THE NEW SPACE RACE: ENSURING U.S. GLOBAL LEADERSHIP ON THE FINAL FRONTIER

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THE NEW SPACE RACE: ENSURING U.S. GLOBAL LEADERSHIP ON THE FINAL FRONTIER

WEDNESDAY, MARCH 13, 2019

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 10 a.m. in room SD-G50, Dirksen Senate Office Building, Hon. Roger Wicker, Chairman of the Committee, presiding.

Present: Senators Wicker [presiding], Cantwell, Rosen, Cruz, Peters, Fischer, Sullivan, Capito, Moran, Blackburn, Klobuchar, Gardner, Blumenthal, and Sinema.

OPENING STATEMENT OF HON. ROGER WICKER,
U.S. SENATOR FROM MISSISSIPPI

The CHAIRMAN. This hearing will come to order.

Thank you all for being here. This morning, we deal with the New Space Race. In his famous 1962 speech announcing that the United States would land on the Moon by decade's end, President John F. Kennedy said, “No nation which expects to be the leader of other nations can expect to stay behind in the race for space.” Those words hold true today.

We are delighted to have two witnesses who are helping to ensure that the United States maintains global leadership in space: the Honorable Jim Bridenstine, Administrator of the National Aeronautics and Space Administration, and Mr. Kevin O’Connell, Director of the Office of Space Commerce at the Department of Commerce.

We are grateful to have you here. Thank you for your presence, looking forward to your testimony.

2019 is an exciting year for space. July 20 will mark the 50th Anniversary of the NASA Apollo 11 Mission. I was in a dormitory in Oxford, Mississippi, on that particular date, hard to believe, which landed humans on the Moon and fulfilled President Kennedy’s bold vision for human space exploration.

By year’s end, NASA Commercial Crew Program will be launching American astronauts from American soil and by American companies. NASA’s flagship Human Exploration Program launch vehicle, the Space Launch System or SLS, and Orion Spacecraft will likely achieve a number of milestones this year, including core stage assembly and integration. That would be followed by test firing the core stage at Stennis Space Center, Mississippi.
The dedicated workforce and testing assets at Stennis show the importance of maintaining national space infrastructure and programs.

We’ve entered into a new space race. This race is different from the one America won 50 years ago. The new space race has three dimensions. First, the United States must maintain its position as the international partner of choice for current and aspiring space-faring nations, strengthening international partnerships through cooperation on space endeavors and NASA’s operations around the world.

The International Space Station is a key part of the U.S. global leadership, but NASA’s Fiscal Year 2020 budget request proposes to end the funding for the ISS in 2025. Witnesses should detail opportunities to enhance space partnerships with other nations and demonstrate how the budget request supports those efforts.

Second, America must maintain our position as the focal point for space commerce. We want space companies to be established and continue to grow in the United States. The global space industry is expected to grow from around $400 billion today to nearly $3 trillion over the next two decades.

President Trump has supported the commercial space industry through policies to streamline regulations for launch, remote sensing, spectrum usage, and export control. In particular, I commend the Vice President’s leadership of the National Space Council, which has achieved interagency consensus on critical issues and provided bold and clear direction on space policy.

Perhaps Mr. O’Connell will address the current state of the industry and provide the Committee with a progress report on meeting various space policy directives to promote the commercial space industry.

Administrator Bridenstine should also address NASA’s role in partnering with commercial providers and growing the industry.

And third, as competition in commercial space heats up, we must stay ahead of rising space powers, notably China. Maintaining America’s position as the preeminent space-faring nation is the final dimension of the new space race.

China’s Space Program could represent a significant challenge to American leadership in space. A recent Defense Intelligence Agency report noted that China’s Space Program supports both civil and military interests.

In January, China became the first country to explore the far side of the Moon. By 2025, China plans to complete its satellite navigation system rival to GPS, launch a rover to Mars, operationalize a space station and begin building a Moon base, among other ambitions.

President Trump has provided clear direction for NASA to lead an innovative and sustainable program of exploration to enable human expansion across the solar system. He is right.

I hope our witnesses will tell the Committee how America can maintain an edge over foreign space programs and show how the budget request will help sustain American leadership in space.

It is essential that we have consistency in policy, stable and sufficient funding, and a robust set of international and commercial partnerships to achieve these goals.
Against a backdrop of international competition and a burgeoning space industry, the stakes articulated by President Kennedy more than half a century ago are even higher today.

I look forward to working with my colleagues to help sustain America's space leadership and chief among those are my friend and our Ranking Member, Senator Cantwell, and I recognize her for her comments.

STATEMENT OF HON. MARIA CANTWELL, U.S. SENATOR FROM WASHINGTON

Senator Cantwell. Thank you, Chairman Wicker, and thank you for holding today's hearing on maintaining U.S. leadership in space.

Obviously this year, 2019, astronauts will be returning to the International Space Station from American soil for the first time in nearly a decade and just last week, SpaceX successfully completed an uncrewed demonstration launch to the International Space Station.

Space tourism is just around the corner and Virgin Galactic recently completed a piloted mission. We expect to see Blue Origin flying people in the very near future.

In the Chairman's statement, he talked about Mississippi and NASA and how they will complete the final tests on the Space Launch System, the most powerful rocket built, in advance of the 2020 mission.

As we look at these accomplishments and hear about our commercial space mission this morning, we also need to look at the challenges of maintaining our leadership role.

Other nations are maturing their space capabilities and the United States needs to keep pace. I appreciate the Administration's focus on maintaining the Nation's focus on space, but the budget request they've put forward undermines this goal.

We need to make sure that there are appropriate resources and the budget seems to cut some of the very programs that we need to keep this leadership. A prime example is the International Space Station. It has been successful and other countries are developing their own space stations.

Then we see the Administration proposing ending funding for the Space Station by 2025. Maybe the witnesses can speak to the rationale for that today.

Standing up commercial space capabilities takes a long time and after years of planning and development within the Commercial Crew Program, we need to continue these efforts. We cannot have a gap in capabilities as other nations are looking to compete in low-Earth orbit.

The Administration's proposed budget cuts are concerning on a number of fronts. For starters, cutting funding to the Enhanced Upper Stage, the component of the Space Launch System that will enable the long-term goals of the program, is problematic.

Also, the Administration is proposing to cancel Earth science missions and zero out funding of the Office of STEM Engagement. NASA is uniquely positioned to inspire the next generation of scientists and engineers and canceling relatively low dollar education programs, I think, is short-sighted.
So all of these cuts, were rejected by Congress last year. I expect Congress will see the wisdom of rejecting them again, but nonetheless it's important to bring up that we have to appropriately prioritize programs if we want to continue these missions going forward.

So I look forward to discussing these this morning, Mr. Chairman. Thank you again for calling the hearing and I look forward to hearing from our witnesses in their leadership role on these important issues.

The Chairman. Thank you very much, Senator Cantwell.

And we'll begin our testimony this morning with Administrator Bridenstine. We'll ask each witness to limit opening statements to 5 minutes. Your entire statement will be placed in the record by unanimous consent.

Mr. Administrator, welcome.

STATEMENT OF HON. JAMES F. BRIDENSTINE, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. BRIDENSTINE. Thank you, Chairman, and it's good to be here, Chairman, Ranking Member, Members of the Committee.

I just want to share with you, as you mentioned, Chairman, in your opening statement, this year marks the 50th Anniversary of Apollo 11 and our landing on the Moon, and from that day to this day, the United States of America has led the world in space.

We have been the preeminent space-faring nation and I am confident with your leadership that we will be able to continue that position into the future.

A couple of things that I think are important to note to achieve this objective. We need to have really impressive goals and stunning achievements that the world can get behind.

