service modules with Orion Pathfinder in Rend. Orbit
2
Winning Commercial Crew Mission Launch from KSC
3
Commercial Crew Delivered to Rend. Orbit
4
Using ISS rendezvous procedures and systems, Commercial Crew Vehicle docks with IM at Rendezvous Orbit , transfers crew and departs
5
TMI Burn using SLS Upper Stage
6
Mars Encounter
7
501 day Transit in Cygnus Habitat
8
Orion Pathfinder (ERP) Reenters Earth Atm.
9
Management
An Innovative Public-Private Partnership with Philanthropic Catalyst
Crew Systems
State of the Art Systems for Life Support, Thermal Control and Crew Health
Air Management
Regulators
PBA
Crew Cabin
CO2
VCA
ECLSS Launch Mass (kg)
ECLSS Architecture and Mission Duratic
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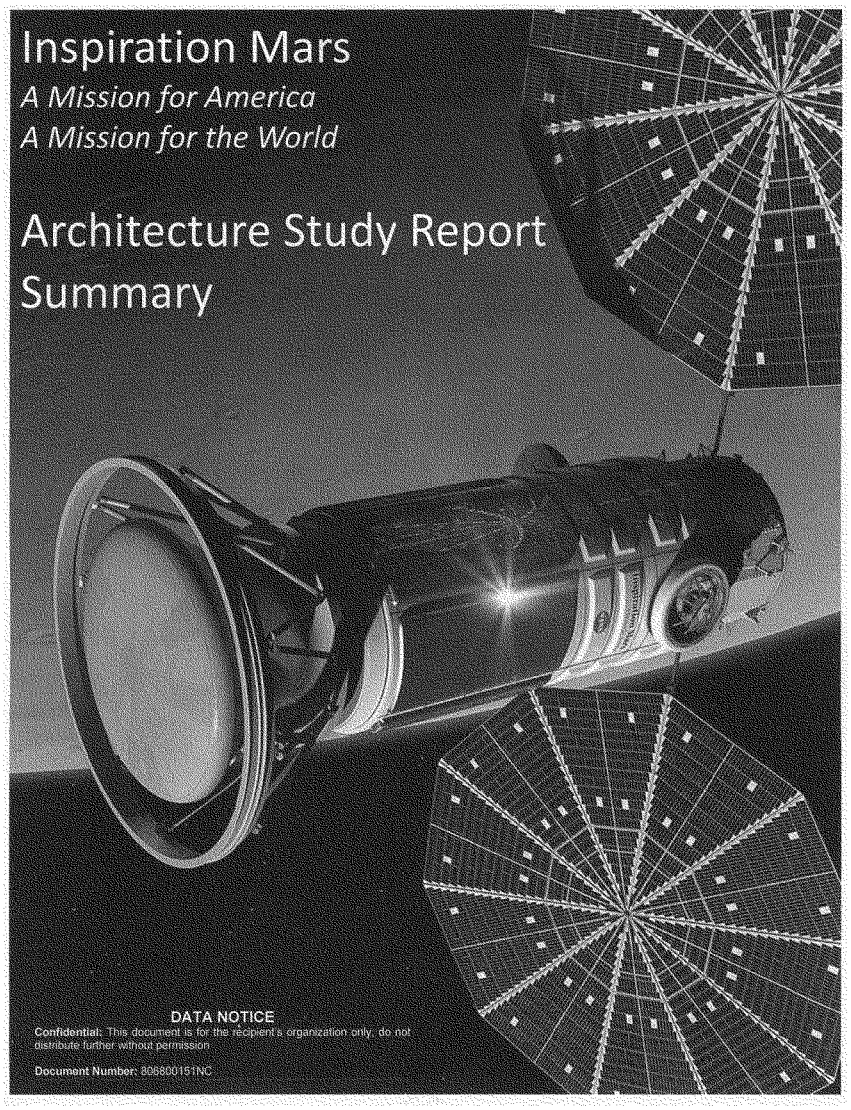
Inspiration Mars
A Mission for America
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Architecture Study Report
Summary
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1. EXECUTIVE SUMMARY

In the summer of 2013, word came from NASA that Voyager 1, a spacecraft in flight since 1977 and nearly forgotten by the world, had passed the outermost limits of the solar system, a threshold on its journey into the infinite. More than three decades after Voyager's flyby of Jupiter and Saturn, this work of human hands is 11.6 billion miles from Earth, and adding 38,000 miles to that distance every hour. The craft is now free of the Sun's realm and on to other stars, carrying into the darkness a camera, a 23-watt transmitter, and a plaque bearing our planet's cosmic address and the image of a man and a woman.

Voyager's crossing was accomplished in our time because it was envisioned in another – and not only envisioned, but approved, designed, built, tested, and sent on its way. This is the manner of all progress in space exploration, carried forward with the audacity of rocket science and the patience of cathedral building. And that latest signal from Voyager leaves us to ask what feats of skill and daring will one day be traced to the beginnings we have made. What great things have we, in our time, set in motion? What leaps have we made for mankind in the 41 years since the last footprint was left in lunar dust? And what of human space travel? Are we content to send forth only the etched likeness of men and women, but not men and women, to see and experience what lies beyond?

With this report, we at the Inspiration Mars Foundation, a private, philanthropic enterprise, offer our best answer to these questions. We submit for the consideration of the American people, the President, Congress, and NASA a new mission. We propose to send a spacecraft bearing two astronauts, a man and woman, to the far side of Mars and return them to Earth, a voyage of 314 million miles in 501 days, in collaboration with NASA, in the name of America, and for the good of humanity.

This first manned mission beyond the Moon, detailed in the pages that follow, would begin in early January of 2018 and end in the spring of 2019. The objective is to place the crew within a hundred miles of Mars. In August of 2018, on the 226th day of flight, the astronauts will enter the gravitational sphere of another world. This will be a momentous achievement in human experience, and also preparation for a landing one day on the second most habitable planet in our solar system.

Expected for decades, envisioned by presidents, and imagined for centuries even before the age of space travel, a landing on the Red Planet is within America's reach. The flyby of 2018 will bring that day closer. It will show what can be done, test what must be tested, measure what must be endured, and reveal what must be known before more manned spacecraft can launch from Cape Canaveral into the cosmic depths – to asteroids and to the Martian moon Phobos, as under current directives, and onward to the surface of Mars itself.

To wait more decades for a Mars flyby is to forfeit an opportunity that will not wait on American initiative. Other nations have designs and aspirations to make this achievement their own. For America, this is our last chance to be first, and even the very movement of planets seems to be saying *"Go"*: The flight to Mars would have to begin between Christmas Day 2017 and January 5, 2018, for a simple reason – speed. A planet's orbital speed around the Sun changes, accelerating as it comes close to the Sun and slowing down as it moves away. This planetary alignment is so rare because it requires Earth to be moving at its maximum speed when the spacecraft departs, essentially giving it a boost, and likewise for Mars to be as close to the Sun as

possible when the spacecraft flies by. Alignments like this occur just once every 15 years, and some are better than others. The next one happens to be the best that this century will offer.

The trajectory we have plotted will require propulsion only to leave Earth and get on course to Mars. The rest of the journey will be propelled by, in turn, the gravitational forces of Mars, the Sun, and Earth. This free-return trajectory is possible only rarely, and the chance will not come again until 2033. The Inspiration Mars spacecraft has to be on its way to Mars in the first days of 2018, if this mission is to happen at all. And if it does not happen, then where does that leave human space exploration by the United States?

* * *

In recent years, the most notable movements of American spacecraft have been powered by trucks and barges in the direction of museums, as if all we can afford and aspire to is a careful preservation of past glories. And for all the considerable feats of NASA in 130 flights by five shuttle orbiters, far-flung robotic missions, cosmic imaging with the Hubble Space Telescope, and an International Space Station now in its second decade of service, we are left with this fact: Since Apollo 17, no human has ventured more than 386 miles from Earth – a distance from Cape Canaveral, if traveled by car, that would not reach Pensacola.

The 18,000 men and women who work at NASA accomplish many things that go unheralded in the press, advances followed and appreciated mostly by academics and space enthusiasts. Each one of these endeavors shows the genius of NASA, its capacity and desire to extend the frontiers of human exploration. There are other spacefaring nations, but there is no other NASA. It has many counterparts, but no equal. Among the agency's partners in the aerospace industry and in American universities, we can see as well a mastery of space science still without rival in any country.

All of these strengths are never more impressive and inspiring than when they are directed toward a great American objective in space. In the space program's defining moments, the various attainments and capacities take on a cumulative force, bringing unity and clarity to all that NASA is doing. Needed in our time is a grand and worthy goal, enlisting all in common effort, marked in bold on every calendar, winning back the world's attention. The Mars mission of 2018-2019 is the kind of hard, daring, and high-yield quest for which NASA was made.

It would complement many other projects of NASA today – in aeronautics, exploration, science, and space technology. No project would be supplanted or interrupted. Indeed, even the spacecraft and crew lift would take place on launches currently scheduled. Far from hindering any undertaking at the agency, the mission will leverage much of this work, give it new focus, reward years of effort, and put to use all that we have learned.

A prime example of assets and knowhow to be leveraged is Orion, the modern successor to the Apollo Command Module. NASA's progress on Orion, critical to any further American exploration of space, can only be accelerated by directing it toward a Mars flyby, a project that would instantly become the agency's marquee mission. The Asteroid Initiative announced in 2010 by President Obama will likewise gain the momentum and public attention that it deserves if it is preceded by a dramatic, high-profile success – especially by one that will help to enable human flight to asteroids. To make more progress on every front, NASA must first make more history, and what better chance than a manned flyby of Mars?

The Inspiration Mars Foundation, as a nonprofit founded to organize the effort and provide a large share of the funding, seeks to broaden a partnership with NASA that we have already begun. At NASA centers including Johnson, Kennedy, Stennis, Langley, Ames, the Jet Propulsion Laboratory, the NASA Engineering and Safety Center and elsewhere, we have consulted closely on such challenges as thermal protection and the ultimate design of the crew capsule. With this venture, we ask Congress and the President to grant an American mission to Mars a place within a launch schedule already set, using rockets and systems already in testing, to meet an objective already set forth.

At the President's direction, current NASA plans aim for a manned mission to circle Mars sometime in the 2030's. The flight we propose will seize an opportunity to conduct the logical precursor mission in the next five years. The first step in a mission to Mars, after all, is to conquer the distance there and back, and a flyby mission will accomplish this. By putting a sprint mission to Mars in the here and now, Congress and the President can prepare the way for the manned orbital mission on NASA's agenda. The first flight to Mars can be an achievement of *this* decade. And by that leadership, the United States can fill the next decade with new attainments that might surprise even the space scientists of today.

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No impediment of engineering or astrophysics compels a delay of 15 years or more in this first human encounter with Mars. And such technical challenges as remain are far likelier to be met in the pressure and creative drive that a target date will inspire. Long, open-ended timetables are not always an ally of great endeavor. Sometimes, before the final hurdles are overcome, and the final problems solved, it takes a decision and a date certain, backed by Congress and the executive. It will not be any easier, or any cheaper, to do in 20 years what can be done in five.

By doing it now, moreover, we expand the range of what can be achieved and learned in the 2020's and 2030's. We will be able to combine the capabilities demonstrated on this mission with those of the coming asteroid missions, in ways that multiply the scientific gains. Robotic missions, for example, could in the 2020's collect large and varied samples of Martian soil and transfer them to Phobos. When the mission sequence turns to Phobos, most likely in 2033 when the next favorable trajectory occurs, that manned journey would be able to retrieve the samples. The soil would give us answers to some basic questions about life in our Solar System – and, with that, one of the monumental benefits of a Mars landing before that landing even takes place.

More than any new federal funding for this mission – some might be needed, but not much – what NASA would require to carry out its part of the work is the freedom to direct existing funds to the enterprise. This is a freedom that Congress can grant and the President can assure, as John F. Kennedy did to clear the bureaucratic path for Apollo. The Inspiration Mars Foundation, for our part, has begun funding development work rallying industry and academia to the cause. The foundation will bring as many resources to bear as private financing can yield, leveraging to maximum effect our government's commitment to this mission.

At a time when many purely commercial space ventures are already well underway, the partnership we propose will keep the United States government as the unquestioned leader in space, even as private support helps to ease stresses on our federal budget. Cooperation of this kind might even show the way for a new model of joint effort and funding, allowing NASA to do what it does best aided by private wealth, the imagination of its scientists and engineers unconstrained by hard lines in a budget.

Perhaps several hundred million dollars in new federal spending can make this mission happen. And that sum is best viewed in this context: The public and private expense of shipping off America's shuttle fleet to museums can be counted in the hundreds of millions of dollars. Moving just the Endeavor from a hangar in Florida to a pedestal in Southern California cost in the range of $40 million. At an additional expense comparable to what we have collectively spent to retire our old spacecraft, America can send a new spacecraft on a single flight that will log close to the miles of all the shuttle missions added together.

For the most part, a Mars flyby would use hardware and systems already developed, proven, and paid for. Going to Mars is a chance for our country to finally claim a clear and compelling return on decades of investment. This mission would gather up the hard-gained knowledge and technical skill of two generations in space science and channel it to great purposes. The history of aviation and space travel has always turned on *firsts*, those breakthrough moments that redefine the possible. Our American astronauts, when they have returned from the realm of another planet, will be witnesses to what this country can do, and where we can go, when we have determined to do so.

So many of the necessary technologies are ready, or almost ready, for that breakthrough moment. NASA in recent years has been perfecting a heavy-lift Space Launch System, more powerful than anything that ever carried an Apollo module. With its intended Dual Use Upper Stage, an SLS vehicle – already scheduled for a late-2017 launch – is all that is needed to carry a Mars-mission payload. With their design of Orion spacecraft, NASA engineers have been thinking hard about the challenges of safe reentry into the Earth's atmosphere at ever-high speeds. The technologies at work there can help with the architecture, heat shield, and trajectory design of a manned vehicle returning from Mars at a rate of nearly nine miles per second. The agency also has the systems and materials nearly in place to support life in a small cabin on a long mission, and we at Inspiration Mars have and are developing innovations of our own to contribute. In partnership with NASA, we can apply all of this knowledge to the longest journey ever made.

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This report describes, in every detail, a mission involving all of the complexity one would expect. As our NASA partners will attest, however, we have worked with them (providing funds through Reimbursable Space Act Agreements) to achieve as spare a primary architecture as possible, relying in nearly every case on technology that America already has, and on things that our space scientists and engineers either know how to do already, or else are now striving to master. Daring greatly is not the same as risking greatly, and at every stage, starting with launch, we have drawn upon the known and familiar – assets in current use or in planning to carry out an established mission sequence.

The SLS, as currently designed, carries either crew in the Orion capsule or an unmanned payload such as a spacecraft. The safety inherent in separating crew and cargo is a fundamental tenet of the architecture. So the plan calls for two launches. In the days before crew departure, an SLS rocket would launch from the Kennedy Space Center, placing into low Earth orbit the full spacecraft for the flyby mission. That payload will consist of four parts: an SLS upper-stage rocket that will propel the spacecraft from Earth's orbit to Mars; a service module containing electrical power, propulsion, and communication systems; a Cygnus-derived habitat module where the astronauts will live for 501 days; and, for the last hours of the mission, an Earth

Reentry Pod. This pod is derived from the work to date on Orion, but will greatly increase the entry speed for this new vehicle to be known as Orion Pathfinder.

In the second launch, a commercial transportation vehicle (to be selected from among competing designs) and crew will carry the astronauts into orbit for rendezvous with the IM Vehicle Stack. The two craft will meet using docking procedures and systems that have been perfected in 136 spaceflights, by 209 astronauts, to the International Space Station. After the crew transfer and detachment of the commercial vehicle, the SLS upper-stage will ignite a Trans-Mars Injection burn to escape Earth's orbit and begin the journey.

Thirteen years' continuous operation of the Space Station has also taught us a great deal about human survival under the pressures of prolonged space travel. On a Mars-bound flight, shielding our astronauts from exposure to cosmic rays and solar particle events is only part of the challenge. There are also the imperatives of basic life support for more than a year and a half; of creating room for backup systems in case any primary units should fail; and of countering the sheer stresses to body and mind for two people alone in a small compartment who, at their highest altitude from Earth, will be looking homeward from a distance of 89,599,814 miles.

Ultimately, success will come down to a combination of the right craft and the right people. Applying the best ideas of both the Space Station and of the new Cygnus multi-purpose vehicle – a spacecraft just launched this September on its maiden flight to service the Station – the Inspiration Mars team is at this moment designing a full, Cygnus-based habitat module to be tested on the Station. With a view to maximum utility at minimum mass, keeping things as simple as possible, the crew's habitat will have 600 cubic feet of living space. The cabin and service module will include such features as advanced shielding against radiation during solar particle events, personalized medical technologies for each astronaut, and proven systems to manage air, water, and all else that is necessary for life on board.

All of this presupposes, of course, a man and a woman capable of persevering in circumstances that will be difficult, sustained, and inalterable. If any organization knows the qualities to look for – courage, fortitude, and inner discipline, just to start with – it is NASA. And with NASA's aid, we are confident that we can find and prepare a married couple for the millions of miles they will traverse together.