I can tell you as the NASA Administrator when I meet with our international partners, one of the things that they are most excited about is the idea that we're going to go to the Moon again. This time, we're going to do it differently. This time, we're going to go with international partners and we're going to go with commercial partners, and this time we're going to go sustainably.

In other words, this time when we go to the Moon, we're going to stay, not permanent human presence on the Moon, but with landers and rovers and robots and humans with more access to more parts of the Moon than ever before.

The President's Space Policy Directive-1 says to go to the Moon sustainably with international partners. When I say sustainably, I want to be clear. That means we're going to stay there. It doesn't mean we're going to have a 1.0 human presence on the surface of the Moon but it does mean we will have continual access whenever we need it on the surface of the Moon with humans but we'll also have robots, landers, and rovers.

We're going to go with international partners and commercial partners and this is the unique capability that is in Space Policy Directive–1. We're going to utilize the resources of the Moon.

In 1969, when we landed on the Moon, we did so, you know, six times, from 1969 to 1972, and in those 3 years, we had 12 people
walking on the surface of the Moon. From that day until 2008, really in 2009, we made a big discovery.

We believed the Moon was bone dry. A lot of scientists believed the Moon was bone dry. Now we know that there’s hundreds of millions of tons of water ice on the surface of the Moon. Water ice represents air to breathe. It represents water to drink. It’s hydrogen and oxygen which is rocket fuel, abundant in hundreds of millions of tons on the surface of the Moon.

So the President’s Space Policy Directive-1 says go to the Moon, go sustainably, go with international partners, go with commercial partners, utilize the resources of the Moon, prove capability, prove technology, retire risk, and then use those capabilities and technologies for a mission to Mars. That’s the objective of this Administration.

I can tell you when I meet with my colleagues around the world, the heads of other agencies, they are all very, very excited about partnering with us in this endeavor. In fact, recently, just a couple weeks ago, we announced that we now have a collaboration with Canada on this next generation endeavor and that collaboration, according to the Prime Minister, is for the next 24 years, which is a great partnership. It’s the first one in this next generation.

I think the biggest thing to note, and this is about American leadership, the biggest thing to note now is that there are more space agencies on the face of the planet than ever before and there are more coming online, which means there’s more opportunity for partnership, more opportunity for shared resources, more opportunity to do more than we’ve ever been able to do before, and all of that is very positive, and I do believe we are the partner of choice in the world.

I also believe it’s critically important that we sustain that position.

So, Mr. Chairman, Ranking Member, Members of the Senate, I’m honored to be here, look forward to answering your questions.

[The prepared statement of Mr. Bridenstine follows:]

PREPARED STATEMENT OF HON. JAMES F. BRIDENSTINE, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Chairman and Members of the Committee, I am very pleased to appear before you today. NASA is proud to be at the forefront of a global effort to advance humanity’s future in space, leading the world while expanding on our Nation’s great capacity for exploration and innovation. This is a role the Agency has played for over 60 years, leveraging the talent and hard work of America’s skilled Government and aerospace industry workforce to push the boundaries of science, exploration, and technology development to achieve bold goals in the aviation and space arenas. Now, pursuant to Space Policy Directive-1 (and consistent with the NASA Transition Authorization Act of 2017), NASA is pursuing “an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities.” We are working on a sustainable campaign of exploration, transitioning the International Space Station (ISS), returning humans to the surface of the Moon and lunar orbit, where we will build the systems, deep space infrastructure, and operational capabilities to expand human presence beyond the Earth-Moon system, eventually embarking on human missions to Mars and other destinations.

Since its inception, NASA’s historic and enduring purpose has been aligned to four major strategic thrusts—Discover, Explore, Develop, and Enable. These correspond to our missions of scientific discovery of the natural phenomena of the Earth, of other worlds, and of the cosmos as a whole. We conduct missions of exploration in our solar system with humans and robotic probes that expand the frontiers...
of the human experience, and missions of development that advance new technologies in aeronautics and space systems. NASA leads these missions in collaboration with international and commercial partners. Our long history of international collaboration is a strength that allows us to go farther and faster, while also strengthening international relationships and U.S. standing in the world.

NASA has maintained continuity of purpose over time by serving the American public and supporting a number of national priorities, whose relative emphasis, specific focus, and context have changed over time:

- U.S. Leadership and Inspiration
- Global Engagement and Diplomacy
- Interactions with the Nation’s Security and Industrial Base
- Economic Development and Growth
- Addressing Societal Challenges
- Fostering New Discoveries and Expanding Human Knowledge
- Expanding Human Presence in Space

The President’s budget request for Fiscal Year 2020 specifically highlights the criticality of partnerships—commercial, international and academic—in maintaining U.S. leadership in space exploration. Partnerships will play a key role in the human exploration of deep space. While we must maintain American leadership in science, technology and human exploration, the involvement of international partners will remain a major part of NASA’s exploration plans. Continued collaboration with partners on ISS will be critical to U.S. efforts to use ISS to inform exploration strategies and to help enable lunar exploration and a follow-on presence in low-Earth orbit (LEO). International collaboration will also be a critical element for the Lunar Gateway, as well as lunar and Martian system assets (reconnaissance, human orbital, and human surface). A key part of our overall National Exploration Campaign strategy is to incentivize better cost performance in developing space systems, and where appropriate, share the cost burden of the overall effort through international, commercial and academic partnerships. A sustainable effort will only be possible with smart leveraging of resources and an affordable path forward. NASA will leverage partnerships with the rapidly advancing commercial sector and international community to lay the foundation for a future of unlimited opportunity, discovery and growth.

Exploration Campaign

The Exploration Campaign builds on over 18 years of Americans and our international ISS Partners—Canada, Europe, Japan, and Russia—living and working continuously on the ISS. It leverages the advances made in commercial launch vehicle capabilities, robotics, and other technologies, and accelerates in the next few years with the launch of the Orion capsule and Space Launch System (SLS) rocket which will expand human exploration to cislunar space and the surface of the Moon. The Campaign expands human and robotic exploration in space by: 1) transitioning LEO capabilities to viable and stable industry partners, and 2) pursuing a cislunar strategy that establishes U.S. preeminence to, around, and on the Moon. Beyond this, we will continue to execute sophisticated robotic missions to Mars while we work to develop and demonstrate the deep space capabilities required to safely send a human crew to the Red Planet. We will expand beyond the ISS partners to lead a broad effort across the strategic areas that encompass human spaceflight, science, and technology interests.

Activities across these domains are closely related and mutually supportive; for example, NASA’s drive to conduct robotic and human exploration of the Moon informs the research and technology development we will conduct on the ISS and future orbital platforms, as well as the development of technologies needed for future Mars missions. Likewise, current and future robotic missions will provide vital science, reconnaissance, and technology demonstrations in support of future human exploration, in addition to their science objectives. NASA is actively working now to support sustainable exploration and development over the coming decades in all three domains.

In carrying out this Campaign, NASA will act as architect, mission leader, and in several key areas, systems integrator, in defining an open architecture that meets national objectives while actively seeking partnerships. The Exploration Campaign will draw upon a variety of innovative partnerships with U.S. commercial industry, other Government agencies, academia, and international partners to meet these objectives. We have designed the Campaign to enable early successes, relying on seamless collaboration across the Agency, and the rapidly advancing capabilities of our commercial partners.
As part of the Campaign, we will also begin sending increasingly capable robotic missions to the lunar surface in the next two years. Developed by U.S. commercial companies, these spacecraft will conduct scientific investigations, characterize resources, and provide lunar landing services to customers from America and around the world. Through an innovative combination of missions involving commercial and international partners, robotic lunar surface missions will begin as early as 2020, focus on scientific exploration of resources, and prepare for a sustained human presence. Ultimately, these efforts will culminate in the safe landing of U.S. astronauts on the Moon in the late 2020s and establish a sustainable human presence.