Assuming a Trans-Mars Injection burn on January 5, 2018, the craft's nearest approach to the Red Planet will occur on August 20 of that year. At that moment, the crew will be closer to Mars than the Space Station is to Earth. As they pass by the planet, on the dark side, Mars will pass by them, catching the spacecraft with its gravitational pull. This will slow the craft relative to the Sun and reorient it toward Earth. Some 30 hours after the crew's closest encounter with Mars, the planet's gravitational influence will give way to the force of the Sun, effecting what astrophysics terms a hyperbolic trajectory, and averting the need for an all-or-nothing propulsion burn to direct the craft homeward. From then on, the celestial mechanics will govern, and indeed the plan employs the same "slingshot" force that propelled Apollo 13 back to Earth after it lost power.

The 274-day journey home will, at one point, carry the astronauts through the solar orbit path of Venus. They will thus become the closest humans ever to the Sun, having already been the farthest humans ever from the Sun. Able at any point to make corrective maneuvers, they will approach Earth's atmosphere on May 21, 2019, for reentry and splashdown. And, of course,

these last moments of the 501-day mission will require some of the hardest and most intricate feats of engineering.

The craft, just before reentry, will still consist of the crew cabin, the service module, and the Orion Pathfinder Earth Reentry Pod. On final approach, the crew will transfer into the Pod, which will then separate from the jettisoned modules and take our astronauts the rest of the way. They will return at a velocity never before attempted, an unavoidable challenge for reentry in the mission. *Any* deep-space mission, undertaken by any country, will have to overcome the final technical problems entailed in high-speed reentry. The first nation into deep space will be the first to master safe reentry at unprecedented speed.

As we know from the success of Curiosity, which landed on Mars despite tremendous heat and velocity by use of similar thermal-protection technologies, NASA is very close to engineering a capsule capable of withstanding all the stresses of a high-speed return to Earth. We have the heat-shield technology. We have, in Orion, the basis for a reentry craft that can in every other crucial respect soon be mission-ready. Eventually, these existing assets and capabilities will have to be integrated anyway to meet NASA's current presidential mandates for deep space. The concentrated creative energy of a Mars mission will complete it in a matter of a few years.

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Picturing that day when two of our own have just splashed down in the South Pacific – two who have seen Earthrise from our planetary neighbor – we might consider as well the creative energies awakened in the lives of young Americans. Perhaps more than to anyone else in a watching world, this mission will speak to them – about their country's potential, and also their own. In the years after Apollo, twice as many high-school students pursued the sciences than before, and twice as many earned science and engineering degrees in college and graduate school. We can hardly calculate all of the good that followed from that single national objective declared and reached. As President Obama observed at NASA in 2010, Apollo "inspired a generation of scientists and innovators. . . . It's contributed to immeasurable technological advances that have improved our health and well-being, from satellite navigation to water purification, from aerospace manufacturing to medical imaging. . . . And leading the world to space helped America achieve new heights of prosperity here on Earth, while demonstrating the power of a free and open society to harness the ingenuity of its people."

All of this can happen again, yielding new discoveries beyond anything we can predict – decades of technological dividends from a new national endeavor in space. No lesson plan, or aggregate goal of educational attainment, can call forth talent and enthusiasm in the life of a child like the sight of thrilling enterprises they want to understand and be a part of. How do we encourage more boys and girls to study the sciences? Show them what science can do. How do we multiply the ranks of engineers, physicists, mathematicians, and doctors in less than a generation? Show American children all that these disciplines are capable of doing – and doing for peaceful and worthy ends, with the mix of daring and humility that guides human pursuits at their best.

There is no rival power, at least right now, for America to catch up with in any space race. Whatever other governments might seek with their own space technology, there is nothing in the heavens that the United States aspires to seize or dominate. American space exploration has

never proceeded at the level of pure self-interest, national vanity, or cheap propaganda, which is surely one reason why no one has done it better. We do it well because we do it for the right purposes. When one of our own first descended that ladder, it was the achievement of a nation but a leap for all mankind, and felt as such by every soul who shared in the moment. The desire to peer beyond our appointed place in the vastness of Creation is in us all, and the greatest journeys are made on behalf of all.

It is true that from far enough away, where the Sun becomes just another star, our galaxy a faint scattering of light, and finally even all of that vanishes into an eternity of thousands of light years – each a distance of 5.87 trillion miles – the flyby of Mars can seem insignificant, a jump from one speck to another. A fair measure, however, looks not at endless space but at finite man and where we began. To say of Mars one day – and of other points beyond in moments that none of us will see – *"We were there,"* is to say much more than that in the story of the cave-dweller who became the spacefarer in an instant of geologic time. As in the journey to a satellite of our planet just 240,000 miles away, an encounter with another planet, and one day a landing there, is not nothing for creatures formed of the dust of this Earth.

Though such missions are not undertaken with a view to sheer drama, it is worth imagining how the flyby might unfold, those 60 hours in the proximity of Mars that justify the 501 days, and how it might feel to the explorers and to us. It is said that in all of science there is no finer instrument than a person with eyes to see, present to tell in words what telescopes, pictures, and robots cannot convey. Looking out through the window of their capsule, this woman and man will see another world, and across the void that little light in the darkness with a touch of blue. And all of humanity can see it with them, in the moment, hearing the voices of two people upon the face of the deep, transmitted back in the universal language of awe. When Apollo 8 made its initial pass by the Moon on the night of December 24, 1968, that was the most widely seen event ever on television. A year of violence and sorrow ended with the shared experience of a lunar sunrise, and three astronauts reading the opening verses of Genesis, Chapter One. Such moments do not fade quickly from memory, and perhaps the much greater distance from Mars to Earth will give new power to the lesson. How small so many human strifes and hatreds can seem, how ungrateful the desire to destroy, when we see from afar from this refuge we share.

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All of this can come about within the next six years, a little less than the time between a ringing presidential vow of a Moon landing and the event itself in the summer of 1969. By chance, the completion of a Mars mission would occur just before the 50th anniversary of Apollo 11. And if America takes on this challenge, and all of the opportunities that come with it, we can then greet the Apollo anniversary with more than nostalgia. Commemorations, apart from giving past attainments their due, are also moments of accounting, and sometimes can carry a hint of rebuke. We will have to ask in July of 2019 how we have used the time, where we have journeyed since, what followed in what President Kennedy called "the greatest adventure on which man has ever embarked."

One of two answers will be open to us. We can reply that in this half-century human space flight never went farther than where the Eagle landed; that we had plans and ideas to make longer missions, but we never did and we never tried. Or, just weeks before the anniversary of America's arrival at Tranquility Base, we will be able to answer that two of our countrymen have just traveled the distance of Mars and back – and that they were the first.

For all of these reasons, and for its own sake, the 2018 Inspiration Mars mission is worth doing. We submit this report with unreserved faith in the men and women of NASA, with a single-minded commitment to surmounting every obstacle, and with complete confidence that this mission can be done.

2. TECHNICAL SUMMARY

2.1 GOALS AND REQUIREMENTS

As stated above, the Inspiration Mars project aims to execute a human flyby mission to Mars in late 2017. In pursuing the mission described in this Study Report, the Inspiration Mars Foundation started by establishing a set of top level goals for the project:

- Demonstrate the feasibility of human missions to Mars
- Foster knowledge, experience and momentum for space exploration
- Address technical risks in human deep space exploration
- Conduct research on the human physiology of deep space travel
- Inspire a sea-change in the American Space Program
- Cement the U.S. position as the world leader in space exploration
- Inspire youth through science, technology, engineering and math (STEM) education and motivation
- Enable in-depth public participation

From the Inspiration Mars goals, four top level requirements emerged that became principal drivers of the mission architecture:

- Implement the earliest practical Inspiration Mars fast free return trajectory
- Two crew members, one man and one woman
- Return the crew safely to Earth
- An American lead mission principally employing US intellectual property, manufacturing capability and facilities.

2.2 TRAJECTORY AND LAUNCH WINDOW

The goal of the Inspiration Mars project is to send two humans in a specially designed spacecraft on a deep space mission that would fly by Mars and return to Earth. To properly represent humanity and inspire the youth of both genders equally, the two person crew will consist of a man and woman, with the best team being a couple with a longstanding bond.

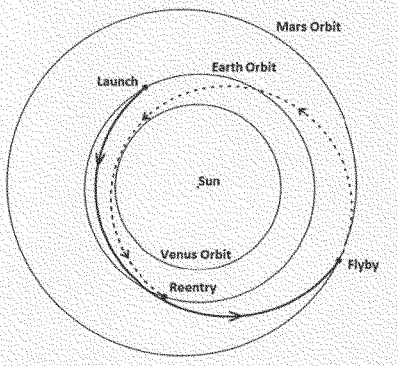

Figure 2-1. Inspiration Mars Trajectory

This mission utilizes what is known as a "fast, free return trajectory." This particular trajectory, shown in Figure 2-1, occurs only once every 15 years with the next opportunity arising in late 2017. The total travel time is 501 days during which the crew will become the first people to leave the Earth-Moon system, to travel furthest from the Sun and to travel closest to the Sun. While this is still a long time compared to our spaceflight experience to date, it is quite fast compared to standard Mars mission concepts with durations of two to three years. The faster mission and small crew size reduces the amount of food, water and living space that will be required, allowing for the use of a smaller spaceship. The faster mission also reduces the radiation exposure to the crew. The smaller spaceship means that the rockets needed to carry out

this mission are within the realm of today's technology. The two person crew requires a relatively small re-entry capsule, which can be made using state-of-the-art technology.

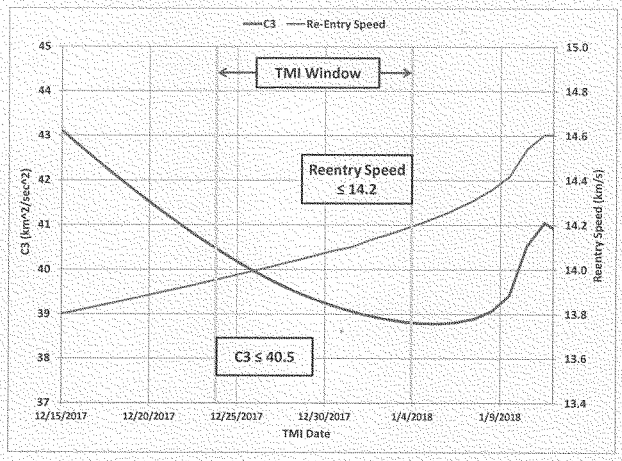

Figure 2-2. Constraints on Mission TMI Burn Date.

As shown in Figure 2-2, there is a fixed and finite window of time in which to execute the trans-Mars injection (TMI) burn for the Inspiration Mars trajectory. Due to the available rocket capabilities, the TMI window opens when the "C3" drops below 40.5 km^2/s^2 (C3 represents the minimum energy requirement to accomplish the mission for a given payload mass). Due to the limitations of the current heat shield materials, the window closes when the expected Earth re-entry speed at the end of the mission exceeds 14.2 km/second. This results in a TMI window from December 24, 2017, to January 4, 2018. Another similar opportunity does not arise for 15 years. The short time period between today and the launch window is both an opportunity to show the world what America can do as well as a challenging constraint that touches every aspect of the mission.

2.3 INSPIRATION MARS MISSION ARCHITECTURE AND SPACECRAFT DEFINITION STUDY

The Inspiration Mars Foundation commissioned a 60 Day Study to evaluate potential mission approaches and spacecraft design concepts that could be used to perform the mission. The challenges included launching the crew and all of the required spacecraft hardware into orbit and headed towards Mars, keeping the crew alive and healthy for the entire 501 day mission, and returning the crew safely from space to the surface of the Earth.

For the launch segment, the study looked at virtually every US launch vehicle available or in development, including the SLS and commercial launch vehicles. Operational scenarios included single and multiple launches, on-orbit rendezvous, docking and refueling, development of higher performing upper stages, as well as three and four stage launch vehicles.

In order to keep the crew alive and healthy, the study team considered the Orion spacecraft, Commercial Crew options, rigid cargo vessels and inflatable modules as options for living space. An environmental control and life support system (ECLSS) design concept was developed to identify the amount of water and food that would be needed as well as technologies to maintain a breathable atmosphere inside the living space.

The IM spacecraft will reenter the Earth's atmosphere at speeds up to 14.2 km/sec, much higher than any other manmade object. To safely carry out this critical phase of the mission we considered various options such as the Orion crew module, different commercial crew vehicles, a refurbished Apollo capsule and a new design optimized for the IM mission.

Two teams were established to work options leading to the best solution. The Primary Architecture Team was tasked with evaluating the potential to use the SLS rocket and Orion spacecraft to carry out the entire mission. A Backup Architecture Design Team looked at using existing and planned rockets, spacecraft and re-entry vehicles. Both teams leveraged the knowledge and experience of various NASA centers and organizations through the use of Reimbursable Space Act Agreements (RSAA) as well as resources from a wide range of industry partners.

The use of SLS and Orion was attractive for many reasons. First, these vehicles are part of the NASA Program of Record and are already progressing on their established development schedules. Second the Orion crew module could serve as both a reentry vehicle and the primary habitable living space (the use of an inflatable module for additional volume was also required). Lastly, the SLS-Orion offered the possibility that the entire mission could be done with a single launch which greatly reduced the overall mission complexity.

Unfortunately, the Primary team's evaluation of the SLS-Orion option uncovered many technical challenges. First, while the Orion spacecraft is being designed to perform a wide variety of mission scenarios, many aspects of the IM mission fall outside of that design envelope. One of these critical areas was the reentry speed. Orion's missions only require reentry into the Earth's atmosphere at speeds up to 11.2 km/sec, whereas the special IM trajectory would have the spacecraft reentering at speeds near 14.2 km/sec. While this is only a 27% increase in reentry speed, the physics of atmospheric heating produce heat loads that are several times greater. To survive the Orion spacecraft would need a new, thicker, heavier heat shield along with a strict mass limit that is difficult to achieve given the fixed geometry of the Orion crew module. Additionally, the specialized ECLSS needed for the 501 day mission and the amount of food and water required for the crew increases the launch mass of the Orion capsule to the point where a safe launch abort is perhaps no longer possible. With respect to SLS, the current program plan calls for the near-term development of an upper stage that is not capable of the producing the throw mass required for Inspiration Mars. However, the program plan does call for the development of the Dual Use Upper Stage (DUUS) in the early 2020's. This version of the SLS will have the required capability. Lastly, using SLS and Orion for IM would mean that people would be on board for the very first launch of the SLS rocket. The Inspiration Mars Advisory Board determined that this brought risks that were inconsistent with the safety goals established for the project. As a result, the combined use of SLS and Orion to perform Inspiration Mars mission was dropped from further consideration.

The Backup Team also faced challenges. Analysis of the existing fleet of launch vehicles (aside from SLS) showed that the mission would require three or more launches to get all of the

hardware into orbit. This would involve launching multiple rockets within very tight launch windows and subsequent multiple rendezvous operations. Additionally, in order for the existing upper stages to have enough propellant to achieve the necessary spacecraft velocity for the required trajectory, on-orbit refueling would be required. This technology has not yet been demonstrated on the scale required. The team also found that the planned Commercial Crew spacecraft are not being designed for any missions beyond low earth orbit (LEO). Hence, while they could be used to get the crew to orbit, they could not be used as living space or reentry vehicles. The Backup team did have success in identifying a suitable spacecraft for living space. The Cygnus pressurized cargo module (PCM) developed by Orbital Sciences has the size and design flexibility to be configured into a spacecraft large enough to provide the living space required per NASA standards and still store all of the required food and water. The Cygnus service module can also provide the power, propulsion and electronics needed for mission. Finally efforts undertaken by the NASA Engineering and Safety Center (NESC) and the Jet Propulsion Lab (JPL) under RSAAs showed the benefits of separating the systems needed to keep the crew alive for 501 days from the systems needed for the crew to survive the hours required for reentry. Therefore it made sense to utilize a small capsule that would only be used for the two crew members to safely reenter the Earth's atmosphere.

By comparing the findings of the two teams charged with developing the architecture needed to carry out the Inspiration Mars mission, a hybrid solution was developed. The IM Vehicle Stack, shown in Figure 2-3 would consist of a Habitat Module made from a modified Cygnus PCM and a Service Module that together would provide everything needed to keep the crew alive during the 501 day mission. Attached to the Cygnus would be a specially designed Orion Pathfinder Earth Reentry Pod (ERP) that would separate prior to reentry and return the crew to Earth. A Spacecraft Adapter would be used to attach the IM Vehicle Stack to the launch vehicle.

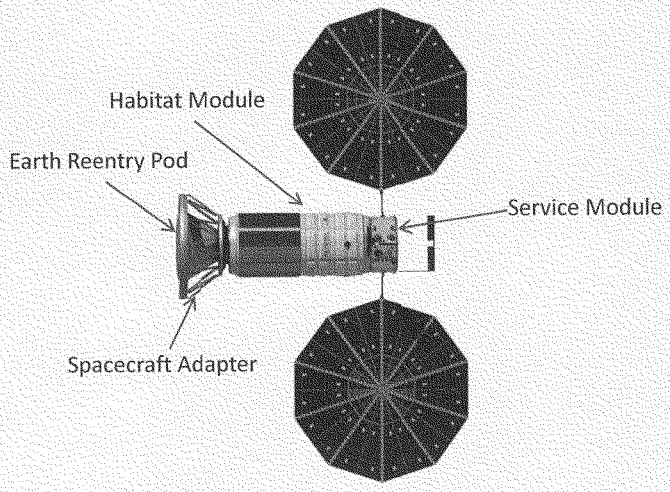

Figure 2-3. The Inspiration Mars IM Vehicle Stack.

2.4 MISSION OPERATIONS

Figure 2-4 shows the Concept of Operations (ConOps) resulting from the hybrid architecture solution. The IM Vehicle Stack would be lifted into LEO by the SLS rocket with the DUUS, the only launch vehicle with enough throw mass for the job. Then the crew would rocket into orbit using the services of a Commercial Crew provider. Once on orbit the Commercial Crew vehicle would dock with the IM Vehicle Stack, transfer the crew and depart. Afterwards, the DUUS would perform the trans-Mars injection burn to send the spacecraft and crew on their way to Mars.

The Martian flyby alters the trajectory of the IM Vehicle Stack sending it on a path to intercept Earth. Just prior to entry interface the crew would transfer over to the ERP and separate from the Habitat Module. The ERP would then carry out the Entry, Descent and Landing portion of the mission ending with a splashdown in the Pacific Ocean.

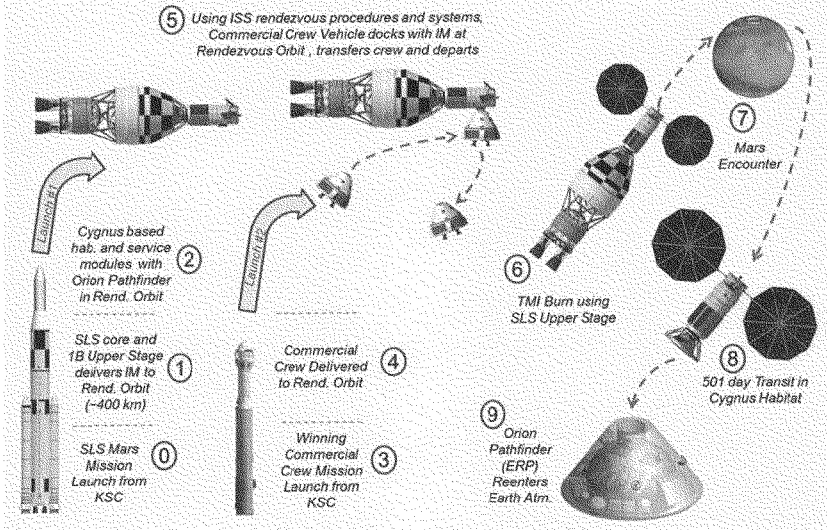

Figure 2-4. Inspiration Mars Concept of Operations.

2.5 CAPABILITY AND TECHNOLOGY DEVELOPMENT

While the Inspiration Mars program utilizes many existing and planned technologies, there is still much work to be done. Three of the key areas of focus for IM are the DUUS, outfitting the crew in-space HAB to maintain crew health and well-being, and the design of the crew entry pod and heat shield for reentry. The main requirements for the upper stage are as follows:

- **Deliver the IM Vehicle Stack to low earth orbit**
- **Loiter on orbit until the Commercial Crew vehicle can dock and transfer crew**
- **Propel the IM Vehicle Stack into the required free return trajectory**

Though SLS is scheduled to be ready for its first flight in time for the IM mission, the slated upper stage (known as the Interim Cryogenic Propulsion Stage, or iCPS) lacks the performance required for the IM mission. While other combinations of upper stages were studied, the planned DUUS is the most expedient and practical solution for the SLS upper stage. Boeing and the SLS program conducted a mission study which indicated that the DUUS should have sufficient performance for the IM mission. Completing the development of this upper stage in time for the mission will require a focused and dedicated effort. However, this development will markedly increase the initial payload capacity of the SLS for all future missions, providing benefits to our nation for future human exploration missions, but also for potential scientific and national security missions as well.

The fundamental driving requirements for crew health and safety are life support, environmental control and free habitable volume. These are summarized below:

- **Life support and environment control shall support the crew for a minimum of 501 Earth days**
- **There shall be a minimum habitable free volume of 5.7 m^3 per crew member, or a total of 11.4 m^3**

The above requirements and the fact that there are no identified mission abort scenarios after TMI drive the need for a high reliability ECLSS design based on the tested systems presently in use on the ISS. ECLSS development has already commenced through ongoing systems engineering and the development of an ECLSS Test and Development Unit (ETDU) scheduled for completion in December 2013. The ETDU will be used to test major life support functions in the baseline design.

The mission trajectory presents additional challenges for life support and human health. Though the mission will fly during a solar minimum, deep space radiation is still a significant concern, one that the IM study team has been studying for almost a year. A medical team, led by Dr. Jonathan Clark, has addressed the radiation exposure and a range of other medical issues associated with the IM mission. This team has determined that the risks are manageable with the relatively short duration of the mission. The human physiology research from the IM mission will certainly lay the medical groundwork for all future deep space missions

While "crew safety" is a mission requirement, a quantitative measure is needed to evaluate the overall mission design. To that end a crew safety risk the goal of 0.99 probability of safe crew return was established, which is consistent with other human spaceflight programs.

The third major area of continued study is the reentry speed and associated heating. As stated above the reentry speed of the ERP will be greater than any other man-made object. Given the significance of the reentry concern an RSAA was put in place with Ames Research Center (ARC) early in the study to address the vehicle shapes, entry trajectories and thermal protection system (TPS) materials that would be required to safely bring the crew back to Earth.

ARC recommended the use of phenolic impregnated carbon ablator (PICA) as the TPS material for the IM ERP heat shield. PICA has been used for multiple heat shield designs and has been successfully tested to heating rates of 1400 W/cm^2, higher than any other existing heat shield material. However, the reentry analyses done to date have shown that the ERP will be exposed to even higher heating rates. The PICA will have to be tested to these rates before the mission can be performed, but the plans for test facility upgrades only expand the limits to 2000 W/cm^2.

Hence this becomes both a restriction on the reentry trajectory and a critical test to be completed before 2017. Hence, the key requirements for reentry are:

- **The entry vehicle shall provide for safe recovery of the crew based on an Earth closing speed of at least 14.2 km/sec.**
- **During reentry the TPS materials shall not be exposed to heating exceeding 2000 W/cm^2**

2.6 PROGRAM TIMELINE AND MANAGEMENT

Aside from the technical opportunities associated with the Inspiration Mars mission, there are programmatic challenges as well. The schedule is admittedly tight with the DUUS and entry pod development having the highest priority for initiation. Extensive discussions with Boeing and the SLS program indicate that the DUUS could be developed in time for the Inspiration Mars Mission. Many other schedule challenges exist, but none beyond America's reach. The top level schedule is provided in Figure 2-5, summarizing an extensive schedule planning effort at the subsystem level with hardware providers.

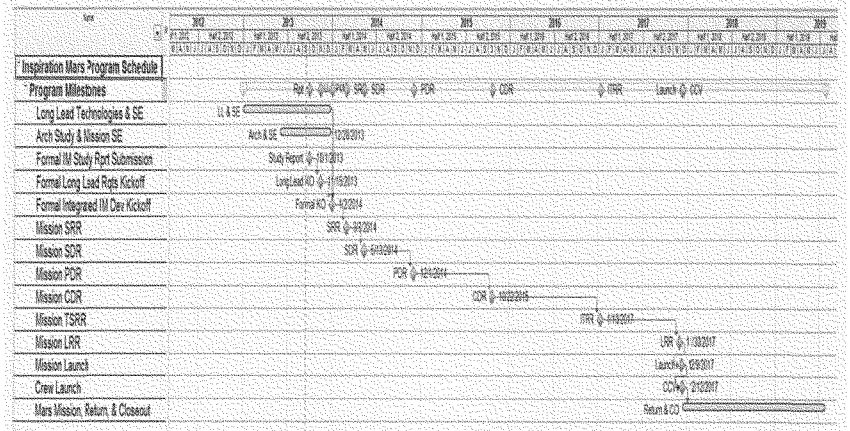

Figure 2-5. Top Level Schedule.

The Inspiration Mars mission is envisioned to be a private–public partnership between the Inspiration Mars Foundation (IMF) and NASA. This proposed partnership will enable the IM mission to benefit from the over five decades of human spaceflight experience by NASA as well the ongoing development of the NASA human spaceflight infrastructure. At the same time it also enables NASA to directly benefit both from the capabilities and technologies being developed by the IMF, the experience gained in the mission development, and the knowledge gained from having two humans in space for 501 days on this Mars flyby mission.

A Principal Investigator (PI) management model is well-suited to meet the IM mission management challenges. The head of IMF will be the PI with responsibilities including mission requirements, constituency development, crew life support systems/health/safety, and conducting payload mission operations. NASA and its industry partners' responsibilities will consist of providing mission infrastructure to include element launch, crew launch, crew transfer operations, the habitation module, trans-Mars injection, crew return, human spaceflight systems expertise, and crew training support. The IM organizational structure would provide NASA and the IMF with management roles consistent with their public-private fiduciary and legal responsibilities.

An IM Mission Development Management Team (MDMT) will be responsible for overall mission management, the payload and payload mission operations. The MDMT will be led by the IM mission Program Manager and comprised of empowered managers from the IMF, NASA and Industry. NASA and/or industry partners will be responsible for the mission infrastructure that supports the PI's payload including the spacecraft bus, system integration, launch and spacecraft mission operations.

2.7 RISK

The Inspiration Mars program leadership is intimately aware of the major challenges and risks this endeavor poses. Success of the mission is directly tied to the proactive mitigation of the risks. Together, the stakeholders and leadership of the Inspiration Mars mission have the capability to execute the necessary mitigation approaches while persistently identifying and mitigating risks as the program progresses. Table 2-1 provides the top 3 programmatic risks identified by the IM program leadership. While technical risks and associated mitigation approaches have been identified for the mission architecture, the programmatic risks in Table 2-1 are the most significant.

Table 2-1. Top 3 IM Risks

Risk Statement	Mitigation Approach
1. Schedule-Without establishing leadership commitments and organizational priorities that will promote the "can- do" environment needed to meet the January 2018 fixed launch date within expected budgets, the IM mission may not be executable.	Pro-active engagement of senior NASA and Industry Partner leadership to inspire their commitment.
2. IM needed elements (SLS, etc.) under development for the current Program of Record may be unavailable if their schedule is not maintained, thus jeopardizing the IM mission.	Ensure Stakeholders are aware of schedule criticality and responsible for maintaining schedule.
3. Development of the upper stage and a crew Earth Reentry Pod are susceptible to complications that can result in detrimental schedule delays.	IMF to work with NASA over the next 90 days to establish a development plan that takes advantage of a Skunk Works environment and puts under contract in a timely manner.

2.8 CONCLUSION

Inspiration Mars represents the next step in human exploration of our universe. The mission will be concurrent with the 500th anniversary of the first circumnavigation of Earth by Magellan and the 50th anniversary of the first circumnavigation of the Moon by Apollo 8. In May 2019, the

ERP will return the Inspiration Mars crew safely to Earth concluding the mission just prior to the 50th anniversary of Apollo 11.

There are definitely challenges in developing the flight hardware and accomplishing the Inspiration Mars mission within the time constraint. However, there is an overwhelming belief that this mission is not only technically feasible, but programmatically achievable in the short time frame remaining We believe it is well-worth the commitment, resources and hard work to take advantage of this truly unique opportunity.

The IM mission blazes the path towards human exploration of the surface of Mars. As the first step in the series of missions that includes visits to asteroids and the orbiting of Mars, the Inspiration Mars mission should not be seen as a change in direction for our nation, but rather an improvement in the tactical implementation of the current space policy. By taking advantage of virtually every major development in the current human spaceflight program (SLS, Orion, commercial cargo and crew, ISS testing, etc.), the IM mission creates synergy between the competing priorities of Commercial Crew and Human Exploration for the first time. The accelerated technology development will even provide benefits to national security.

We now call on our nation's leaders to seize this singular opportunity to begin human exploration of the solar system and affirm America's leadership throughout the world.

3. ACKNOWLEDGEMENTS

It is with upmost importance that we acknowledge those people and organizations that have thus far contributed to the Inspiration Mars mission and through their interest and belief in this mission have made this report and the future of the Inspiration Mars mission possible.

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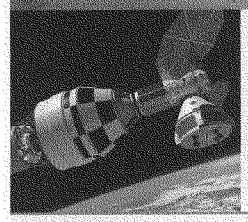
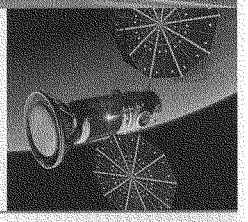


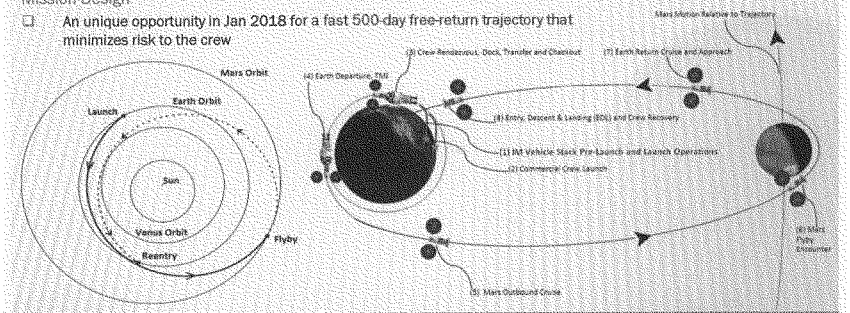
Inspiration Mars Goals

- An American crew – a man and a woman – on an historic journey to fly within 100 miles of the Red Planet and return safely to Earth
- Inspire a sea change in the U.S. Space Program and maintain leadership in space exploration
- Demonstrate feasibility of human missions to Mars and retire risks of human deep space exploration
- Foster knowledge, experience and momentum for space exploration



Mission Design

- An unique opportunity in Jan 2018 for a fast 500-day free-return trajectory that minimizes risk to the crew

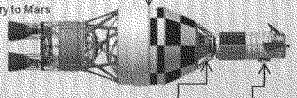


Vehicle Systems

- Leverage existing systems combined with custom new developments

Mass Margin Approach		
SLS TMI limit with performance margin reductions	19,000 kg	
SLS Performance over Margined Estimated Value	469 kg	3%
Margined Estimated Value	18,531 kg	
Average Contingency Margin	2,764 kg	17.5%
Current Best Estimate	15,767 kg	
Estimated Average Mass Growth Allowance	2,628 kg	20%
Base Mass Estimate	13,139 kg	
Total of Margin over Base Estimate	5,861 kg	45%

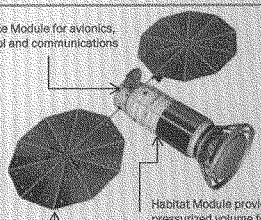
Cross section showing crew volume



Advanced Upper Stage to deliver vehicle stack on a trajectory to Mars

Payload Faring Adaptor

Docking portal for crew embarkation and Mars viewing

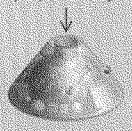


Service Module for avionics, control and communications

45% Cumulative mass margin

Habitat Module provides pressurized volume for crew

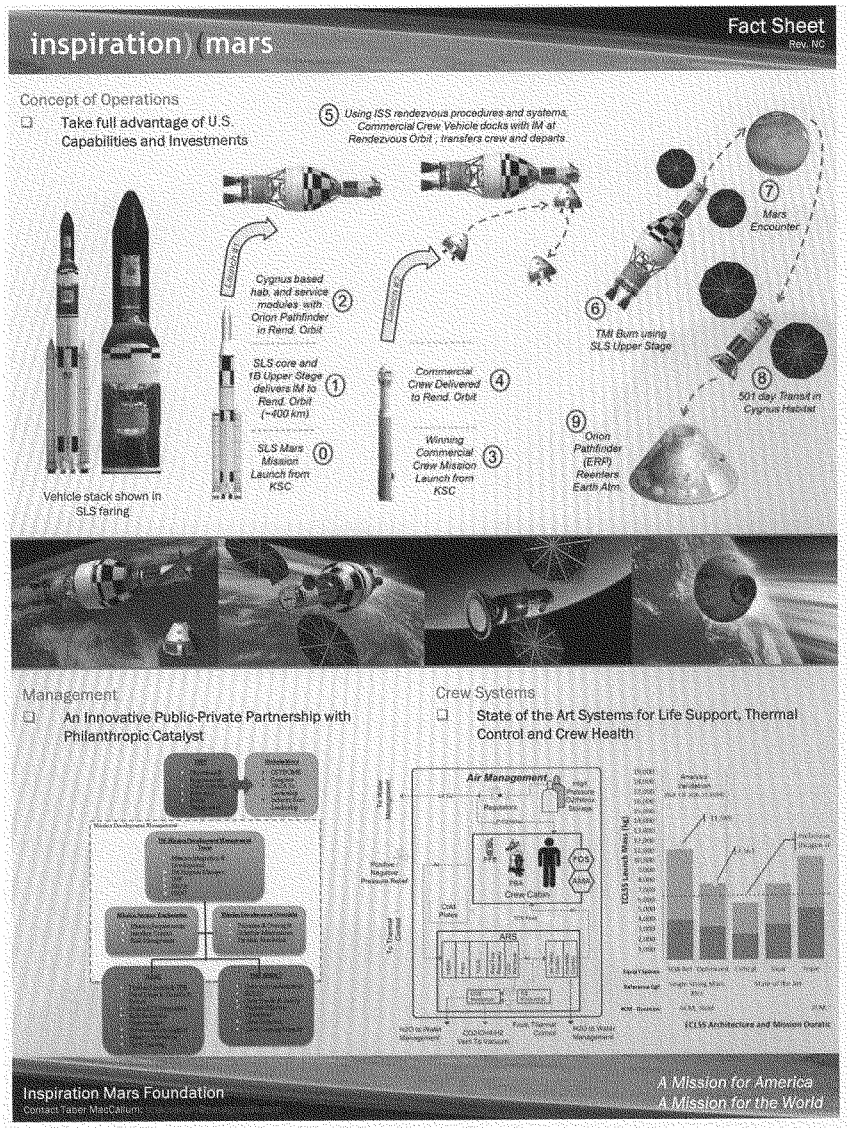
Solar Arrays provide primary power to vehicle systems