Transitioning LEO
NASA will continue its mission in LEO with the ISS to enable exploration with humans to the Moon and on to Mars, while continuing to perform research that benefits humanity, supporting National Laboratory research by private industry and other organizations, and working towards reducing operations and maintenance costs. NASA will continue leading the international partnership that forms the basis of human spaceflight continuity and will leverage and expand beyond the ISS Partnership for the next steps beyond LEO. The Partnership is also being leveraged to define exploration standards that will allow commercial as well as international partnership in the exploration architecture. NASA will continue to leverage its resources and capabilities to enable the development of a commercial market in LEO and alternatives to a Government-directed human spaceflight infrastructure in LEO.

Under the auspices of the ISS National Laboratory, managed by the Center for the Advancement of Science in Space (CASIS), NASA and CASIS continue to expand research on the ISS sponsored by pharmaceutical, technology, consumer product, and other industries, as well as by other Government agencies, such as the National Institutes of Health and the National Science Foundation. Through CASIS’ efforts, the ISS National Lab has reached full capacity for allocated crew time and upmass and downmass. NASA also works with commercial companies, such as NanoRacks, to support commercial activity on the ISS.

NASA intends to transition from the current Government-dominated model of human spaceflight activities in LEO to a model where Government is only one customer for commercial services. The Agency is increasing the breadth and depth of commercial and international LEO activities. NASA will expand partnerships in LEO to include new companies and other nations beyond the ISS Partners, including working with commercial partners to support visiting crew. Based on inputs from international, Government and commercial stakeholders, NASA will begin this year to take steps that will enable the transition from direct Government funding of ISS to the use of commercial services and partnerships by 2025. The plan will feature new, independent commercial platforms or a non-NASA operating model for some form or elements of the ISS, or both. In addition, NASA will expand public-private partnerships to develop and demonstrate technologies and capabilities to enable new commercial space products and services.

SLS, Orion and Exploration Ground Systems
NASA is building a deep space launch and crew system—the Orion spacecraft, the heavy-lift SLS launch vehicle, and the supporting Exploration Ground Systems (EGS)—to support the Exploration Campaign. The SLS Block 1 will be capable of delivering Orion to cislunar space by the early 2020s and will play a critical role in delivering crew to the Lunar Gateway. While upgrading the SLS to the Block 1B configuration remains an important future capability, recent performance issues and delays in SLS core stage manufacturing and design updates related to the Exploration Upper Stage requirements, require that NASA concentrate in the near term on the successful completion of Exploration Mission-1 (EM–1) and EM–2, and supporting a reliable annual SLS and Orion flight cadence thereafter. As a result, SLS Block 1B final development efforts will be deferred to later exploration missions. The Orion crew vehicle will carry up to four humans to deep space for up to 21 days, and when combined with additional habitation can support longer-duration missions.

The first SLS/Orion mission will be the uncrewed EM–1, followed by the first crewed SLS/Orion mission, EM–2. The EM–1 and EM–2 launch dates are under review pending completion of independent assessments of core stage production and the integrated mission schedule. These SLS/Orion missions will demonstrate the capability to operate safely and productively around the Moon. SLS, Orion, and EGS are the critical capabilities for maintaining and extending U.S. human spaceflight leadership beyond LEO to the Moon, Mars, and beyond.
Lunar Gateway

As a key part of the Exploration Campaign, NASA will establish the Lunar Gateway, a way station that will orbit the Moon and enable human and robotic missions to the lunar surface. The Lunar Gateway will support exploration on and around the Moon, and sustainable human lunar surface exploration missions by supporting reusable human landers. It will be a temporary home for astronauts and will foster growing domestic and international economic opportunities for commercial logistics and refueling services as well as provide robust communications with spacecraft in cislunar space and on the lunar surface. The Lunar Gateway will be a continuously expanding knowledge base in the area of deep space maneuvering and solar electric propulsion (SEP). Through the development of Lunar Gateway, the U.S. will maintain in leadership in space exploration and discovery as it pion-ers a new era of space travel research, logistics, and economic developments.

The Lunar Gateway will be assembled in orbit around the Moon where it will be used immediately as a staging point for missions to the lunar surface. The initial functionality will support lunar landers and requires two main functions: A Power and Propulsion Element (PPE) and habitation. These functions will provide critical abilities for the Lunar Gateway to support human-class reusable landers, landing a crew of up to four astronauts on the lunar surface and ultimately developing sus-taining lunar operations on the Moon. Gateway is evolvable and supports early re-usable lunar surface capability and later more complex lunar science and Mars exploration technology development.

From a strategic perspective, the Lunar Gateway takes advantage of existing ISS partnerships with private companies and the international community from LEO to the Moon. The ISS international partnership on 5 March 2019 signed a joint state-ment that commits the ISS space agencies to evaluate their potential contributions to the Gateway. It will give us a strategic presence in cislunar space that will enable sustainable exploration of the Moon and its resources and leverage that experience for eventual human missions to Mars. The Lunar Gateway provides access to a vari-ety of lunar surface destinations that scientific investigations have found worthy of direct human inspection and exploration. Opportunities for U.S. commercial and international partners could range from the supply of utilization payloads and logistics, to the provision of entire modules of the Lunar Gateway. International partner-ships have been a vital component of space exploration, allowing countries to ad- vance national objectives while working together to achieve greater and more col-laborative goals. Following the commercial model that NASA pioneered in LEO for space station resupply, NASA plans to launch Lunar Gateway elements and resupply it through competitively-procured commercial cargo missions and internation-ally-contributed cargo missions. Commercial spacecraft could also dock to the Lunar Gateway between crewed missions to conduct other activities. Additional potential exists for future commercial spacecraft to transport crew to visit the Lunar Gate-way. The Lunar Gateway will be designed with standard interfaces, encouraging all partners to leverage its capabilities and improve competition for the benefit of space exploration. These strategies will be essential toward establishing a sustainable and resilient Exploration Campaign. Subsequent cost savings will enable NASA to redirect funding towards in-space and lunar surface activities.

While NASA will remain the overall lead as Lunar Gateway architect, systems integrator, and operator, the Lunar Gateway team has been studying various implementa-tion approaches to identify U.S. commercial and international contributions to the Lunar Gateway architecture. The U.S. commercial efforts include design con-ccepts initiated under the Next Space Technologies for Exploration Partnerships (NextSTEP) habitation development activity and international concepts have been initially identified through architecture studies with the ISS partners.

Prime Minister of Canada Justin Trudeau formally announced on February 28, 2019 Canada’s intention to join NASA in U.S.-led exploration at the Lunar Gateway and the lunar surface, the first international partner to do so. In accordance with a joint statement signed by all partners on 5 March 2019, additional commitments are expected by the end of the year, with ultimate participation by all existing ISS Partners. NASA is currently conducting architecture studies to evaluate all options for accelerating human lunar return, including potential international contributions. The results of these studies may lead to international contributions focused on lunar surface exploration prior to Gateway expansion beyond an initial few (2–3) modules.

While additional international contributions to enable sustainable lunar surface exploration are examined, potential Lunar Gateway contributions currently include:

- Upon approval by its Member States, the European Space Agency (ESA)’s provi-sion of the European System Providing Refueling Infrastructure and Tele-
communications (ESPRIT) module with a science airlock including additional propellant storage and advanced lunar telecommunications capabilities;
• European development of a Lunar Gateway habitation module with significant contributions from the Japan Aerospace Exploration Agency (JAXA);
• Russia’s expressed interest in developing and contributing a multi-purpose module, which would also include airlock functionality and redundant human transportation capability; and
• Logistics Modules delivered to the Lunar Gateway by both U.S. and international partners, the cadence of which would be driven by mission needs.