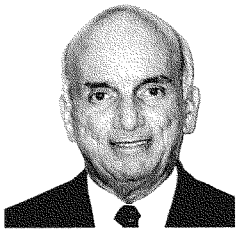


Earth Reentry Pod for high-velocity (14.2 km/sec) Earth reentry

Inspiration Mars Foundation
Contact: Taber MacCallum

A Mission for America
A Mission for the World


inspiration mars
Fact Sheet
Rev. NC
Concept of Operations
Take full advantage of U.S. Capabilities and Investments
5 Using ISS rendezvous procedures and systems, Commercial Crew Vehicle docks with IM at Rendezvous Orbit ; transfers crew and departs.
7 Mars Encounter
Cygnus based hab, and service modules with Orion Pathfinder in Rend. Orbit 2
6 TMI Burn using SLS Upper Stage
SLS core and 1B Upper Stage delivers IM to Rend. Orbit (~400 km) 1
Commercial Crew Delivered to Rend. Orbit 4
8 501 day Transit in Cygnus Habitat
SLS Mars Mission Launch from KSC 0
Winning Commercial Crew Mission Launch from KSC 3
9 Orion Pathfinder (ERP) Reenters Earth Atm.
Vehicle stack shown in SLS faring
Management
An Innovative Public-Private Partnership with Philanthropic Catalyst
Crew Systems
State of the Art Systems for Life Support, Thermal Control and Crew Health
Air Management
Crew Cabin
ARS
ECLSS Architecture and Mission Details
Inspiration Mars Foundation
Contact Taber MacCallum:
A Mission for America
A Mission for the World



Dennis A. Tito is the Chief Executive Officer of Wilshire Associates Incorporated, a leading provider of investment management, consulting and technology services as well as the Executive Director of the Inspiration Mars Foundation.

Tito earned a B.S. in Astronautics and Aeronautics from NYU College of Engineering and a M.S. from Rensselaer in Engineering Science. He began his career as an aerospace engineer with NASA's Jet Propulsion Laboratory at the age of 23. While serving at JPL, he was responsible for designing the trajectories for the Mariner spacecraft missions to Mars and Venus. Although he left to pursue a career in investment management, Tito remained interested in and committed to the exploration of space.

On April 28, 2001, Tito, who served as a crewmember of an eight-day Russian Soyuz taxi mission to the International Space Station, fulfilled his 40 year dream to orbit the earth.

In February 2013, Tito announced his intention to send a privately financed spaceflight to Mars by 2018 and founded the non-profit Inspiration Mars Foundation.

Chairman PALAZZO. Thank you, Mr. Tito. I thank the witnesses for being available for questioning today, reminding Members that Committee rules limit questioning to five minutes. The Chair will at this point open the round of questions. The Chair recognizes himself for five minutes.

The current third-party liability risk-sharing regime has been in place for almost two decades. The purpose of this regime was to assist a nascent industry that needed a backstop for possible third-party claims in the event of an accident. Please explain to the Committee why the indemnification regime is still necessary and what reforms to the current regimes are needed. Mr. Witt, Ms. Cooper, you briefly touched on this topic. Will you please explain in detail or elaborate in detail? Thank you. Ms. Cooper?

Ms. COOPER. Thank you, Mr. Chairman. The Commercial Space Launch Act risk management provision is absolutely essential and an appropriate use for government in the view of the members of the Satellite Industry Association. We strongly recommend that it be renewed before it expires.

The government's role in safeguarding for launch services is only at a very extraordinary circumstance. Under the FAA rules and the rules set out under the Launch Act, launch providers themselves are responsible for the bulk of damages that might occur if the unthinkable were to happen. The FAA sets a maximum probable loss limit of $500 million and expects their licensees to take responsibility for those damages, usually in the form of private launch insurance.

And I would note that those maximum probable losses cover not only all parties involved in the launch, including third parties, but also damages to U.S. Government property.

Damages in excess of that maximum probable loss limit of $500 million up to a cap of $1.5 million are what are at stake here in this launch liability provision. This was not just to protect a nascent industry but to ensure that the risk of launching a satellite or any other payload didn't require the company to pretty much bet the company every time they launched. This allowed the largest, most catastrophic damages to be safeguarded by the government.

I would note that this is appropriate. I looked back a little bit in 1988 when the first Commercial Space Launch Act was passed. The environment today in the marketplace with not only several commercial launch companies looking at launching satellites but also the extraordinary proliferation of interest and investment and exploration of commercial launch for other purposes is an environment far more like the 1988 environment than it was five years ago.

I would also note that international competition is far more intense, and other governments, the hosts of those other launch providers, offer comparable safeguards from significant damage.

And finally, I would just note that the U.S. Government itself carries liability that it has taken on under several treaties, the Outer Space Treaty, the Space Liability Treaty, and these are satisfied by the commercial space launch indemnification provisions, and we certainly think that it is an appropriate role for government and one that this Committee we hope will support extending. Thank you.

Mr. WITT. Mr. Chair? I have to learn my protocols. Mr. Chairman, this particular question to me is just foundational of the right way to do business. There seems to be a perception and then there is a reality, and the perception is that there is no skin in the game on the part of the operators. And the reality is, the way the law is written, there is $500 million at stake to the operator, plus they play this little game every day in Mojave called let us bet the company every time they fly. There is certainly no motivation to fail. There is certainly a motivation to be rigorous. But for a license launch, when it comes down to actually launching, the FAA, the Federal Government, makes the determination of the maximum probable loss and caps it, and it is the operator that has to find the insurance or post a bond if you will that they have financial solvency to cover any losses up to that limit. For 20 years the government has not been placed at risk. If a program that was put in place is working that well, I would look for some compelling reason to change it. I think it should be extended indefinitely. That is my opinion.

Chairman PALAZZO. Thank you. Mr. Tito, in your testimony you talk about a public-private partnership with NASA for a deep space mission and that in contrast to past development programs would be funded at least in part by private investment. How much do you expect this mission to cost private investors? Would those investors expect a return on their investment or would they be considered donations? And do you intend to ask for NASA for funding, and if so, how much do you plan on asking for?

Mr. TITO. Well, this is a philanthropic effort, so you would not consider any contribution an investment. Once a mission was established and ongoing, I think there would be the prospect of raising several hundred million dollars philanthropically but not until we actually have a mission on the manifest.

As far as overall cost over and above what NASA is already spending on existing programs, I would say that it would be less than $1 billion, and you subtract roughly $300 million which I think could be raised philanthropically over the five-year period between now and the end of the mission, it would cost the government about $700 million or about a little over $100 million a year.

Chairman PALAZZO. Well, thank you. My time is expired. I now recognize Ms. Bonamici.

Ms. BONAMICI. Thank you very much, Mr. Chairman, and thank you to the witnesses for your testimony. One of the things that I have emphasized since joining the Subcommittee last year is the importance of educating the public about the benefits of space exploration and justifying the investment which, those of us on this Subcommittee all believe in. And one of the things I wanted to point out and thank you for, Mr. Witt, is in your testimony talking about how there has been this spinoff potential beyond aerospace, especially with the discoveries being applied to, for example, conventional internal combustion engines, and I think the more the public knows about benefits beyond that in all-important leadership the more that we can convince the public that these are wise investments in space. So thank you for bringing that to our attention.

Ms. Cooper, the commercial satellite industry is one of the first commercial space industries and has really seen significant growth over the years. So as you consider the range of activities and issues being discussed here today, can you tell us from your experience what lessons have been learned that could benefit the other emerging space enterprises?

Ms. COOPER. Thank you. I think the commercial satellite industry in its origin has some similarities to other younger space ventures in that there were assumptions of a government role at the outset. There was an assumption that the idea of launching a satellite and building one was too complex, too costly, too risky for an individual company or country even to undertake it.

As the experience grew and the confidence in the capability on orbit grew and also as the idea of services and what was the value of those satellites grew, companies naturally entered the arena. I think that was a critical part for government regulation to establish rules of the road for a competitive environment, to allow enabling an environment, but also to establish how those companies would be able to compete with each other and for them what they needed.

For the commercial satellite industry, it is absolutely orbital slots which is an international regime managed by the International Telecommunications Union but also satellite spectrum which is needed not only to manage the spacecraft but also to deliver communication services.

That is probably our biggest challenge right now is that we have become almost so ubiquitous and so relied upon that the communications industry may forget that we are delivering these services from 22,000 miles away and that there are significant considerations when you figure out how you might be able to share that spectrum.

I would also just note the other consideration is safety and safety of flight. That is a genuine role for government regulation, and I think the partnership between industry and government is essential there to establish an understanding of what is in space and an understanding of what the private and government actors in space are doing for the safety of all in space. Thank you.

Ms. BONAMICI. Thank you very much. And for all of you, the work that your organizations are performing calls for innovation is certainly a highly skilled workforce to achieve the goals in certainly a competitive environment. So how important is the workforce to the growth of commercial space, and from your perspective, what is the most important thing we can do to ensure the future viability and sustainability of a workforce that is prepared for this type of work? I will start with Mr. Witt. Your thoughts on that?

Mr. WITT. Ms. Bonamici, that is a great question. That goes right to my heart. The last ten years I have served—11 years served on a college board, and I have learned a little bit about the education process in America. But for the last 20 years in my businesses and in my current business, I have required each one of my employees to spend four hours a year in a classroom.

Ms. BONAMICI. That is good.

Mr. WITT. And to a person. When I had my company here, when my current—everybody said only four hours? And I said, just curi-

ous, but how many did you do last year? And we all know the answer to that, don't we? Zero. And to set a standard in your own business and from your seats as Members of Congress, you have the opportunity to speak to people all over this Nation all the time. You all get invited for public events. People listen to your words, your policy and your words. Make it part of your daily speech to promote science and technology nationwide in this Nation. Do the little things. When you walk into a Masten space system and you—and I bring in teachers. We brought in students, but we now found out, you know, teachers in classrooms—I think I learned in our discussion at lunch one day—they have all the kids. If we bring them in for an hour, we have 100 kids and me for an hour. But these teachers have the kids all year long. Bring the teachers in. Spend the day with 30 teachers, and they have access to these kids for a year. Show them the passion. Show them the people. Take them into a Masten space systems and let them ask an engineer, if you could talk to your science teacher today in high school, what would you tell him? I remember that question specifically. And the kid with the wrenches and the T-shirts building a rocket says it would have been nice of you to come by my desk every now and then, but you are always worried about the lowest kid in the class or the brightest kid in the class. But somewhere I was lost in the middle. Those are powerful things to learn on the shop floor of a rocket factory.

But those are lessons we can extend, and you can extend in all of your daily activities in lunch rooms. Make it the standard that people make every employee that works for them spend four hours a year in a classroom. My janitor, who is trilingual, spends four hours a year in a classroom. There is a job for every kid, and their job is important.

Ms. BONAMICI. That is great. Thank you very much. I am afraid I have run out of time. I yield back. Thank you, Mr. Chairman.

Chairman PALAZZO. I now recognize Mr. Rohrabacher.

Mr. ROHRABACHER. I thought I was going to be down the line a bit. Well, thank you very much and appreciate the witnesses and certainly appreciate the leadership of the Chairman on this, making sure that we focus on this element of America's space program. This element of America's space program is playing an ever-increasingly vital role. I would like to first of all give my regards to Dennis Tito here who years ago took the initiative to show that one person could make a difference and could inspire a whole Nation. It is one thing to have a group of people working for the government, working together to accomplish something. It is one thing for this guy to on his own decide he is going to get something done and go out and do it. And I remember the first time I met Mr. Tito. We went out for dinner, and the waiter in the restaurant where we went asked, "Aren't you the guy who went into space?" And talk about inspiring people. I mean, this was—he was inspiring regular Americans out there. Thanks for doing that, Dennis, and not giving up on that job of inspiring people. I will hopefully work with you on your project. I don't know if we can get it done, but we will see what we can do. And it is inspiring to see you doing this.

Ms. Cooper, I want to get to some really basics here. One of the things that are limiting our ability to use space, commercial space

and otherwise, is orbital debris. At what point, are we reaching a point now where we are going to have to put the lid on what we are doing in space because of this problem?

Ms. COOPER. Thank you, Mr. Rohrabacher. For the commercial satellite industry we do not think that the orbital debris environment is limiting our ability to deploy new satellites. It does affect our operations. I will say that the commercial satellite industry takes extremely seriously its responsibilities to operate in space and to assist in the larger question of debris.

I want to point to a private initiative that many of the satellite operators have undertaken called the Space Data Association in which a number of satellite companies have pooled their resources to explain where they are in very specific ephemeris data, also to share information about what they see on orbit and also discuss EMI/RFI interference issues.

Mr. ROHRABACHER. Well, that is the—

Ms. COOPER. They share that with the Strategic Command as well.

Mr. ROHRABACHER. Well, that is very commendable that this is happening on a voluntary basis with your industry. I would suggest, Mr. Chairman, that dealing with the ever-increasing level of space debris might be one use of commercial space. There might be commercial people, people who commercially would like to go out and get the contract to dealing with space debris. And rather than simply make this a government program, it could be—we could look at it as a potential commercial program.

And I would also like to—I mentioned—Mr. Tito, I would like to mention Jim Muncy who is sitting back behind the panel today who never got credit for enormous things that were getting done in this Committee and in commercial space. Thank you, Mr. Muncy.

One note about how—Mr. Tito mentioned the Chinese might be doing things. I would suggest this, however. The Chinese get a lot of their technology by stealing it, and I would hope that we don't let thieves beat us to various important goals in space. But I would also hope that we don't partner with thieves. And until we see reform in China, we should not be partnering in space ventures with the world's worst human rights abuser.

Finally, Mr. Witt, what would you say—you know, you are right there in the front. I just mentioned space debris. Could you give us a couple of ideas of where commercial space—are we going to have a ride between—are we going to be able to deliver a FedEx package yesterday to Tokyo?

Mr. WITT. It is certainly in the possibility. I think one of the Members have recently asked me what is the timeframe for point-to-point suborbit travel, halfway around the world. Is it five years, ten years, 50 years? I think the answer is it could be in the ten-year regime. It is more likely going to be in the out years, but we certainly ought to be thinking there now. It is time for us to take the long view of the future and start setting the stage for policies and planning for it today. This is not revolutionary. This is frankly evolutionary. It is going from props to jets. Now we are going from jets to faster jets and air breathers and using a different band of

the atmosphere. But it is certainly possible. And I hope it happens in my lifetime, Mr. Rohrabacher.

Mr. ROHRABACHER. Mr. Chairman, thank you again for your leadership, and let me just note on the last point that was made that suborbital space and the development of that for the benefit of mankind is being done basically through private investment, and that is something that we can be very proud of, that our innovators are capitalists. And Mr. Tito, by the way, is the ultimate capitalist involved in this, that people are putting their own resources to this and suborbital space could change the very nature of transportation and again lead us to a new era of humankind. Thank you very much, Mr. Chairman.

Chairman PALAZZO. I now recognize Mr. Bera.

Mr. BERA. Great. Thank you, Mr. Chairman. You know, as a child who grew up in the 1960s and early '70s in the heart of the space race, obviously it captured our imagination. I think everyone in this room who grew up in that era would love to see that sense of curiosity, that sense of awe and wonder that inspired multiple industries, inspired many of us to go into science and inspired a generation.

The challenge I have right now is my one year in Congress. And I will ask the members on the panel, could you in a sentence clearly define what NASA's mission is today, what we are trying to accomplish in a way that President Kennedy clearly defined what we were aspiring to within a specific timeframe and so forth. And, as a Member of the Space Committee, I think I have a hard time. So I would ask you what our mission is today, the one that inspires folks that has been clearly articulated to the public?

Ms. COOPER. The commercial satellite industry is a little bit adjacent to NASA, so I am going to yield to my colleagues on the panel.

Mr. BERA. Okay.