Lunar Landers and Robotic Missions

Our goal is not just to leave footsteps and plant flags but to learn how to live away from Earth. Working with our commercial and international partners, we will establish a foundation for ongoing human exploration of our nearest celestial neighbor. Fostering a buildup of capabilities, our goal is to land astronauts on the Moon within the next decade. Astronauts will explore the surface for increasing periods of time while developing the experience and technology we need for future missions to Mars and other destinations.

NASA will work with American companies through Broad Agency Announcement (BAA) awards and funded Space Act Agreements (SAAs) to design and develop new reusable systems for astronauts to land on the lunar surface. The Agency is asking American companies to study the best approach to landing astronauts on the Moon and start the development as quickly as possible with current and future anticipated technologies. NASA is planning a series of lunar lander demonstration missions with the first uncrewed mission testing human descent capabilities on the surface in 2024. Early commercial delivery missions to the Moon will test technologies, and demonstrate capabilities that will help improve designs for landers to carry astronauts. These missions, coupled with early uncrewed descent demonstration missions, will once again help NASA gain real-world experience to land astronauts on the Moon.

Science remains critical to the exploration goals of the Agency, contributing both capabilities and knowledge needed to advance human and robotic exploration of the Moon, Mars, and beyond. The Lunar Discovery and Exploration program advances an integrated strategy for exploration, not only through improved collaboration across the Agency but also by leveraging interagency, international, and commercial partnerships. In November 2018, NASA selected nine U.S. companies to bid on delivery services to the lunar surface through Commercial Lunar Payload Services (CLPS) contracts. Lunar payloads from a variety of customers, including NASA, will fly on contracted missions starting in 2020, enabling critical technology demonstrations and scientific observations; most recently, NASA selected 10 proposals for the Development and Advancement of Lunar Instrumentation (DALI) program, which will support instruments that will fly on future lunar missions. NASA’s Lunar Reconnaissance Orbiter (LRO), which marks its tenth anniversary in 2019, continues to help scientists characterize the lunar surface, providing insights into lunar resource analysis that could support future human exploration.

NASA’s lunar efforts will incorporate results from the following:
• The Lunar Cargo Transportation and Landing by Soft Touchdown (CATALYST) initiative, established in 2014, is encouraging the development of U.S. private-sector robotic lunar landers capable of successfully delivering payloads to the lunar surface using U.S. commercial launch capabilities.
• NASA issued a solicitation on February 7, 2019 to seek proposals from industry for human lander system studies, risk reduction, development, and spaceflight demonstrations. These NextSTEP partnerships will enable rapid development and flight demonstrations of human lunar landers by supporting critical studies and risk reduction activities, maturing requirements, tailoring applicable standards, and creating technology maturation plans.
• NASA and its industrial partners are also working on NextSTEP habitation systems to develop concepts for cislunar habitats and to conduct ground-based testing of prototype habitats to evaluate human factors, validate subsystem integration, and test standard interfaces. The knowledge gained from testing the NextSTEP habitats will reduce risk in the design of the Lunar Gateway.

Missions to the Moon and cislunar space will also serve as a stepping-stone, a training ground, and a platform to strengthen commercial and international partnerships and prepare for future human missions to Mars and other destinations.
Exploration Technology

NASA's Exploration Technology will accelerate technology development to enable human and robotic exploration of the Moon and Mars and foster commercial expansion in LEO and beyond. Technology drives exploration with investments spanning the Technology Readiness Level (TRL) spectrum, advancing early-stage concepts and maturing key technologies and systems that enable demonstrations in relevant environments.

Within Exploration Technology, NASA will accelerate development of lunar surface technologies through the Lunar Surface Innovation Initiative, driving essential technologies required for humans to successfully operate on the lunar surface:

- NASA is developing the technologies to make use of resources available on the Moon, on Mars, and on other planetary bodies (in situ resources). This technology holds the potential to produce consumables, including oxygen, water, and hydrogen on the Moon, thus drastically reducing mission mass, cost, and risk for human exploration.
- In order to address power requirements for long-duration human missions on the Moon, NASA is continuing work on its Kilopower technology project to demonstrate a small, lightweight fission power system. The Kilopower project will transition into a demonstration mission in FY 2020 that would permit long-duration crewed missions on the surface of the Moon.

The Lunar Surface Innovation Initiative will bring together the full range of stakeholders, including entrepreneurs, academia, small businesses, industry, and the NASA workforce to catalyze technology and systems development.

On to Mars

Ultimately, the Moon will serve as a stepping-stone, a training ground, and a platform to strengthen commercial and international partnerships and prepare for future human missions to Mars and other destinations.

NASA will advance robotic access to Mars in preparation for human exploration. The Agency will:

- Continue the search for life with a Mars rover in 2020;
- Demonstrate technology to produce oxygen from Mars resources, critical for future human Mars missions;
- Begin planning a first-ever sample-return Mars mission;
- Appropriately prioritize and guide investments and partnerships in long-pole technology areas and resource characterization needed for deep-space exploration; and
- Develop standards for human long-duration deep space transportation vehicles.

Working with science and human exploration communities, our international partners, and U.S. industry, NASA will refine the goals and objectives for a robust lunar exploration and science program.

Partnerships

In implementing its human exploration plans, NASA will work to make best use of the tools available for partnership opportunities so the Agency can leverage the knowledge, skills, and resources of potential commercial, academic, and international partners. In the public-private partnership arena, NASA will consider a variety of mechanisms from university grants, to SAAs (which may be funded or unfunded), to Federal Acquisition Regulation-based contracts. The use of SAAs and contracts has played a key role in the operation of ISS, and NASA anticipates using the flexibility of different types of partnership to best effect as the Agency proceeds with human missions into deep space. Similarly, in the international arena, the ISS partnership, for example, has enabled construction and operation of a space station that benefits from the support of dedicated aerospace professionals around the world. Significant international collaboration is also occurring at the Moon and Mars, bringing benefit to the whole of the exploration endeavor.

International partnerships have been a vital component of space exploration. When nations develop indigenous technologies, systems, and missions to further domestic objectives, they contribute to the aggregated advancement of capabilities that enable greater and more collaborative goals. The success of the ISS is a testament to the viability of a long-term, multi-national technology and exploration partnership, which will remain a key aspect of human exploration further into the solar system.

NASA’s strategy for leading global collaboration, based on mutually beneficial international and commercial partnerships, will leverage successful ISS and other
NASA partnerships and build new cooperative exploration ventures to develop spaceflight capabilities. This strategy will take into account risks, challenges, and rewards posed by relying on partners for critical capabilities and technologies. NASA is also coordinating exploration planning with external organizations: the Lunar Exploration Analysis Group, Mars Exploration Program Analysis Group (MEPAG), International Space Exploration Coordination Group, International Mars Exploration Working Group (IMEWG), National Academy of Sciences decadal surveys, etc. Through these partnerships, the expansion of humans beyond LEO can be achieved faster and in a more cost effective manner.

Similarly, NASA is working with its international partners to advance human and robotic exploration on and around the Moon. Last year, I chaired a meeting of senior leaders from space agencies around the world in conjunction with the International Astronautical Congress in Bremen, Germany. Following this exchange of ideas, NASA is working to identify partnership opportunities that widen the pool of resources, enhance sustainability, and advance our most important exploration objectives. I look forward to convening similar multilateral discussions this year.

Conclusion

One of the Agency’s key goals is opening the space frontier with the objective of extending human presence deeper into the solar system starting with returning humans to the Moon through a sustainable human and robotic spaceflight program. The Agency has developed a strategic, pioneering approach to expand the distance and duration of human space exploration, building off the research happening today on the ISS. As NASA continues to develop an acquisition strategy for the Exploration Campaign, we will identify new sources for critical technologies in the U.S. private sector and Government, and international partners. NASA will demonstrate and enhance U.S. leadership in space by collaborating with international counterparts on mutually beneficial goals. The Agency believes this human exploration infrastructure can be achieved and sustained with the national funding commitment laid out in the President’s Budget request. Key to our success will be reforming our programs to be more cost effective and to successfully achieve the objectives laid out through new business models and partnerships. Space exploration, at sustainable funding levels and supported with domestic and international capabilities and collaborations, is a long-term endeavor. NASA is pushing human presence deeper into space while making new discoveries and strengthening the Nation’s diplomatic posture. We appreciate the Committee’s continued support, and I would be pleased to respond to your questions.

The CHAIRMAN. Thank you very, very much.

Mr. O’Connell, welcome.

STATEMENT OF KEVIN M. O’CONNELL, DIRECTOR, OFFICE OF SPACE COMMERCE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Mr. O’CONNELL. Good morning, everyone.

My name is Kevin O’Connell, and I’m the Director of the Office of Space Commerce at the Department of Commerce inside the National Oceanic and Atmospheric Administration.

I’m pleased to testify before you today with Administrator Bridenstine about U.S. leadership on the Final Frontier.

My perspectives are drawn from my early time at the Commerce Department as well as my many years of work on the policy market and security issues related to commercial remote sensing.

I start by saying that one of the most powerful tools we have in the new competition for space is the ability to harness the private sector in a rapidly growing space economy.

Mr. Chairman, you have already cited some of the statistics marching toward a $3 trillion economy over the next two decades.

American space companies confront an extremely complex and competitive landscape. As the global space economy grows, countries are trying to find ways to gain advantage, protect nascent industries, and capture market share.
Countries with mature regulatory systems are trying to quickly modernize policy and regulation while newer space-bearing countries struggle with how to best regulate commercial space activities.

U.S. companies confront a wide range of unfair practices in the market, including dumping of space products and other anti-competitive tactics.

The Trump Administration’s emphasis on space, starting with the re-establishment of the National Space Council, recognizes the highly competitive nature of the global space environment and the need for the United States to become more agile in order to compete and retain preeminence.

Space Policy Directive-2 explicitly recognizes the need to undertake broad regulatory reform to enable space commerce to flourish.

One specific mandate of SPD-2 calls for the reorganization of the Department of Commerce in order to encourage space commerce. It has been a long-held U.S. Government view that the department would play a significant role in America’s space commerce pursuits.

How? As an industry advocate, as a source of economic and commercial information, as a regulator, and sometimes as a counterbalance to security concerns about space commercialization.

The position that I currently occupy is one that was empty for more than a decade. As a personal note, I would say that this industry is so important to this Nation’s future that such disregard should never be allowed to happen again.

In 2018, the Administration proposed elevating the Office of Space Commerce to a bureau within the Department of Commerce so that it can permanently leverage all of the department’s many capabilities on behalf of U.S. space industry.

Presently, many Federal agencies have statutory responsibilities on space commerce issues, including export controls, remote sensing, spectrum management, payload review, and launch.

As the department executes its duty to foster conditions for the economic growth and technological advancement of the U.S. commercial space industry, I see great opportunity to work across agencies to align and simplify regulations in order to accelerate the growth of space commerce and make the United States the flag of choice for space operations and innovation.

We have already learned a lot about the value of a revised regulatory approach. U.S. space regulation must create incentives for companies to responsibly invest, innovate and operate in space. Regulations should be performance-based and advance innovation by allowing for new business models to be licensed rapidly and to allow companies to bring services to market. Active consultation and transparency with industry are key.

In addition, as countries try to gain market share of their own in the global space economy, there is a risk of dual regulation that will hinder American business. We need to work carefully with our international partners to reconcile regulatory differences among nations.

The department has also taken on considerable new responsibility under Space Policy Directive–3, the Nation’s first comprehensive policy on space traffic management.
Specifically, in partnership with the Department of Defense and other Federal agencies, we will assume no later than 2024 the responsibility to provide conjunction analysis and other basic space flight safety services to civil and commercial users.

One key aspect of the department’s efforts in this area is to create an open architecture data repository, essentially a state-of-the-art cloud-based platform for creating highly accurate warnings for space operators.

As importantly, though, it will also serve as an innovation platform that draws upon the new sensors, analytic tools, and visualization capabilities coming out of the commercial market.

Here, too, we see the value of international partnerships and are considering how allied, civil, and private sector partners might participate in this architecture as yet another reflection of American space leadership.

Let me also comment briefly on international activities within the department.

The mission of the Department of Commerce is global in nature and is reflected in its many bureaus and organizations, such as the International Trade Administration. ITA’s Advocacy Center currently has 26 cases supporting the U.S. space industry with a value of over $3 billion.

NOAA is also no stranger to space partnerships. For more than two decades, NOAA has recognized that in order to remain a world leader in earth observation, it would have to shift the world of only government-owned systems to a world with significant commercial and international partners.

NOAA continues to affirm partnerships both at home and abroad, including participation in multinational fora, like the Group on Earth Observation, World Meteorological Organization, and others.

Challenges to Space Primacy. A growing U.S. commercial space industry represents another aspect of protecting U.S. advantages in space. In this sense, economic growth underpins national security.

At the department, we are hearing a growing number of U.S. industry concerns about Chinese behaviors in the market as part of Beijing’s drive for space primacy.

For example, we are aware of Chinese willingness to undercut prices in the market in order to capture market share and undercut U.S. companies. China is, through a belt and roads spatial information corridor, broadening its own international footprint, although partner countries are starting to recognize the possible dual use nature of hosting Chinese infrastructure and researchers.

We cannot allow the undermining of U.S. technology investments in development. According to one U.S. study, recent U.S. study, China is using foreign investment as a means for technology transfer assessed at approximately $300 billion per year.

Strong protection of U.S. intellectual property rights for cutting edge space technology is vital. In addition, the United States and the department will continue to use our routine industry engagement to identify and address unfair trade practices.

Mr. Chairman and Members of the Committee, thank you for your consideration today.
We find ourselves at an unprecedented time, at the nexus of leadership, technology and finance. From my early time at the Department of Commerce, I can say that the world is actively watching our efforts to harness the extraordinary power of the U.S. commercial space industry.

Thank you.

[The prepared statement of Mr. O'Connell follows:]

PREPARED STATEMENT OF KEVIN M. O'CONNELL, DIRECTOR, OFFICE OF SPACE COMMERCE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Thank you, Chairman Wicker, Ranking Member Cantwell, and members of the Committee. I am pleased to testify before you today along with Administrator Bridenstine on how to advance U.S. space leadership in a complex global environment. The perspective that I offer is drawn from my time as the Director of the Office of Space Commerce within the Department of Commerce’s National Oceanic and Atmospheric Administration (NOAA), as well as from my 25 years of work on policy, market, and security issues related to commercial remote sensing.

Creating a Highly Competitive U.S. Policy and Regulatory Framework

American space companies confront an extremely complex and competitive landscape. As the global space economy grows, countries are trying to find ways to gain advantage, protect nascent industries, and capture market share. Countries with mature regulatory systems find themselves needing to urgently modernize policy and regulatory environments, while countries with newer systems struggle with understanding the best ways to regulate commercial space activities. U.S. companies confront a wide range of unfair practices in the market, including subsidies, dumping of space products, unfair provision of space services, and other anti-competitive tactics.