Mr. WITT. Sir, it is outside my area of expertise, but I do get asked that regularly, and my answer has not changed. America deserves, expects and demands a forward-leaning, well-funded, laser-focused national space agency, focused on the big jobs, the big deals. Where the commercial industry should fill gaps, we should fill the gaps and we should be allowed to fill those gaps in earnest, and it is private enterprise. But we deserve, expect and demand a forward-leaning, well-funded laser-focused national space agency.

Mr. BERA. Mr. Tito?

Mr. TITO. Well, in 1957 when the Soviets launched Sputnik, that changed the world as far as I was concerned and put America in the minds of a lot of people in the world as number two technologically. And one of our responses was to form NASA to lead our space program. And the role of NASA of course was for scientific purposes, to develop technology like the preceding firm NACA did for the aircraft industry. But the real mission of NASA at the beginning as we all know was to win the space race. And we did win it after ten years, and somehow we don't have that drive that we had 50 years ago. And we may be in a position of having Sputnik occur again. Sputnik will be in flight to Mars by either China or Russia.

Mr. BERA. Well, would it be reasonable then to push the administration as well as the NASA Administrator to perhaps define manned space travel, human space travel, to Mars within a certain timeframe as a mission that the public can grasp that then within that context we could look at what is the role of the private sector and commercial space travel to help us get there, as well as what is the role of the Federal sector in terms of NASA and the funds that we would have to appropriate? But you know, again, I would challenge the administration as well as the NASA Administrator to clearly define that because then it makes our jobs a lot easier to say, okay, what framework allows us to both take the public sector and the private sector working together in an innovative way to go out there, capture the public imagination?

Mr. TITO. Look, we are at a point where we have to make a decision as a Nation. We can either make a decision to spend a relatively small amount of additional funds to a very expensive human exploration program now that does not have a mission and make a mission out of it, and be the first to get to Mars, or by not making a decision, we will be forfeiting that opportunity.

Now in 2021, we could get to Mars, but we may not be the only ones. It is an interesting mission. It is Venus and Mars, and of course, we are proposing a man and a woman. That would make a very interesting combination.

But I think we have to really look at this opportunity very seriously and decide one way or another as to whether the United States should pass on it or act on it.

Mr. BERA. Great. I think that is a great place to end. I will yield back.

Chairman PALAZZO. Just to add, you know, Mr. Bera asked the same question a lot of us have been asking ourselves, and we get asked it a lot. And I would just like to reiterate that is one of the reasons why the NASA Authorization Act is so important. It does establish a roadmap for NASA so we can come up with a timeline, destinations and focus, laser-like focus and back it up with our resources to achieve that objective.

At this time I recognize Mr. Bridenstine.

Mr. BRIDENSTINE. Thank you, Mr. Chairman, and I would just really like to thank the panel. You know, I firmly believe we do have an opportunity to advance rocket science and space technology in the private sector in many cases apart from the whimsical budgets of us politicians. And what you guys are doing in that area is unique and special, and you are really leading the way and I appreciate that very much.

What I would like to ask Mr. Witt, part of your testimony you talked about ITAR, and some of the regulations that are affecting the commercial space flight industry, maybe space tourism. Would you share with us a little bit about how ITAR is affecting the businesses and the industry at the Mojave Air and Space Port?

Mr. WITT. Sure, Mr. Bridenstine. Did I get that right?

Mr. BRIDENSTINE. Yes, sir.

Mr. WITT. ITAR. If you have a rocket and you have a human attached to that rocket, you are born into ITAR. So you are regulated by the International Treaty and Arms Regulations.

The developers at Mojave, let us just put a name to them, Masten, XCOR and Virgin Galactic, all seek to make their industry a worldwide industry. They want to take American products and extend them around the globe. One of those investors happens to be an international investor, Sir Richard Branson. So isn't it ironic that an international investor developing a system in the United States currently under current law can't fly it outside the United States?

I believe we have grown up in a new day. There are new products. We have agreements all around the world with nations that want to explore space for peaceful purposes. Space tourism is a great example. If I could choose a location where I would like to fly, a suborbital space flight, I would like to fly through the aurora borealis out of northern Sweden. It is fast. Why not? Fly at night. Do something that no one else has done, like Mr. Tito suggests.

This is what is possible. But unless we find some relief on the ITAR regulations and really crack that can open and take a look, I don't think we are going to be able to extend these things internationally and we need to. It is good for American business.

Mr. BRIDENSTINE. When you think about the market for whether it is space tourism or private space suborbital science experiments and exploration, that market exists in large part outside our own country, while it does exist in our own country. Could you give maybe an example of how big that market would be if we were able to take that market outside the United States?

Mr. WITT. The Tauri Group is a great place to ask that question. I am not an expert in that, but I do know the studies are out there and the numbers exist. And I would recommend to the Committee that you ask for that, maybe through the CSF.

But it is a market. Like Mr. Tito said, if we don't provide the services, they are going to buy the services from providers that are willing to provide the services. They are out there.

Mr. BRIDENSTINE. Right.

Mr. WITT. I think we need to be in the game in all corners, and I think if you are not trying to find relief—I totally agree with Mr. Rohrabacher's comments. But ITAR is more than a speed bump as currently written.

Mr. BRIDENSTINE. When you think about investment in the private space flight industry, we think about high net-worth investors. Can you share, what is the resistance or is there resistance to receiving investment from institutional investors? Is it happening, is it slow to happen? Can you share a little bit about that?

Mr. WITT. I don't have any examples of that currently. The majority of my tenants are the high net-worth investor. Some institutional investing is starting to show up. I have said for years we will have an industry when we have an underwriter——

Mr. BRIDENSTINE. Right.

Mr. WITT. —and we have Wall Street. We are starting to show signs of both. But I think it took some successes and namely by SpaceX, now Orbital Sciences, now Boeing. It is going to take a new day, new players in the system showing enormous successes to start drawing in the more institutional, conventional investment. And I think it is beginning to happen.

Mr. BRIDENSTINE. And of course, indemnification, which you guys are very interested in is a key piece of attracting that kind of institutional investor, is that correct?

Mr. WITT. It brings certainty to the game, absolutely. And I think we look to the government to be a good partner. We can't keep moving the goal posts or changing the rules. The indemnification regime is sound policy. It has worked.

Mr. BRIDENSTINE. Right.

Mr. WITT. And the operators have the skin in the game first, and the government portion has never been used.

Mr. BRIDENSTINE. Roger that. Thank you. I yield back.

Chairman PALAZZO. I now recognize Mr. Veasey.

Mr. VEASEY. Thank you, Mr. Chairman. I want to ask you a little bit about commercial space activities and pop culture. I know that you probably have saw that Lady Gaga was going to be the first person to perform in space. I think that is going to happen sometime in 2015, and I believe she is going to—I think it is in conjunction with Richard Branson. I was just wondering what you thought of pop culture and how maybe it can play a role in sort of aiding or just getting people more interested in what is going on in commercial space travel.

Mr. WITT. Is that for me, Mr. Veasey?

Mr. VEASEY. Yes.

Mr. WITT. Okay. Lady Gaga. Okay. I got to admit, I didn't know I was going to get this question in front of Congress.

I will tell you, I do have an answer for that. I think you raise a valid question. When you talk about the totality of an industry, industries usually come along with different things like fashion, food, housing, all those certain elements are key to commercial space. What will you take? What provisions do you need? How long do you plan to be on this journey? What do you wear? All these questions.

But the industry on the ground around that tends to mirror trends. And I don't know anything about the Lady Gaga, Sir Richard Branson thing you mentioned. It is a little out of scope for Mojave. But I do know that fashion design and pop culture—I mean, Rocket Man.

Mr. VEASEY. Elton John.

Mr. WITT. Elton John.

Mr. VEASEY. Right.

Mr. WITT. I mean, there you go. I play it every time we launch a rocket. So it is certainly important to capture the young people and to get them engaged. It certainly has a role, and I think it is greater than just the pop culture. It is more fashion, design, food, the whole industry.

Mr. VEASEY. Do you think there is anything that NASA could possibly learn as a—you know, because one of the things about Richard Branson, like for instance even in commercial air travel, if you go to his airline, whenever you are getting your ticket at the kiosk, they are playing Red Hot Chili Peppers, there is a different sort of a vibe. And obviously some of the things that they are doing with pop culture and this Lady Gaga flight is really interesting.

Do you think that is something that NASA can learn in order to maybe inspire a lot of young people that may be interested in space

travel or may even maybe be able to sort of catapult space travel to what it probably was like back in the 1970s and early '80s for a lot of young people?

Mr. WITT. It is possible, but it is an engineering organization, and engineers don't tend to think in terms of pop culture. It doesn't come oozing out of them naturally. But certainly NASA could use a dose of marketing skills that come from the Branson organization. They are expert at that and selling the brand and selling the concept. You would think that the NASA experience that I grew up with and watched on TV that brought me into this industry, it could use a jolt of reinvention. And what I think you are really asking is what is the value to the buying public? If you have a choice of buying airlines—if you have ridden on a Virgin flight, they are different, they are fun. That brings value to exchanging money for your ticket. Maybe there is a value proposition that needs to be revisited in the rebranding, rediscovery of the future NASA.

Mr. VEASEY. Thank you. Mr. Chairman, I yield back my time.

Chairman PALAZZO. I now recognize Mr. Schweikert.

Mr. SCHWEIKERT. Thank you, Mr. Chairman, though I don't know if I am going to be able to reach the heights of pop culture sort of inquiry, but I guess I could embarrass my wife and go, who is Lady Gaga?

But in all sincerity, okay, privatization, private ventures, now the next question is on the financing, the access to capital. When I look at much of what I see in the private investments and what is going on in Mojave, I don't want to—well, I am going to refer to it somewhat as vanity capital. You know, some of the ventures are funded substantially with a handful of high net-worth individuals, with great hopes and dreams because it is their interest, their hobby. Where are we going on the financing mechanisms where the investment side—now, we know the satellite industry now has some terrific rates of return. Where is the next level of investment where I see an investment index that is where it is a more referred to as sort of egalitarian investment mechanic? How far away? Please, give me some concepts of where the money is going and coming from.

Mr. TITO. About ten years ago I actually did consider making an investment in one of those organizations that you referred to at Mojave, and somehow I just wasn't able to pencil it together as an investment that would provide return on investment given the risk involved. And one of the problems with investing in space programs is that you have to develop a business model, and the business model is how much are people going to pay to participate in the sort of mission? And as you know, there were seven people that paid to fly orbiting the Earth on the Space Station with the Russians at a fairly high price. And you know, that market is limited.

Mr. SCHWEIKERT. And maybe part of this is for Ms. Cooper. We do now see I guess a series of very standardized structured investments to finance communication satellites, satellites that drive data. From your view of the world from the satellite industry, is that the future for other types of financing mechanisms?

Ms. COOPER. Thank you. Certainly the experience in the commercial satellite industry is three parts, inspiration, the creative aspects, which sometimes comes from governments or countries or

multilateral groups. But the satellite industry certainly has had individual high net-worth investors, like Rene Anselmo who founded PanAmSat, the first company I worked at, ——

Mr. SCHWEIKERT. But literally—your third?

Ms. COOPER. And then you have to—if I may go then to the second piece which is you have to show a certain technical capability to deliver the service. And finally, you have to close a business case to show how you are going to sustain what is typically a high, upfront investment cost. That, at that third phase, on a sustainable rate of return kind of approach is where the more traditional investors respond.

Mr. SCHWEIKERT. Yeah, I mean, let us say it was this afternoon, and we decided that I am putting money into a satellite. My understanding is most satellite launches are sponsored. It is, you know, we are a company. It is communication. We need 40 percent of the bandwidth capacity. The rest will be sold off. The ability to—do they sell interest in that? Could I find an exchange or a broker or a platform to buy and sell and finance that launch?

Ms. COOPER. I am not aware of any exchanges for the launch. What I can say is that the commercial satellite piece of it——

Mr. SCHWEIKERT. And when I say that I mean the whole package.

Ms. COOPER. The commercial satellite nowadays is almost—the financial environments reward a satellite with an established, prelaunch customer base. Often as much as 80 percent of the satellite's capability is booked pre-launch.

Mr. SCHWEIKERT. Okay.

Ms. COOPER. And then the excess of that is sold after launch, after the satellite has been put in orbit over the course of its 15-year lifespan. There are certainly satellites that are speculative, that are built with a customer base to be determined.

Mr. SCHWEIKERT. I would like to learn more about that because a year ago I was approached by some folks that literally wanted to set up—the closest thing I could refer to it is like a REIT that would be based in financing, the construction, the maintenance, the launch of the satellite and you know, literally selling its bandwidth.

Mr. Chairman, with that I yield back.

Chairman PALAZZO. I now recognize Ms. Edwards.

Ms. EDWARDS. Thank you, Mr. Chairman. Thank you, Mr. Chairman, and thank you very much to Ms. Bonamici for sitting in for me earlier. I had a conflict. I really appreciate our witnesses here today. Mr. Tito, it is good to see you again.

I want to reiterate, and I know my statements has been submitted for the record, but I want to reiterate to Chairman Palazzo my commitment to working with him and with the Chairman and the Ranking Member for a clean one year extension of the commercial launch indemnification provisions, and I hope that over this next year we really will take to the task of doing the kind of oversight hearings that we need to give the commercial space industry, the kind of certainty that we need with respect to indemnification, and we can only do that if we get the FAA in here and get experts in so that we can look at the future environment and climate with

respect to commercial activity. But I do support a clean one-year extension as we are approaching that date of December 31.

To all of the panelists, I think that much of what we think of as commercial space really involves a lot of significant government contribution, and sometimes we don't hear that. And in fact, the delineation between public and private appears increasingly blurred. As somebody who came out of NASA, I think it has always been a little blurred, and that is okay. But how should Congress and its oversight role look at the role of public-private relationships to ensure that both taxpayers and commercial entities' interest are appropriately considered? And then I would like each of you if you would give me an indication as to whether you know how much in fact taxpayers have contributed to the current commercial environment?

Ms. COOPER. For the commercial satellite sector, there is not a taxpayer contribution. These are privately financed, privately launched, privately operated satellites. Obviously there is government regulatory regimes that license and oversee those. It is my understanding at the FCC for example that those license fees are cost-based in terms of the agencies.

Ms. EDWARDS. What about the technology that went into the commercial satellite industry? Any idea of the contribution of NASA or any of our agencies in terms of their contribution?

Ms. COOPER. I am not aware of any government programs to develop commercial satellite technology. There certainly is an interplay between the commercial satellite sector and the broader space enterprise where products that are developed in the NASA context may later be commercialized.

Ms. EDWARDS. Okay. Mr. Tito, in the Architecture Report that is attached to your statement it says that, "perhaps several hundred million dollars in new Federal spending could make this mission happen." Are you suggesting that the mission couldn't be undertaken without additional NASA funding? And is there evidence in the current fiscal environment that those several hundred million dollars would be available?

Mr. TITO. Well, right now I don't see a lot of evidence that money is available. We do have an opportunity in four years, but we have an opportunity in eight years and a lot can happen.

Ms. EDWARDS. So when you say several hundred million dollars would be required from NASA. Is that $100 million? Is it $900 million?

Mr. TITO. Well, I think initially we are talking about per year basis, so it might be $100 to 200 million a year would be needed to fund the dual use upper stage which the Nation needs anyway to provide heavy lift capability. So that would be one project that would have to take place.

Ms. EDWARDS. And that would require taxpayer support, right?

Mr. TITO. Yes.

Ms. EDWARDS. Okay.

Mr. TITO. And it is already planned, but it is not funded yet over the longer time period.

Ms. EDWARDS. And Mr. Witt, do you have an idea of how much taxpayer support has gone into the commercial activities that you are engaged in or that others of your partners are?

Mr. WITT. Well, Ms. Edwards, I can only speak to Mojave Air and Space Port. We are a California special district, so we are a quasi-government entity that can qualify for Federal grants from the FAA and others. And I think I gave that to the committee, and I could give you a number but the exact number was submitted in my packet. But it was a good question, and we did extend a runway and we bought a fire truck. So we are talking in terms of a couple million dollars. But my organization, if we don't make money, I don't pay my employees. I don't get any operational funds from anyone. I have to run as a business. And so there has been some public investment, but in terms of my total operation, it is small.

Ms. EDWARDS. And I will close, Mr. Chairman. I guess the point is—and I don't mind that and I really do understand the point of the commercial space industry is to make money. But I think sometimes the public gets confused as though somehow this industry would just be off and going on its own without the requisite support of technology and other kinds of development and investment that the taxpayers made. And I think we get a great benefit for the bargain, but I don't want to pretend that we can engage in this activity without the hand of the taxpayer in there helping it out. Thank you very much, Mr. Chairman.

Chairman PALAZZO. I now recognize Ms. Wilson.

Ms. WILSON. Thank you, Mr. Chair. This is a very interesting hearing this morning, and bringing in Lady Gaga just made it even more exciting for people to look forward to.

I have a question for Ms. Cooper. In your statement you note the satellite industry association support for extending the U.S. commercial launch indemnification regime which expires at the end of this year. How in concrete terms would the absence of the indemnification provisions affect the U.S. commercial satellite industry in terms of price, market share or revenues? And on what data do you base your conclusions?

Ms. COOPER. Thank you. I don't have any statistical surveys for that question specifically. I will note that the commercial satellite sector primarily has not been launched by U.S. launch vehicles over the past five years certainly. Those launches are primarily held by European or Russian satellite launch operators. But there is a great deal of interest in the emerging capabilities of new and existing satellite launch providers for the United States. Absent the commercial launch indemnification, we expect that the prices for launches would have to incorporate additional risk assumed by the launch providers, perhaps affecting the competitiveness of those U.S. providers in that international launch community. I don't have data on how much—that would be speculation. Thank you.

Ms. WILSON. Okay. Thank you. Mr. Witt, the SOARS Act seeks to introduce a number of provisions to streamline commercial space flight. I would like to understand from your perspective what is missing from the existing law that needs fixing and how in your view the SOARS Act would address those issues.

Mr. WITT. Okay, Ms. Wilson. The SOARS Act as presented has two provisions I believe in Section 2 and one in Section 3, and the two in Section 2 basically provide one-stop shopping for an applicant seeking a license to operate and currently—almost have to un-

derstand the FAA to understand the provision in the law. But the way the FAA is organized, they have people that manage air traffic control, they have people who fund airports, they have people who license pilots in aircraft and maintainers. And then they have people who license launches. Well, we have a new day. Now we have airplanes, purpose-built airplanes that are stage one that carry a rocket aloft and then launch. So you have this hybrid. Where does it fit? And it creates again some uncertainty in the current law because we have new developments. And the law just aims to streamline that in Section 2. The Section 3 provision, and it really is a great provision, where commercial companies can provide training for participants who choose to buy tickets to go to suborbit on commercial lines. It is a mechanism for training these people to make them aeronautically adaptable to the flight they are about to take. If you can imagine being in a very confined space with six colleagues for an hour to go to space, it would—I think if you spend $250,000 or $100,000 for that experience, it is reasonable from a business perspective to assume that all of you had similar training before the experience so you could handle it physiologically.

That is what provision three intends to allow. The question I had in my testimony was does that belong under AVS at FAA or does it belong under AST? When I reasoned myself through that and spoke to the experts of which I am probably one with, I had questions about it. I think we could, if we don't get it right and I think it is a good measure—I just want to get it right the first time where we are not going down the land of unintended consequences because of how you work within the FAA. I think you could leave it up to the Administrator or leave it up to the Secretary of Transportation to solve it. I think they will find a way to solve it within the Agency. But I think it is a good provision. I just don't know if the way it is written is clean.

Ms. WILSON. Thank you.

Mr. WITT. Yes, ma'am.

Ms. WILSON. I yield back the balance of my time.

Chairman PALAZZO. All right. At this time without objection the Chair recognizes Mr. Takano for five minutes.

Mr. TAKANO. Thank you, Mr. Chair. I appreciate this opportunity. Mr. Witt, I really did enjoy my visit to Space Port. What you have there is a tremendous ecosystem of entrepreneurs and researchers, and it calls to mind the early days of Silicon Valley, and I wish you well in your enterprise.

Ms. Cooper, I am curious about your comments about the spectrum. What are you specifically saying that needs to be done? Do we need to preserve a certain part of that spectrum for your industry? And tell me, is it not possible for your industry to actually compete in an auction for the spectrum vis-&-vis the communication companies?

Ms. COOPER. The commercial use of radio frequencies spectrum is regulated by the FCC and coordinated internationally with the International Telecommunications Union. There are existing allocations for satellite services of a variety of different ways. It is enormously complex. We have a number of different swaths of the radio spectrum.

The issue today comes from this press towards trying to find additional spectrum to allow new services, more broadband to your mobile phone, more services throughout the telecommunications world. And how can we share and make efficient use of that spectrum. The concern that the satellite industry has is that those ideas of collaborating and sharing frequencies need to be thought of a little differently for satellite services. We need very clean spectrum to communicate so far away, and we file regularly at the FCC and engage regularly with both—the FCC is the regulator of commercial spectrum and NTIA at Commerce, the regulator of the Federal spectrum—to make sure that if they are considering adding another unlicensed user or co-primary or secondary user in the frequencies we are already using, have invested in it and have spacecraft, you know, spinning away for 15 years, that we can continue to use that frequency not only with high reliability but with the high level of quality that media customers, broadband customers, U.S. military require.

Mr. TAKANO. Well, thank you. Mr. Witt, I also visited the Dryden Space Center at Edwards along with my visit to you at Space Port. What struck me there was the tremendous research going on there. And you and I talked about the role of basic scientific research or the partnership. I am concerned about our country losing its preeminence or its exceptionalism in research and development of new technologies. Would you support more money available for aerospace research or that end of NASA? People forget that NASA also has aeronautical as part of its mission.

Mr. WITT. Mr. Takano, yes, in a short version. And we have done something beyond that. David McBride, the Center Director of NASA Dryden, and I were on a trip to Europe together. And we decided we would do a home-on-home. We would actually trade engineers for a year. An engineer from NASA Dryden would come to work for me, and we would find a way to work in kind the other way. So they found out there was a mechanism within NASA to do that, and we are just completing that first year.

Mr. John Kelly worked with us at Mojave, and it was a way that we thought was a fantastic way to share ideas, best practices, to actually institutionalize some of these lessons learned, the people's investment if you will, back to Mojave, and with the other companies.

There is a lot that can be done in no atmospheric research by the national space agency through Dryden, very much so. I would very much support.

Mr. TAKANO. Real quick. Can anyone tell me, who indemnifies the European launches since they are, so many of our satellites—do we know if the European Union subsidizes those or not? It would be interesting to find that out.

Also, I want to put a plug in for the wonderful simulator experience I had, and I would love to see more opportunities for young people to visit the Dryden Center and also participate in some of their experimental flights. That would be a great way to try to promote STEM education. I appreciate the common interest that I share with my conservative friend, Mr. Rohrabacher, and private space—in California. That is one where you and I share a common interest. I yield back, sir.

Chairman PALAZZO. The gentleman yields back. I want to thank the witnesses for their valuable testimony and the Members for their questions. The Members of the Committee may have additional questions for you, and we will ask you to respond to those in writing. The record will remain open for two weeks for additional comments and written questions from Members. The witnesses are excused, and this hearing is adjourned.

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

Appendix I

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Ms. Patricia Cooper

Patricia A. Cooper

President, Satellite Industry Association (SIA)

Before the House Committee on Science, Space, and Technology

Subcommittee on Space

Hearing on Commercial Space

Responses to Questions for the Record

January 29, 2014

Questions Submitted by Rep. Steven Palazzo, Chairman, Subcommittee on Space

1. *According to experts in the insurance industry, there is a large pool of capital available for launch and payload insurance but this pool is also used for various other types of specialty insurance and is susceptible to quickly changing world events. What can Congress do to ensure this insurance does not become prohibitively expensive for U.S. manufacturers and launch providers?*

In general, the Satellite Industry Association (SIA)[1] observes that the markets for satellite manufacturing and space launch services are quite competitive and subject to market forces, as is the related market for launch insurance. As such, the pricing of insurance against the possibility of partial or complete launch failures is heavily affected by both the value of the launch vehicle and the satellite payload being launched and by the perceived riskiness of the launch service. These factors also influence the amount of capital provided by insurance companies participating on launch insurance policies, and are generally well-understood by the insurance providers.

Governments of launching nations do, however, play an important contributing role by offering indemnification against the possibility of extraordinary third party injuries or damages caused by launch failures. Indemnification allows aerospace manufacturers to operate more

[1] SIA Executive Members include: The Boeing Company; The DIRECTV Group; EchoStar Corporation; Harris CapRock Communications; Intelsat S.A.; Iridium Communications Inc.; Kratos Defense & Security Solutions; LightSquared; Lockheed Martin Corporation.; Northrop Grumman Corporation; Rockwell Collins Government Systems; SES Americom, Inc.; and SSL. SIA Associate Members include: Artel, LLC; Astrium Services Government, Inc.; ATK Inc.; Cisco; Cobham SATCOM Land Systems; Comtech EF Data Corp.; DigitalGlobe, Inc.; DRS Technologies, Inc.; Encompass Government Solutions; Eutelsat America Corp.; Globecomm Systems, Inc.; Inmarsat, Inc.; Exelis, Inc.; Marshall Communications Corporation.; MTN Government; NewSat America, Inc.; O3b Networks; Orbital Sciences Corporation; Panasonic Avionics Corporation; Raytheon Space and Airborne Systems; Row 44, Inc.; Spacecom, Ltd.; Spacenet Inc.; TeleCommunication Systems, Inc.; Telesat Canada; The SI Organization, Inc.; TrustComm, Inc.; Ultisat, Inc.; ViaSat, Inc., and XTAR, LLC.

effectively by reducing the need to secure private insurance for so-called "black swan" events – launch failures that are both extremely damaging and very unlikely to occur – and price them into customer contracts. Indemnification also allows the insurance market to provide the primary working layer of coverage with sums insured (as dictated by the Federal Aviation Administration) that are considered acceptable by underwriters. This allows the private insurance market to focus on the events that are the most likely to occur and the best understood, reducing overall risk exposure. Helping the market focus on the more probable events helps keep the cost of insurance reasonable and supports the ability of satellite and launch vehicle manufacturers to provide services to their customers.

In SIA's view, the most important thing that the U.S. Congress can do to promote the long-term viability of the market for launch insurance is to commit to the existing U.S. commercial launch indemnification regime by extending it indefinitely. Short-term extensions of this regime simply do not provide sufficient assurance of the ongoing availability of indemnification, which causes perturbations in the long-term market stability required by our industry's longer business planning and financing time horizons.

2. *In your testimony you explain the need for long time arcs of stability in both regulations and policy.*

    a. *What are the greatest regulatory challenges faced by the commercial satellite industry and what can the federal government do to ameliorate those challenges?*

SIA's members see two primary regulatory challenges for the satellite industry: access to a sufficient amount of radiofrequency spectrum and stable, transparent, and reasonable regulations, including fees. Like all radiofrequency-based service providers, the satellite industry cannot survive unless its satellite operators and service providers can continue to provide high-quality, reliable and innovative services. This requires access to radiofrequency spectrum that is free of unacceptable levels of interference from services in adjacent frequency bands or from terrestrial services sharing bands allocated for satellite services. For the satellite service business model to be healthy, customers of satellite services must feel comfortable that their vendor is reliable, and that the services they procure will be available in the future.

The federal government plays a critical role in securing the satellite industry's access to spectrum, both in its responsibility for allocating and enforcing spectrum usage domestically and also in its representation of U.S. interests in international spectrum policy fora, such as the International Telecommunications Union. Spectrum planning and allocation in general must be carefully calibrated, regulated, and enforced. This is particularly critical when considering proposals to share spectrum traditionally allocated for satellite services with new applications or services. The satellite industry seeks to ensure that the satellite services underpinning key national and international telecommunications requirements are not disrupted. Proposals to share satellite spectrum with other services need to be evaluated very carefully with respect to the

spectrum requirements of the new service and the suitability of the spectrum band for sharing. Sharing proposals should also be subjected to a rigorous and unbiased technical evaluation of their potential impact on satellite services. Careful calibration of spectrum policy is also important for the federal government's internal spectrum guidance, which should encourage creative and flexible uses of existing commercial and government spectrum allocations to enable the delivery of critical communications services to government customers.

The satellite industry also is concerned that the regulations and licensing fees for spacecraft and earth stations are reasonable. The Federal Communications Commission has been streamlining its regulations for space station and earth station licensing, a process that SIA strongly supports. We urge the Commission to continue to look for ways to maximize the flexibility and responsiveness of its licensing processes while minimizing the burden placed on applicants, with due consideration to public interest requirements. We encourage the federal government to continue to base its fee structures on the recovery of regulatory costs only, in order to encourage investment in and further deployment of satellite networks. SIA opposes the imposition of auctions or additional non-cost-based spectrum fees for the international spectrum bands used to deliver satellite services in the United States. Auctions and non-cost-based spectrum fees are not needed to ensure the efficient use of spectrum by satellite operators and could, if implemented in markets around the globe, severely curtail the satellite's industry's viability.

b. In comparison to other countries, how does the U.S. rank in encouraging the growth of the satellite and launch industry?

As a trade association focused on U.S. domestic policies and U.S. positions with respect to bilateral and multilateral negotiations, SIA does not collect data comparing the domestic policy regimes of other nations. However, our annual SIA State of the Satellite Industry Report does compare U.S. and non-U.S. revenue figures for sales of completed spacecraft and for launch vehicles and services. Our reports reflect a variety of market forces, including government policies, and show that the U.S. market share for satellite manufacturing has declined measurably since peaking in the late 1990s. SIA's reports also show that while both U.S. and non-U.S. launch revenues increased between 2007 and 2012, non-U.S. revenues grew more quickly. SIA notes that the foreign satellite manufacturing and launch providers that have gained market share typically enjoy foreign government policies that include aggressive export credit agency financing and permanent launch indemnification regimes.

Should further exploration of the impacts of various government policies on the international commercial marketplace for completed spacecraft and for launch vehicles and services be of interest to the Subcommittee, SIA would be happy to identify relevant experts and data sources to expand on this issue.

c. What critical policy support can the U.S. government provide to continue the successful growth of the U.S. satellite industry?

SIA sees four key areas where U.S. government policies can support a continuation of the extraordinary growth and innovation experienced by the U.S. satellite industry over the past half century. First, the U.S. government's support for and commitment to the satellite sector's ongoing access to sufficient radiofrequency spectrum, to maintaining an effective regulatory regime, and to setting a reasonable fee structure are vital to support the continued growth of the entire U.S. satellite industry. Also important is the careful calibration of the federal government's internal spectrum guidance to encourage creative and flexible uses of existing spectrum allocations to support services provided to government customers. Second, timely implementation of the reforms to the U.S. satellite export control system that were authorized by the Fiscal Year 2013 National Defense Authorization Act is an important step to enhance the international competitiveness of U.S. satellite and component manufacturers. Third, the indefinite extension of the existing U.S. commercial launch indemnification regime would enhance the long-term competitiveness of U.S. launch service providers. Finally, as described in my testimony, the re-authorization of the U.S. Export-Import Bank will allow that institution to extend its important role in supporting exports of U.S.-manufactured satellites. Extending the Bank's operating authority beyond its current expiration date at the end of 2014 and increasing the statutory limitation on its portfolio of loans, guarantees, and insurance would allow continued export financing to support international sales of U.S.-made satellites in a highly competitive marketplace where sales are often influenced by the availability of export financing.

Additionally, SIA notes that the U.S. government also interacts with the satellite industry as a customer – spending billions of dollars each year to buy satellite services, acquire spacecraft and launch services, and purchase ground equipment and satellite networks. The U.S. government can make the most of its spending on space, and industry can provide the best products and services, if U.S. government budgets and acquisition processes are transparent, fair, stable, and responsive to the government's needs. Additional savings would be available if the government were better able to adopt commercial procurement best practices.

3. There is currently no agency in the federal government which has jurisdiction over on-orbit traffic. With the continued growth of the countries placing satellites in orbit, what is the best framework to control this traffic and what should Congress do to ensure that these spacecraft can operate safely?

SIA and our member companies place a high priority on safe space operations and have noted with interest the continued growth in the number of governments, private companies, and non-government organizations that operate Earth-orbiting spacecraft. In response to industry concerns about safe space operations, several commercial satellite operators have formed the Space Data Association (SDA), a voluntary not-for-profit entity designed, funded, and operated by its members to improve the integrity of satellite operations and facilitate improved

management of the shared resources of the space environment and radiofrequency spectrum. Several government agencies that operate satellites, including NASA and NOAA, participate in SDA. While SDA is a separate entity from SIA, we share many common member companies.

SIA also participates in and monitors the activities of the U.N. Committee on the Peaceful Uses of Outer Space (COPUOS), which has held multilateral discussions over a number of years on the subject of safe space operations. Most recently, the U.N. COPUOS has been developing best practices recommendations, with considerable input from SIA and the satellite sector. Although SIA and its members are active proponents of safe space operations, we also wish to avoid the imposition of burdensome or unnecessary regulations that would dampen investment and innovation in the sector. SIA has not addressed whether any specific new regulatory or oversight framework is required. We would welcome Congressional support for an industry-government discussion of the nature and efficacy of existing initiatives and the effect on commercial industry of any new initiatives, organizations, or frameworks intended to promote safe space operations.

4. *The FCC recently proposed new regulations for spectrum management and on-orbit operations. Please explain how this has impacted the commercial sector.*

SIA has filed public comments with the FCC detailing our views on the rules proposed by the Commission. As the rules have not yet been finalized or implemented, it is unclear at present what impact they will ultimately have. With respect to the portion of the proposed rule that concerns spectrum management, SIA believes that there is currently no need for change to the spectrum allocations used to support space launches. Continued centralized federal government control of these critical frequencies would promote reliability and certainty of access to this spectrum. While the rule did not address on-orbit operations, it did propose technical rules for federal earth stations communicating with commercial communications satellites. SIA believes that a modified version of the Allocation Approach outlined in the Commission's proposal would meet the FCC's stated objectives and serve the interests of federal earth station operators and commercial satellite service providers alike.