The Trump Administration’s emphasis on space, starting with the re-establishment of the National Space Council, recognizes the highly competitive nature of the global space environment and the need for the United States to become more agile in order to compete and retain preeminence. Space Policy Directive-2 explicitly recognizes the need to undertake broad regulatory reform to enable space commerce to flourish. The President made clear that Executive Branch regulations across agencies must "promote economic growth; minimize uncertainty for taxpayers, investors, and private industry; protect national security, public safety, and foreign policy interests; and encourage American leadership in space commerce."

One specific mandate of SPD–2 calls for the reorganization of the Department of Commerce for the specific purpose of encouraging U.S. space commerce. It was a long-held U.S. Government vision dating back over four decades that the Department would play a significant role in America’s space commerce pursuits as an advocate for industry, a source of economic and commercial information to fuel national, state, local, and commercial efforts, and sometimes as a counterbalance to security concerns about space commercialization. Yet the position that I currently occupy was empty for more than a decade. This industry is so important to the Nation’s economic and national security future that such disregard should never be allowed to happen again.

In 2018, the Administration proposed elevating the Office of Space Commerce to the bureau-level within the Department of Commerce so that it can permanently leverage the entire set of knowledge and skills within the Department on behalf of the U.S. commercial space industry.

Presently, many agencies have discrete requirements and statutory responsibilities on key issues to space commerce, including separate efforts on export controls, remote sensing, spectrum management, payload review, and launch. As the Department executes its duty to foster conditions for the economic growth and technological advancement of the United States space commerce industry, I see great opportunity to work across agencies to align and simplify these regulations in a manner that reflects the President’s policy to speed U.S. space commerce growth and make the United States the “flag of choice” for responsible space innovation, investment, and operation.

The Department’s efforts have provided some key policy insights on how to grow U.S. space commerce with a revitalized regulatory approach. U.S. space regulation must create an incentive for companies to responsibly invest, innovate, and operate in space. Moreover, any regulations for space operators must be easily navigated...
and consolidated when possible. Regulations for space operations should be performance-based, allowing flexibility for meeting baseline standards, to properly accommodate the rapidly-evolving commercial space industry. Some key elements of a commercial space regulation must include reasonable timelines, transparency between government and industry, and collaborative pre-consultation processes. Regulations should be designed in a manner that advances investment in the commercial space industry and serves to advance innovation by allowing for previously unseen business models and technologies to be licensed rapidly and bring their services to market.

In addition, as countries try to gain market share of their own in the global space economy, there is a risk of dual regulation that will hinder American businesses. We will need to work carefully with international partners to reconcile regulatory differences among nations.

Beyond its interagency work to shape regulations to reflect Executive Branch policy on space commerce, the Department has taken on considerable new responsibility under Space Policy Directive-3, the Nation’s first comprehensive policy on space traffic management (STM). Specifically, in partnership with the Department of Defense, the Department of Commerce will assume, no later than 2024, responsibilities to provide conjunction analysis (that is, two or more objects coming together at the same or nearly the same point in time and space) and other basic space flight safety-related data and services to civil and commercial users. A key aspect of the Department’s efforts is to create an open architecture data repository, essentially a cloud-based environment for more precise warnings of safety hazards as well as experimentation with new sensors, analytic tools, visualization platforms and other emerging capabilities. We see the value of international partnerships and intend to invite allied and like-minded civil and private sector partners to participate in this architecture. This is another reflection of American space leadership that is consistent with our rich history and our plans for the future.

The Department of Commerce cannot perform this task in isolation. We are finalizing a Request for Information to address:

1) specific capabilities which commercial and other private sector entities might provide to enhance the space situational awareness (SSA) data and the space traffic management services the U.S. Government currently provides through an open architecture data repository to the public;
2) SSA, STM, and orbital debris mitigation best practices; and
3) perspectives on the appropriate regulatory structures which the Department should adopt to drive the development and responsible use of such SSA and STM enhancements to protect national interests and further encourage U.S. commercial space investment.

Private sector input on these key questions will help guide our path on the SSA/STM open architecture.

International Space Efforts within the Department of Commerce

Just as Administrator Bridenstine has commented on NASA’s international partnerships, please allow me to comment on some closer to home. The mission of the Department of Commerce is global in nature and is reflected in the strong international presence of the International Trade Administration (ITA), including ITA’s Foreign Commercial Service, the Bureau of Industry and Security, and the National Telecommunications and Information Administration. NOAA is also no stranger to space partnerships. For more than two decades, NOAA has acknowledged that, to remain a leader in operational Earth Observation, it needed to evolve from an era where it only operated government-owned systems to a world where the commercial sector and international partnerships offer significant contributions. NOAA recognizes that successful partnerships allow us to meet our mission cost-effectively, increase overall system resiliency, and to be more responsive to the needs of our users and stakeholders. Nations can no longer afford to launch and operate the full suite of satellites and instruments necessary to support evolving applications. NOAA continues to uphold its commitment to act as a good partner seeking to improve services to operational users worldwide. Our domestic partnerships with NASA, the Department of State, the Department of Defense, and the U.S. Geological Survey (USGS) have been re-affirmed, while our international partnerships continue to be strengthened to include Europe, Japan, Canada, and Taiwan.

Further, the United States continues to provide invaluable leadership in a number of multilateral fora in which NOAA, NASA, and USGS participate. NOAA continues to strengthen our role as a global leader, promoting an integrated global Earth observing system by maintaining leadership roles in multilateral coordinating groups and advocating for data sharing and harmonization across platforms and
partners. These international groups include strategic engagement in the Group on Earth Observations, the Committee on Earth Observation Satellites, the Coordination Group for Meteorological Satellites, and the World Meteorological Organization.

**Challenges to Space Primacy**

Leadership in commercial space requires both strong partnerships and a commitment to protecting U.S. opportunities in space. In addition to the domestic challenges involved with maintaining American competitiveness in space, foreign competitors, in particular China, are making concerted efforts to become space powers. The Department is aware of China’s initiatives that should merit our careful attention, and we welcome China’s support for an international regime that is favorable to commercial space activity. However, we are also concerned that China is trying to create unfair advantage by undercutting prices in order to capture market share. China also has a track record of making space commitments to developing nations in order to gain access to those nations’ geography and technology. For example, China is working to build a “Belt and Road Spatial Information Corridor” that aspires to boost the space capabilities of developing nations while also enhancing Beijing’s global space reach and broadening its own international footprint. There is a mounting body of evidence that partner countries are recognizing possible dual-use concerns of hosting Chinese infrastructure and researchers.

China is also attempting to stifle U.S. space commerce access to spectrum in international forums such as the International Telecommunication Union’s World Radio Conference (WRC). Given this threat, the Administration’s efforts to establish the United States as first in 5G also must support its concurrent efforts to ensure U.S. leadership in space. Satellite systems need a stable and predictable spectrum environment given their long-lasting nature, mission-critical uses, and far-reaching scientific and economic benefits. The United States leadership at the 2019 WRC and beyond will seek to achieve these policy objectives.

We cannot allow the undermining of U.S. technology investments and development. According to one recent U.S. study, China is using foreign investment as a means for licit and illicit technology transfer assessed at approximately $300 billion per year. Strong protection of U.S. intellectual property rights for cutting edge space technology is vital. In addition, the United States will continue to use its trade laws to identify and address unfair trade practices. In order for the U.S. to be a strong partner to its allies, it must also establish healthy boundaries that allow U.S. commercial space to flourish.

**Conclusion**

Mr. Chairman and members of the Committee, thank you for your consideration of my ideas. From my early time at the Department of Commerce, I can say that the world is actively watching with interest our new-found interest in harnessing the power of the U.S. commercial space industry. But here, America first does not mean America alone: U.S. space leadership will depend vitally on both traditional and new space partners across government and commercial sectors. Thank you.

The Chairman. Thank you very much to both of our witnesses. We’ll begin a five-minute round of questioning. Mr. Administrator, the Exploration Mission-1’s goal is to assure a safe crew module entry, descent, splash down, and recovery, an unscrewed Orion capsule, 1.3 million miles, over 25 days, around the Moon before returning to Earth.

It has been delayed. Last week, NASA informed Congress of yet another delay in EM-1. NASA had planned to launch no later than June 2020. However, NASA now says that further delays are anticipated.

What about that? What are your plans to address this situation, and have you considered alternatives?

Mr. Bridenstine. Yes, sir. We have considered alternatives. I will say this.

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Before I answer this question, I want to start with a point of emphasis, which is, the Space Launch System, SLS, the largest rocket that's ever been built in American history is a critical piece of what the United States of America needs to build.

We're talking about a rocket that has a throw weight larger than anything we've ever been able to throw before. We're talking about a rocket that's taller than the Statue of Liberty, with a fairing size that can put really big objects into space, and in fact into deep space, in orbit around the Moon even. It is a critical capability.

Now here's the challenge that we have with EM-1. SLS is struggling to meet its schedule. It was originally intended to launch in December 2019 with, as you mentioned, sir, no later than June 2020. We are now understanding better how difficult this project is and that it is going to take some additional time.

I want to be really clear. I think we as an agency need to stick to our commitments. Sir, if we tell you and others that we're going to launch in June 2020 around the Moon, which is what EM-1 is, I think we should launch around the Moon in June 2020 and I think it can be done.

We need to consider as an agency all options to accomplish that objective. Some of those options would include launching the Orion crew capsule and the European service module on a commercial rocket. It's been done before, actually not with the European service module, but certainly there are opportunities to utilize commercial capabilities to put the Orion crew capsule and the European service module in orbit around the Moon by June 2020, which was our originally stated objective.

I've tasked the agency to look into how we might accomplish that objective. So, yes, sir, this is a challenge, but I think we can rise up to meeting it, but the key is we want to test fully the Orion crew capsule and the European service module around the Moon and then ultimately maintain the SLS Program so that by the time we do EM-2, it will have done a full green run test.

By the way, that would be done at the Stennis Space Center in Mississippi, Mr. Chairman, and then after the green run test, we will have tested the SLS. We will have tested the Orion crew capsule and the European service module around the Moon, and then we can get back on track for EM-2. The goal is to get back on track.

The CHAIRMAN. OK. Now as far as I know, this is the first forum in which you've made a statement like this, is that correct?

Mr. BRIDENSTINE. Yes, sir.

The CHAIRMAN. OK.

Mr. BRIDENSTINE. Last week, it came to our attention that we're not going to be able to maintain the schedule.

The CHAIRMAN. OK. Now let me parse your words a little. Consider options. We're looking at the possibility of using a commercial rocket. Whose rocket would that be, and how far along are you in making a decision to go this route in an effort to stick to the mid-2020 schedule?

Mr. BRIDENSTINE. All important questions, sir. The challenge is we don't have a rocket right now that can launch Orion and the European service module around the Moon. That rocket doesn't exist.

The CHAIRMAN. There isn't such a rocket?
Mr. BRIDENSTINE. It doesn’t—that’s what the SLS is all about.
Now here’s what we can do potentially. Again, we’re starting the
process now. We could use two heavy-lift rockets to put the Euro-
pean service module into orbit around the—the Orion crew capsule
and the European service module in orbit around the Earth, launch
a second heavy-lift rocket to put an upper stage in orbit around the
Earth, and then dock those two together to throw around the
Moon, the Orion crew capsule with the European service module.
Now that is—I want to be clear. We do not have right now an
ability to dock the Orion crew capsule with anything in orbit. So
between now and June 2020, we’d have to make that a reality.
The CHAIRMAN. This is 2019.
Mr. BRIDENSTINE. Yes, sir. Here’s the glory of the United States
of America. We have amazing capability that exists right now that
we can use off the shelf in order to accomplish this objective.
Just a few years ago, we launched an Orion crew capsule into
deep space on a commercially procured rocket. That has already
happened. What’s different now is we have this European service
module, which is how we have propulsion and life support and all
those capabilities that we need to last for a period of time with hu-
mans in deep space.
We can use off-the-shelf capability, sir, to accomplish this objec-
tive for EM-1 but not change the direction of the SLS and EM-2.
The CHAIRMAN. OK. Well, I’m not setting a real good example on
the time.
This has really been my only question. How close are we to being
able to make a decision about whether to do this or not?
Mr. BRIDENSTINE. I think it can be done, sir, in the next couple
of weeks and every moment counts because I want to be clear.
NASA has a history of not meeting launch dates and I’m trying to
change that.
The CHAIRMAN. And what are the expense considerations in mak-
ing this decision?
Mr. BRIDENSTINE. That’s another discussion. I think there are op-
tions to achieve the objective, but it might require some help from
the Congress.
The CHAIRMAN. Well, I’d sure like to keep us on schedule. Thank
you very much.
Mr. BRIDENSTINE. Yes, sir.
The CHAIRMAN. Senator Cantwell.
Senator CANTWELL. Thank you, Mr. Chairman, and again thank
you to the witnesses.
Mr. O’Connell, I’m going to focus a little bit more on you this
morning because the state of Washington now has over 6,000 em-
ployees, over 1,400 different space companies, and it’s remarkable
to me how much the commercial space industry has flourished in
the last several years.
I remember the late Paul Allen and his early days of trying to
challenge everyone in this area and you can see how much it’s be-
come, as some people call it, a little Silicon Valley for space in the
Pacific Northwest.
So your comments about an open architecture to keep that dy-
namic going are interesting and I want to understand how novel
you think that is in generating more—I don’t know if you’d call them applications—but more interest.

I can see that becoming a critical point to our national strategy because it is an open architecture. Secondly, I just feel like we constantly are underestimating the applications of commercial space activities. For example, you mentioned NOAA and the increasing importance of the commercial space industry to that agency and I couldn’t agree with you more.

When I think about the Earth information that we could get as it relates to weather alone, every particle in a storm now can be an algorithm, and if we just get the information and use the supercomputing time, the United States could assess all sorts of information and data that would be so helpful to us.

So, one, is the open architecture a key strategic play by us and, two, what would be the next steps for us to breathe more life into these applications? They’re here. I just don’t know if we’re actually putting the dollars behind them to allow them to flourish or empowering the agencies that could use them to do so. I’m thinking of all sorts of natural resource issues that would be so useful to solve, like doing a better job as stewards of our lands and waters.

Mr. O’CONNELL. Ranking Member, thank you for the question.

I’d start just with a general comment. There is not a part of this great country that today is not affected deeply by the commercial space industry and so that’s a wonderful saying. We see it all the time from different places.

In fact, we’re trying to understand better what the size and shape is of the space economy in all of the states in order to help government leaders as well as others, entrepreneurs, in those states achieve pieces of that global space economy we talked about.

On the open architecture data repository, those remarks from me were confined to our responsibilities under SPD–3 on space traffic management.

If you study the space debris problem, it has become a very urgent problem. Space debris essentially potentially harms anything that flies in space, starting with the Space Station, the economic value and scientific value of all the satellites that are up there.

Because the problem is so urgent, General Hyten and the Department of Defense turned to us and said, Number 1, we think it’s natural that the Commerce Department actually take over notification for commercial and civil entities.