5. *Orbital debris is an ongoing problem for the satellite industry. Debris is quickly filling up heavily used orbits and there is currently no plan for mitigating the risk of this debris.*

    a. *What is industry doing to address this concern?*

SIA observes that while there are many outstanding questions with respect to the risk posed by orbital debris, most countries require in their domestic licensing regimes that satellite operators take steps to avoid the creation of new debris and to promote a safe space operating environment. These regulations are typically designed to minimize the creation of debris throughout the lifetime of a satellite, including during the launch, operational, and end-of-life retirement phases. The current U.S. requirements are perhaps the most stringent of any country.

Additionally, commercial satellite operators have implemented numerous voluntary best practices into their standard operating procedures to ensure the long-term viability of the most useful orbital regimes. Among the voluntary best practices widely adopted by commercial satellite operators are participation in the Space Data Association and the establishment of space situational awareness data sharing arrangements with U.S. Strategic Command, both of which help operators avoid close approaches or collisions with other satellites and with debris.

b. What can the Federal government do to help clear out the debris build-up?

Although various technical concepts have been promoted to actively remove debris from orbit, SIA is not aware of any successful tests of these concepts in an operational environment. SIA encourages the federal government to be cognizant of the evolution of proposed technologies that might offset the growth of the orbital debris population, and to refrain from premature regulation that would retard the advancement of these technologies. Once the technology to remove debris from orbit is viable, the federal government may also consider whether the costs and risks of doing so merit employing the available technical solutions. SIA also urges that any U.S. policies or regulations that are eventually considered remain sufficiently flexible to allow for potential commercial capabilities that may emerge in this field. Given that commercial satellite operators currently control over one third of all operational spacecraft, many of which are in congested orbits, it is entirely possible that a capability and marketplace for debris removal services could eventually develop in response to the commercial environment.

c. What role can the international community play in mitigating debris build-up?

Given the early and unproven state of debris mitigation technology, SIA believes that the international space community should continue to exchange information about new technological capabilities that may emerge, and focus on encouraging new space-faring nations to adopt the best practices which today promote responsible and safe space operations while also enhancing the long-term sustainability of space. Bodies such as the U.N. COPUOS are well situated to serve as international clearinghouses for such informational exchanges.

d. How can the United States help enforce the international mitigation guidelines that are already in place?

SIA would encourage the United States government to set a model for other governments to follow by implementing international mitigation guidelines in an efficient and effective manner. In SIA's view, there is more work to be done before the U.S. approach to implementing these international guidelines is replicated elsewhere. SIA has shared its views, both in formal public comments and in informal discussions, for improving the implementation of existing international debris mitigation guidelines with staff at the Federal Communications Commission.

6. *There is a recent increase in demand for "smallsat" or "cubesat" technologies as well as hosted payload opportunities. Advances in the miniaturization of various technologies*

have made payloads affordable for students of all ages to participate in space science. These systems also offer scientists low-cost alternatives to launching full payloads on traditional architectures.

a. What is the future of hosted payloads and has the industry embraced this new concept?

SIA notes that a broad cross-section of the manufacturing and satellite operator communities are actively pursuing and promoting various versions of hosted payload projects, and contributing heavily to discussions within the U.S. government about the technical and policy frameworks that support this concept.

SIA has observed a recent surge in interest from U.S. and foreign government agencies and military services in hosting government or military payloads on commercial satellites. Several policies and programs designed to take practical steps toward the more regular employment of commercially-hosted government payloads are currently in development or being implemented, and SIA supports these efforts.

b. What is economic utility for small satellites?

In SIA's experience, the satellite sector has long provided spacecraft of various weights, physical sizes and capabilities in order to support the requirements of government, commercial, and other customers, as well as to test, research and educate. While SIA does not make forecasts about the future demand for any portion of the satellite industry, small satellites produced by commercial satellite manufacturers and educational and research institutions can provide rapidly-deployable and flexible solutions, grow and diversify the demand for space launch services, and also allow for the development and testing of new space technology. However, SIA notes that the widespread proliferation of small satellites poses an operational concern. To the extent that small satellites are deployed into orbits with lengthy natural rates of decay (i.e. orbits from which they will not naturally and independently re-enter the earth's atmosphere within a relatively short amount of time), SIA urges that they are accounted for within the existing frameworks for orbital debris management and safe space operations.

7. *In the past, the satellite industry has expressed interest in on-orbit servicing. What is the current state of satellite servicing technology? Is there a market for such a capability at this time? What types of changes would need to be made in standard satellite manufacturing to enable servicing?*

The significant costs associated with building and launching replacement satellites have spurred both the U.S. government and private industry to explore alternate means to prolong a satellite's life, even by just a few years. On-orbit servicing can include satellite inspection, repair, assembly, relocation, repurposing, refueling/life extension, replenishment, and retirement/de-orbit (including debris removal). The fundamental technologies needed to perform

many of these satellite servicing functions currently exist in industry and in the international community, and sources of private financing are beginning to emerge. SIA notes that a few private companies, including some in the United States, are exploring the technical and commercial viability of on-orbit servicing. Some of these commercial companies are identifying additional potential opportunities beyond satellite life extension, including space situational awareness and ride-sharing for small secondary payloads. The U.S. government is also developing technology with on-orbit servicing applications, most notably within NASA's Satellite Servicing Capabilities Office and DARPA's Phoenix program. Both NASA and DARPA have experience with demonstrations advancing on-orbit servicing technologies, and have employed them operationally during Hubble Space Telescope repair missions and the assembly of the International Space Station.

Given the complexity of the technology and the different approaches taken by various companies, SIA would be pleased to arrange a follow-up meeting with the Subcommittee to provide a more comprehensive overview of the state of on-orbit servicing technology, including the relationship between current U.S. government programs and services being offered by some U.S. commercial operators.

Questions Submitted by Rep. Donna Edwards, Ranking Member, Subcommittee on Space

1. *Your prepared statement referred to the U.S. space industrial base, which you note has been eroding and is of national security concern. How serious is the state of the U.S. space industrial base, especially with respect to the supplier base? How long do you anticipate it will take before export control reforms take effect and help to strengthen the U.S. space industrial base, as you suggested in your prepared statement will occur?*

SIA notes that the U.S. space industrial base has long supplied market-leading communications, imagery and meteorological capabilities for the U.S. government and for domestic and international commercial customers. The marketplace for completed commercial spacecraft is a global one, with U.S. manufacturers competing vigorously with foreign spacecraft manufacturers, the most competitive of which are based in France and other parts of Europe. SIA has tracked revenues and sales for completed satellites for more than a decade in our annual SIA State of the Satellite Industry Report, which show that the U.S. share of the market for completed commercial spacecraft has declined since a peak of roughly 75 percent in the late 1990s. In the past five years, U.S. market share has fluctuated between 35 and 50 percent.

SIA is aware of more than fifty studies conducted over the last decade on various aspects of the space industrial base. The most comprehensive of these have been conducted by the U.S.

Department of Commerce on behalf of the U.S. Air Force and NASA.[2] Several of these studies have focused specifically on the supply chain for satellites and launch vehicles, and identified specific product areas where there is either one U.S. supplier, or none. Despite these concerns, U.S.-manufactured satellites have unparalleled records of reliability and performance. SIA also notes that there are two distinct types of concerns about the supply chain: 1) concern about the ability to acquire components that are reliable, affordable, and delivered on time (a concern shared by both commercial and government customers); and 2) concern about sourcing components from non-U.S. companies due to the potential introduction of back doors or other vulnerabilities (a concern that may be more important to government customers than their commercial counterparts).

In SIA's view, the satellite industry may not feel the positive effects from U.S. export control reform until late in calendar year 2014, depending on when the new rules are published by the Departments of State and Commerce. Once the new rules are published in the Federal Register, they are likely to take effect 180 days (6 months) later, to allow time for industry to adjust its license application and compliance processes and for government to incorporate the new rules into its licensing and enforcement frameworks. This means that the first orders for satellites and components to be exported under the new system would likely be placed in late 2014 or early 2015. Some deals may, of course, be affected positively by the atmospherics of the reform effort, and early anecdotal reports suggest that the reforms have generated increased interest in purchasing U.S.-manufactured components and spacecraft. Based on this projected implementation timeline, SIA would expect to see the statistical impact of export control reform as we collect year-end industry performance data for calendar year 2015.

2. *NASA and DOD are discussing the potential for increased use of hosted payloads. Is this a partnership development you support, and if so why? What are the challenges associated with hosted payloads from a satellite provider's perspective and what is needed to address any commercial and governmental barriers?*

SIA generally does not comment on specific acquisition programs. However, in general, SIA encourages U.S. government agencies with a strong interest in space activities to work together to exchange ideas and develop paths forward on innovative acquisition approaches, such as the hosted payload concept.

SIA members believe that the most significant challenges associated with hosted payloads are not technical – government payloads have been successfully hosted on commercial satellites for years, and there is an even longer history of government satellites hosting payloads for other government agencies. Instead, the major challenge facing the hosted payload community today is how to make the execution of hosted payload programs recurring and

[2] *See* U.S. Department of Commerce, Bureau of Industry and Security (BIS), "U.S. Space Industry 'Deep Dive' Final Dataset Findings," February 13, 2013, http://www.bis.doc.gov/index.php/forms-documents/doc_download/769-final-dataset-overview.

sustainable. To make progress on this front, government and industry will have to work together to find alternative business models that are acceptable to government customers, and to synchronize planning, decision, and production cycles for the government payload and commercial host satellite. Additionally, guidance provided by the U.S. government on the usage of radiofrequency spectrum by hosted payloads should encourage collaboration with industry to find mutually beneficial solutions. SIA would welcome a Congressional encouragement of the discussions on finding acceptable alternative business models and providing additional flexibility that may help the U.S. government.

3. *Congress has been actively engaged with the U.S. space industry to bolster our industrial base and improve our global competitiveness. One major achievement is the recent ITAR reform. Similarly, it is in the U.S. Government's interest to remove unnecessary impediments that prevent the U.S. Government from being a smart buyer of commercial space capabilities and services. Are there any critical legislative actions that Congress should consider to enable U.S. Government agencies to become more effective and smart buyers?*

SIA member companies have a variety of perspectives on how to improve U.S. government budgeting and acquisition processes. Many of our member companies contribute actively to discussions with both Congress and the Executive Branch on specific policy improvements and technological solutions to optimize both buying processes and the effectiveness of space products and services provided to U.S. government customers. SIA encourages an open dialogue between the relevant government and industry stakeholders on this important question, and facilitates a number of fora with the military and intelligence communities to augment the individual discussions held by our member companies.

SIA members believe that both dedicated military satellite communications and leased commercial capabilities are critical elements of U.S. communications networks and are essential for national security, and agree that the Department of Defense should incorporate the sustained reliance on both government-controlled and commercial satellite capabilities into its planning, budgeting, acquisition, and spectrum policies.

With respect to military satellite systems, SIA encourages the Department of Defense to create a long range plan for their efficient acquisition and deliberate modernization, which should be fully funded by Congress. With respect to commercial capabilities, SIA recommends that the Department of Defense take similar steps to budget and fund their acquisition over a longer time horizon. Despite having relied on commercial satellite communications capabilities for years, Department of Defense typically budgets for commercial capabilities in one-year increments and funding is typically provided through operations and maintenance (O&M) accounts and supplemental budgets. Reliance on these sources of funding creates a number of constraints, including limits on longer-term contract commitments, uncertainty in planning, and

the possibility of termination of funding for an entire category of critical communications capability.

SIA's members are committed to engaging with the Executive Branch and leaders in Congress to ensure that the U.S. government has access to the most effective and technically advanced capabilities in the world. We continue to welcome Congressional interest in this topic.

Responses by Mr. Stuart Witt

Stuart O. Witt's Response to:

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON SPACE
"Commercial Space"

Questions for the Record, Mr. Stuart O. Witt, CEO Mojave Air and Space Port

Questions submitted by Rep. Steven Palazzo, Chairman, Subcommittee on Space

1. One of the potential uses for suborbital flight is "point-to-point" transportation for humans and goods. In your testimony you cite this type of activity as a potential commercial application.

a. How long do you estimate it will be before this type of travel is possible?
Answer: Five years before a prototype is flying and ten years before passengers are flying.

b. Is anyone at Mojave currently working on this type of activity?
Answer: Yes

c. What regulatory or legal impediments do you envision for this activity?
Answer: Potentially international treaty changes or additional ICAO agreements and standards on fueling and exotic fueling protocols.

2. In your testimony you stated, "The emerging industry has certainly captured the investment eye of the high net worth community."

a. What is the minimum return on investment expected by the high net worth individuals for them to invest in these types of companies?
Answer: I don't know. What I do know is that some simply want to see the needle move at a time when the Federal Government has limited R&D investment funds.

b. Is there anything different between this industry and other high-risk high-reward industries?
Answer: Yes. Point-to-Point suborbital travel will cross boundaries at speeds, which were previously only capable of carrying weapons. As technology has changed and humans are provided a new mode/means of travel so must treaties and laws change to reflect new technologies.

c. How does the current budget environment for the federal government influence those investments?
Answer: The high net worth investor is looking for regulatory certainty that their investment into human mobility across the planet will be protected. "Moving the goalpost annually" as a regulatory strategy is usually not a sound investment environment.

3. For quite some time the suborbital industry has claimed there is a market for space tourism and that the various companies working in this area believe there will be significant interest.

a. Do you see the same interest in this area of tourism as the companies do?
Answer: Yes. It is difficult to gauge the level of interest until providers offering flights arrive at the marketplace. The industry is still in the R&D phase and my professional focus remains on a successful R&D cycle for the industry.

b. What is your assessment of the potential suborbital tourism market?
Answer: The fact is, more than 700 tickets have been pre-purchased, which is enough evidence to suggest the general public has a desire to go to space. The market is ripe for competition and the more competition exists, the lower the price becomes, the larger the addressable market recognized by the operators. From a personal perspective, I've never fully understood the business plan until the notion of small micro gravity or other scientific experiments was introduced in detail. The ability to carry small, affordable science payloads may be the long term market sustainability investors seek. Maybe it will be growth in human flight to sub-orbit as operators move to market.

4. The FAA regulates spaceports throughout the country and does not have a statutory limit on how many licenses it can offer.

a. What does the Mojave Air and Space Port offer its occupants that other spaceports do not?
Answer: I can't speak to what other spaceports do or don't offer, but here are some things we provide beyond infrastructure that my tenants have told me provide value: Landlord professional services including licensing support, ground handling support, fire/life/hazmat/security/safety support, access to space and restricted airspace support, regulatory and policy support and professional industry relationship support.

b. Can other spaceports be as successful or have we hit a ceiling with spaceports that can actually be viable?
Answer: No way of knowing for certain, but as the industry matures infrastructure will be necessary to accommodate growth. My opinion is: The industry currently has more locations than are needed for R&D. We have built for the future of operations. Our industry is similar to the emerging aircraft industry 100 years ago when we did not need destination airports until there were craft to fly from point to point.

c. Do you anticipate that different spaceports will begin to specialize in different types of missions?
Answer: Yes

d. Do you believe that spaceport license applicants should pay for the cost the FAA incurs for processing their license through a fee-based system?
Answer: As long as there is value to the applicant from the FAA licensing process.

5. NASA is working with private companies to develop new launch vehicles that can safely deliver cargo and crew to the International Space Station. What is the effect of those

development efforts on the space tourism and launch markets? Have you seen a change in private investments since these programs began?

Answer: Not sure I fully understand the question but with each success by private firms, SpaceX, Sierra Nevada, and Orbital as they carry cargo to station or demonstrate a new spaceship the industry as a whole benefits. Success breeds success. Activity breeds activity in Business. (Read "investment" as firms demonstrate quantifiable capability)

6. It seems that the suborbital industry has been focused on research and development for quite some time and only one company thus far shows potential for starting commercial operations in the immediate future.

a. When do you expect the market to mature enough for multiple providers?
Answer: I'm not sure what firm you are referring but multiple providers should be operating within five years.

b. How far off is the industry from providing the same type of regular commercial operations that we have seen from orbital launch providers?
Answer: I predict two sub-orbit firms will be performing R&D sub-orbit test flights in 2014 and based on R&D outcomes, offering sub-orbit services in 2015. But certainly within five years. I'm not quite sure what is meant by "the same type of regular commercial operations that we have seen from orbital launch providers". For the past 30 years we have continued to lose market share to foreign providers, which is what we seek to regain for the United States.

c. When do you think the first paid commercial suborbital launch will take place?
Answer: Within 24 months assuming a successful R&D workup phase in 2014/15.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY SUBCOMMITTEE ON SPACE
"Commercial Space"

Questions for the Record, Mr. Stuart O. Witt, CEO Mojave Air and Space Port

Questions submitted by Rep. Donna Edwards, Ranking Member, Subcommittee on Space

1. I understand that regulations for third-party liability, i.e. protecting the safety of people and property on the ground during commercial space launches, are different than regulations for ensuring the safety and protection of the people who might one day be flying in the spacecraft. That said, do you think there is any inconsistency in the commercial spaceflight industry's desire for both the protections extended by the government against third-party liability and an extension to the "learning period" before which the FAA can impose regulations to protect the safety of commercial spaceflight passengers? How does one justify providing government indemnification for passenger-carrying vehicles prior to the issuance of safety regulations?

Answer: The two subjects are unrelated. Regarding "indemnification," the protection that the government provides (as recently extended) only does so in the case when third party claims exceed an amount calculated by the FAA to be the maximum probable loss that would occur in all but one in ten million launches. This protection has never been invoked. The launch operators themselves, on the other hand, have financial responsibility for all claims below that amount, including any against the government for its role in licensing the launch. This risk-sharing scheme makes launch providers financially responsible for third party claims in all but the most extremely unlikely cases, while at the same time shielding the government. The "learning period" deals with second party regulation; it in no way restricts regulation to achieve third party safety.

The committee may be interested in Mr. James Muncy's perspective to this question, which follows:

James Muncy: *"No, there is no inconsistency, nor is the government providing third party indemnification in the absence of regulations governing third party safety. In fact, the government has promulgated 71 specific rules and 10 appendices regarding "Launch Safety" in just one section (14 CFR Part 417) of the licensing regulations. Whereas, the Commercial Space Launch Amendment Act of 2004's "learning period" only partially restricts second party safety regulations. In no way does it restrict regulations to achieve third party safety. There is simply no inconsistency here, and no policy conflict between industry's positions on indemnification and the learning period that requires justification.*

Government indemnification of human spaceflight against excess third party claims – like its indemnification of all space launch activities – is simply the government keeping its promise made in 1988 when the Congress created a regime to share the risk of third party damages from commercial space transportation activities. Industry is required to buy insurance or set aside assets to cover the maximum probable loss, i.e. the greatest possible amount of third party damages in 9,999,999 out of 10,000,000 launches. But industry not only buys this insurance to ensure that victims have somewhere to go for restitution... industry is required by law to protect the federal government against third party claims based on its role(s) in the launch activity that led to the damages. Industry is therefore indemnifying the government. In exchange for that valuable and costly protection, the government agrees to seek funds to pay claims above the insured amount for that 1 in 10,000,000 situation.

More importantly, industry is required by regulation, and by specific conditions of its license, to protect the public from the overwhelming fraction of possible accidents that could cause the loss of life or property by a third party. A license applicant must show that the chance of a public casualty for any given mission is less than 30 in one million, and that this analysis must assume the launch system will fail catastrophically at any moment during a planned mission.

In conclusion, it is vitally important for policymakers to understand that second-party and third-party risks and regulations are and must remain completely separate. Spaceflight is

not a common carrier industry holding itself out to fly everyone with a high expectation of safety.

We are required to meet, and do meet, the highest standards of protecting uninvolved parties. Because the federal government is legally implicated by the UN Space Liability Convention and the Federal Tort Claims Act, Congress instituted a risk-sharing regime for unlikely (but not impossible) third party losses.

Separately from this, we are strongly motivated to meet ever-higher-standards of safety for involved parties. And the government is not prevented from promulgating regulations based on demonstrated participant safety issues. But we are also free to innovate and find newer, safer ways to fly people and payloads into space, without the uncertainty of unrestricted regulation based on speculation instead of relevant data." (Muncy)

2. Your prepared statement referred to the SOARS Act, HR 3038. In particular you note that "companies should be able to get one stop shopping at FAA for a single license or permit for all flights of their system." Could you clarify what that means in practice? Is it simply a matter of going to one office in the FAA to obtain any needed launch licenses, reentry licenses, and aviation certificates? Or are you seeking a single license or permit to cover all the aspects of air and spaceflight involved in commercial spaceflight systems?

> Answer: As an example, WhiteKnightTwo was specifically designed to carry a commercial spacecraft, either a satellite delivery system or a space tourism/research system and when not carrying either, for use in crew/participant training. When engaged in flight activity related to its license, one stop shopping at FAA/AST should be sufficient to accommodate the licensee.

3. What entity should have the authority to investigate commercial spaceflight accidents, including those involving human spaceflight participants, and how should accident investigations be handled?

> Answer: The Question is outside my area of expertise. However as a career aviator, the NTSB certainly has the expertise to conduct a detailed aircraft mishap investigation.

Responses by Mr. Dennis Tito

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON SPACE

"Commercial Space"

Questions for the Record, Mr. Dennis Tito, Chairman, Inspiration Mars Foundation

Questions submitted by Rep. Steven Palazzo, Chairman, Subcommittee on Space

1. Investments in space exploration by private companies or individuals are exceedingly rare. While the inspirational aspect of exploration is an important component, what other incentive does a private entity have to invest in these ventures?

   I, like many other Americans, have benefited from our nation's investments in technology based undertakings such as Apollo that stimulated following generations to pursue careers in science and technology. I, like many other Americans, have also seen our technological leadership slowly but directly move to other countries, and want to give something to America that will not only re-establish our leadership in space exploration, but inspire a younger generation to become our future technology-skilled workforce by pursuing STEM educations and challenging careers that keep our economy strong and continue to improve the quality of life on Earth.

   a. Does the future of private exploration require an economic incentive or would you expect it to survive through charitable contributions?

      It has become clear that private exploration will require some degree of partnership with the government to ensure the availability of the best solutions for the job. Charitable contributions can play a significant role in connecting such missions to the needs and interests of private citizens. This is an area with great potential.

   b. Is this sustainable?

      Through long term partnerships that best leverage the respective strengths of government and the private sector, this can very much be sustainable. However, an important ingredient to such partnerships is a clear signal from the government that they will have a sustained program, and if the private sector makes an investment, the government commitment, barring unforeseen National emergencies, will survive changes in political leadership.

2. To do the mission outlined in your testimony, you would require the use of NASA assets in addition to your own. In the event that NASA chose to partner with you, what do you anticipate would happen to the intellectual property developed in the process?

   It is the intent of the Inspiration Mars Foundation that the rights to intellectual properties developed in partnership with NASA would reside with the public, under the management and purview of NASA.

3. Please elaborate on the structure of the public-private partnership that you envision between Inspiration Mars and NASA. How would work be divided between the two entities? Who would have the final say in decision making? What accountability and oversight measures would you recommend be implemented?

It is our intent that NASA would lead the mission, continuing to provide program management, integration and oversight for the ongoing development of SLS/Orion and upper stage, and mission planning, while the Inspiration Mars Foundation would contribute, in a supporting role, life support technology and a crew habitat module for the long trip. IMF would also contribute significantly to public outreach and engagement with the mission through educational and informational programs.

4. Would your proposed public-private partnership model accommodate contributions from multiple philanthropic sources? Are there any possible negative repercussions that could result from setting a precedent of private contributions to public projects?

There would most definitely be opportunities for philanthropic contributions to various aspects of the proposed mission. And, yes, there are always possibilities for repercussion. Private contributions come with expectations of sustained commitment and continuity - and results.

5. Your written testimony stresses that many of the hardware and systems needed for a Mars flyby have already been developed. What technical capabilities would need to be developed or completed between now and the proposed launch date? Is NASA already working on these systems?

The technical capabilities that currently are not either under development or funded to bring to operational readiness are:

- ***The development of Dual Use Upper Stage (DUUS) for the SLS. This is already in NASA long term vision but not yet funded.***
- ***A crew Environmental Control and Life Support System (ECLSS). The IMF has already made a significant investment in development in the ECLSS and a functioning engineering model of the critical subsystems exists. The IMF intends to provide technology to NASA for their testing, packaging and flight qualification. The IM architecture proposes to integrate the ECLSS into one of the commercial ISS Cargo carriers which then would be the Habitation Module***

6. Your proposed Mars mission would have two crewmembers, a married man and woman operating the mission to Mars.
   a. Will two crewmembers be sufficient to fully operate the mission?
   b. Would two crewmembers be able to troubleshoot problems that might arise aboard the spacecraft?

The answer to both questions is, emphatically, yes. The mission is designed specifically with that qualification as a basic requirement.

7. There are several companies that are interested in developing private long-term habitats for humans in space, on the Moon, on Mars, and beyond. What are the intangible benefits for these types of endeavors? Is there profit to be made in a deep space habitat or a private laboratory on the Moon?

I am not a commercial space entrepreneur, and have not considered the commercial market prospects for long term habitats. As a philanthropist, my focus is on enabling a bold mission for America without any profit motives, whatsoever.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON SPACE
"Commercial Space"

Questions for the Record, Mr. Dennis Tito, Chairman, Inspiration Mars Foundation

Questions submitted by Rep. Donna Edwards, Ranking Member, Subcommittee on Space

1. I understand that regulations for third-party liability, i.e. protecting the safety of people and property on the ground during commercial space launches are different than regulations for ensuring the safety and protection of the people who might one day be flying in the spacecraft. That said, do you think there is any inconsistency in the commercial spaceflight industry's desire for both the protections extended by the government against third-party liability and an extension to the "learning period" before which the FAA can impose regulations to protect the safety of commercial spaceflight passengers? How does one justify providing government indemnification for passenger-carrying vehicles prior to the issuance of safety regulations?

Inspiration Mars is a philanthropic initiative rather than a commercial enterprise. We are proposing a mission under NASA's leadership and do not have plans to generate revenue or profit from this national endeavor. I do not have adequate insight to offer an informed opinion on this matter.

2. You stated in your prepared statement that you have "designed the architecture" for a mission to the far side of Mars and back. Can you provide further explanation of what it means to design an architecture for a mission? How detailed is your plan? How did you go about estimating the cost of the proposed mission? What is the cost? Have you submitted any proposals to NASA? What has their reaction been?

For a space system, the architecture defines the flight and ground hardware, software and operations support elements to meet a set of mission objectives. For Inspiration Mars the mission objective is to take advantage of a unique alignment of the Earth and Mars to provide America with an Inspiration Mission to fly two people around Mars and return them safely to Earth. The trajectory and sizing of the crew for two people provided the basis for the IMF initial study team to define the mission top level requirements such as duration, the mission space environment and launch mass of the crew needs such as food, water etc. After quantifying these requirements, the IMF funded two NASA/Industry/Academia Study Teams charged with developing alternative architectures for launching, transiting to Mars and returning the crew to Earth. One Team looked at fully commercial options and the other at an SLS/Orion based option

A critical parameter of a space system architecture is the mass required to be able to launch to orbit, and that was the primary driver in our final selection of the candidate architecture. The differences in the various design choices for habitation and its supporting service module were evaluated, including their impact on the total mass required to be launched. The mission support subsystem design concepts and sizing for services such as power, communications and navigation were also developed. As a result we concluded that a SLS based architecture was the most practical choice to

meet the Inspiration Mars mission. We validated this approach through a series of Technical Interchange Meetings with industry and NASA Centers. The determination of cost will be accomplished through continuing collaboration between government and industry, and will be dependent upon partnering agreements.

3. In the acknowledgment section to the attachment to your Architecture report, several individuals from NASA Centers are listed. What was their role and what arrangement was used to enlist their assistance? Does the identification of companies such as ATK Space Systems, Boeing, and ULA signify technical verification of the architecture by them? If not, what has been their role?

As described above NASA, JPL, Industry, and Academia under the leadership of Dr. Jonathon Clark in the case of Crew medical countermeasures were active participants in the Architecture Study Teams. Formal Space Act Agreements were put in place between the IMF and NASA for technical support. Industry partners funded their participants in the study.

Most of the details provided in the Report came for the NASA/Industry/Academia partners and were reviewed and agreed upon by all participants through Technical Interchange Meetings (TIMs). I believe the technical feasibility of the proposed architecture, has been validated by the participants in the IM Architecture Study.

4. What entity should have the authority to investigate commercial spaceflight accidents, including those involving human spaceflight participants, and how should accident investigations be handled?

Inspiration Mars is a philanthropic initiative rather than a commercial enterprise. I do not have relevant insight to offer an informed opinion on this matter.

Appendix II

Additional Material for the Record

SUBMITTED STATEMENT OF DONNA F. EDWARDS, RANKING MEMBER, SUBCOMMITTEE ON SPACE, COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

Thank you, Mr. Chairman, for holding today's hearing on "Commercial Space," and welcome to our witnesses. In particular, I know that we will be hearing from Representative McCarthy, and I look forward to hearing his perspectives.

Now, before I go any further, I'd like to congratulate NASA, and particularly NASA Goddard Space Flight Center near my District, as well as the University of Colorado Boulder, the University of California Berkeley, Lockheed Martin, the Jet Propulsion Laboratory, the United Launch Alliance, and all those involved, on the successful launch of the Mars Atmosphere and Volatile Evolution (MAVEN) mission. While not strictly a "commercial" mission per se, it takes a dedicated team including government, the private sector, and academia to accomplish challenging missions such as MAVEN.

In fact, MAVEN, and its commercial partners, serves as an important reminder that over 80 percent of NASA's entire budget is and has been paid to commercial entities for products and services. And many ofthe commercial space activities that are being discussed today, as well as others, have and continue to rely on taxpayer investments, NASA expertise and experience, and NASA infrastructure.

In addition, an important factor in the initiation of new commercial space businesses is that NASA-developed technologies have matured to a point that the private sector can begin to seek commercial uses for them. So while I'm as excited as anyone about the potential for growth in commercial space, whether it's in the satellite industry and services, commercial cargo transportation, and commercial reusable suborbital and orbital human spacetlight—oh, and I want to be one of those private passengers—I don't want to perpetuate the misconception that these are purely "commercial" endeavors.

There are significant taxpayer dollars associated with these "commercial" activities and there is much at stake for the Government in the successful execution of these programs. As a result, we in Congress need to carry out the oversight that is required to protect the taxpayers' investments and the Government's contributions to these efforts.

Yet another important Government role in commercial space is in establishing regulations to ensure that commercial space programs are carried out safely and that the uninvolved public is not harmed, should an accident occur. In that regard, Congress has, over the past two decades, enacted provisions to support a shared government-industry third-party liability regime for commercial space launches. These provisions expire at the end of this year. And I know that many commercial space entities have an interest in the government-industry liability regime for commercial space launch, since that regime is active for any commercial FAA-licensed launch. That is the reason I am puzzled, Mr. Chairman, as to why this hearing is not focused on the pressing legislative issue of commercial space launch indemnification.

Furthermore, the legislation that is being discussed today, HR 3038—the SOARS Act—appears to deal with a number of FAA-related aviation and space regulatory issues, yet FAA is not represented here today. And I'm not aware that any of the witnesses who will testify are regulatory experts or can discuss the details of how this legislation would be implemented in practice or what the cost of its implementation would be.

Mr. Chairman, my criticism should not be misconstrued. I share in the excitement and promise of the commercial space activities being discussed today and of the many innovative ideas and strengths that commercial enterprises bring to our nation's space activities. I stand ready to work with you, Mr. Chairman, through future hearings, to examine the whole range of issues associated with commercial space. These include, at a minimum, how to ensure the safety of human spaceflight participants; whether the existing shared-risk third-party liability regime requires adjustments; and how commercial space accidents will be investigated. And, given the looming expiration of the commercial space launch indemnification provisions, I am pleased to join Chairman Smith, Ranking Member Johnson, and Space Subcommittee Chairman Palazzo in introducing a clean one-year extension of the provisions.

I hope that we can move the bill quickly to the floor after the Thanksgiving break so that we can ensure that commercial space launches have continued access to the existing protections while this Committee conducts the necessary oversight of the issues associated with a longer-term extension.

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

SUBMITTED STATEMENT OF EDDIE BERNICE JOHNSON, RANKING MEMBER, COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

Good morning. I would like to welcome each of our witnesses to today's hearing.

The topic of today's hearing is an important one. About ten years ago, this Committee held a hearing entitled "Commercial Human Spaceflight." Mr. Tito, who is on one of today's panels, testified at that hearing. A lot has happened over the course of those ten years. The International Space Station was completed and continues to show great promise as an orbital laboratory. NASA is building the next deep space exploration system of the future. With the Space Shuttle retired, cargo resupply of the ISS is being turned over to two commercial providers, albeit a success made possible with substantial NASA financial investment and technical transfer. Today, constellations of commercial satellites circle the Earth, performing a multitude of critical functions. NASA and FAA are working together in anticipation of future manned commercial orbital flights. And both entrepreneurs and established companies are actively exploring a range of commercial space opportunities.

So it is fitting that we begin a comprehensive examination of what is needed to continue to grow commercial space. And I view today's hearing as exactly that, hopefully just the beginning of a series of hearings that will thoughtfully examine all facets of commercial space prior to considering any legislation that will affect commercial space for years to come.

Ten years ago, Mr. Tito expressed concern about the regulations that might be imposed on the nascent commercial space industry. He was clear to say that he was not looking to escape the regulations, but rather wanted clarity on which government agency, and which set of regulations, would oversee the then-new industry.

His questions are still valid today.

In addition, the fact that much of what we think of as commercial space in reality involves such a significant governmental role, and the fact that the lines between public and private may be becoming blurred for some space activities, requires a clear understanding of the roles and responsibilities envisioned for these future commercial space endeavors.

And, the fact that we are staring at yet another expiration of the risk sharing regime established in the Commercial Space Launch Act Amendments should not and must not detract us from the greater goal of examining this indemnification issue comprehensively. In the meantime, I am pleased to join Chairman Smith, Space Subcommittee Ranking Member Edwards, and Space Subcommittee Chair Palazzo in providing a clean, one-year extension of these provisions, while the Subcommittee has an opportunity to consider whether any changes are needed.

I look forward to this and future hearings to help us forge a clear direction.