The way we want to approach that is to take a problem that was traditionally behind closed doors and put it into a state-of-the-art modern cloud-computing capability and what we get there, in addition to our responsibilities to warn owner-operators, we will get a place within which folks coming forward in the commercial market and academia will be able to experiment, to vet, to validate both sensors, new analytic tools, etcetera, in what we hope and sometimes playfully refer to as disruption of the space debris problem because it’s a very serious problem and we need to make rapid progress in understanding it better and mitigating it.

Senator CANTWELL. And on the applications, like those most useful to NOAA, what do we need to do to better take advantage of those current technologies?
Mr. O’CONNELL. So we see—there’s a uniquely American phe-
nomenon in the market here, which is the role of private capital.
About the third week I was on the job, the Secretary sent me to
a meeting in New York with about 50 people, which essentially
represented $2 trillion of private investment in the market, and we
see that as really a driving source behind the development of all
new applications, resource management, decisionmaking of all
kinds, and so some of that’s going to come from within the market.
The government will also have unique needs, as well, that it can
develop those applications through.
Senator CANTWELL. Well, thank you. I don’t know if it’s living in
the shadow of the Space Needle that furthered all of this, but I’m
just telling you that the industry, the private side of the industry
is definitely alive and well.
Administrator Bridenstine, my time has expired, but I’m going to
submit for the record a question for you about the NEOWISE Pro-
gram and just as Mr. O’Connell’s talking about accuracy in infor-
mation, I think there are some concerns about NEOCam and large
synoptic survey telescope.
So I want to get a question for the record for you from that and
will follow up.
Thank you, Mr. Chairman.
Mr. BRIDENSTINE. Yes, ma’am.
The CHAIRMAN. Thank you, Senator Cantwell.
I have Senator Rosen, then Cruz, and then Peters.
Senator Rosen.
STATEMENT OF HON. JACKY ROSEN,
U.S. SENATOR FROM NEVADA

Senator ROSEN. Thank you, and thank you, Mr. Chairman. Thank
you for being here and for your testimony today.
And what I’d like to do is shift a little bit and to address the
issue of satellites. You’re talking about space debris. There’s a lot
orbiting the Earth and the increasing role that they’re going to
play, both militarily and commercially. So with that, that’s also
going to increase the vulnerabilities that must be addressed.
You know, in 2017, China launched three new satellites. I’m sure
that those numbers will be increasing by them and by others.
So, Administrator Bridenstine, with the rise in the international
competition in space, I’m really concerned particularly about not
just the data that we store, what we transmit, how we commu-
nicate with our military complex and allies and partners around
the world and what vulnerabilities that creates.
So what are you doing with the satellites that connect us all to
intervene in this area?
Mr. BRIDENSTINE. So that’s an important question when you
think about space-based communications. When you think about
what a satellite is, Senator, it is a node and a communication net-
work. That’s all it is.
So we’re collecting data. It could be imagery. It could be, you
know, any part of imaging the Earth with the electromagnetic spec-
trum for science, discovery, those kind of things, looking into deep
space, but it’s just—it’s data and that data then gets transmitted
and, of course, those are all, you know, using the electromagnetic spectrum.

So one of the challenges is, and we’ve seen this in the past, especially as it relates to NOAA, one of the challenges is we have competitors in the world that would love to, you know, shut down our capabilities when and if they like.

Senator Rosen. Not even shut down. What about modify the data that’s returned to us so we make an inaccurate—changes the outcome of an algorithm for something in our military perhaps?

Mr. Bridenstine. Yes, so that is definitely a concern. I will tell you what the DoD does and what NASA does. We’re kind of different. We intentionally try to make sure that our data is available to the world. We give it away for free. We want to make sure that we are doing science, discovery, exploration, all of those things that are soft power things.

On the DoD side, their communication networks, of course, they need to be frequency hopping for anti-jam. They need to have a lot of encryption and, of course, we have encryption, too. I want to be clear.

Our goals are very different than their goals. Our architectures are different, but I would say the key is cybersecurity which we are focused on, you know, like a laser as an agency.

When I was in the House of Representatives, we had to shut down some weather satellites for a period of 3 days and that was, of course, because we had an international actor hack into the National Weather Service and my state of Oklahoma for a period of 3 days didn’t get any data.

Senator Rosen. It’s not going to change the weather but it can change what we do about it.

Mr. Bridenstine. That’s exactly right. So the key is why is an international actor interested in disrupting weather prediction? Well, they’re proving capabilities. They’re proving technology and so if the weather enterprise is at risk, you can imagine——

Senator Rosen. Right.

Mr. Bridenstine.—NASA is at risk and so we understand this critical, you know, challenge and we’re making adjustments every day to be on top of it.

Senator Rosen. Thank you.

Mr. Bridenstine. Yes, ma’am.

Senator Rosen. Mr. O’Connell, we’re talking about this. I’d like if you could address something the private/public partnerships or private sector.

How do you think they’re addressing it, and are they on top of what they need to be?

Mr. O’Connell. Absolutely, Senator, and again thank you for the question.

We’re actively working with the industry to do two things. One, to understand the kind of threats that they are seeing to their systems. You know, what are they experiencing in their data flows, but also to share information out in the other direction on security practices, etcetera.

The office has just been invited to a National Security Council Working Group on Space Cyber Integration that will deal with a lot of the issues that Administrator Bridenstine has raised.
Senator Rosen. And I see this is an easy way for bad actors to infiltrate our systems. So it’s something we need to be hyper-vigilant about.

Thank you for being here.

The Chairman. Thank you, Senator Rosen.

The Senator from the Houston Space Center.

STATEMENT OF HON. TED CRUZ,
U.S. SENATOR FROM TEXAS

Senator Cruz. Thank you, Mr. Chairman. Gentlemen, thank you for your testimony, your leadership.

Administrator Bridenstine, let’s talk a little bit about the ISS. As you are aware, last year’s budget from the Administration proposed ending all Federal Government funding for the ISS by the year 2025.

The Space Subcommittee of this committee held a series of hearings on whether that was wise, whether that was prudent. The testimony we received consistently was that it was not. The Space Station, as a matter of scientific and technical capability, can continue to be utilized at least until 2030, if not later, and given that the taxpayers have invested over a $100 billion in it, the testimony we received is that it was prudent to get the maximum return for that investment and that it would be nothing short of catastrophic to cede low Earth orbit to the Chinese.

In light of that testimony, I introduced legislation that explicitly extended funding for the Space Station until 2030. This committee passed that legislation unanimously. It went on to pass the Senate unanimously.

I was very pleased to see this year’s President’s budget that did not have that language zeroing out the funding but instead talked about transitioning to more commercial opportunities which all of us would like to see but no longer suggested a threat to the funding for the Space Station in 2025.

I think that is beneficial to the American taxpayer. I think it’s also beneficial to our partners in the Space Station making clear that our commitment to the station is to get the maximum reasonable life and use out of it.

Do you agree with that sentiment?

Mr. Bridenstine. Yes, sir. I have been watching your leadership on this issue with great interest, as you can imagine, and I would say we are starting even right now today to put together all of the tools so that we can commercialize low earth orbit as rapidly as possible.

It is true the language ending direct funding is not the language we’re using anymore in 2025, but instead we’re transitioning and that’s starting today, transitioning to new funding models that would be enabling of commercial activities.

What you’ll find in this budget request is a $150 million specifically for commercialization activities in low earth orbit, but that $150 million does not include the great investment that is the ISS that helps us transition. We need to utilize the ISS for the transition to commercialization. It is a tool to get to commercialization.

So know this. I believe a day is coming when we will have commercial activities in low Earth orbit. The goal here, Senator, and
you know this, NASA wants to be one customer of many customers in a robust commercial marketplace for human activities in low earth orbit.

At the same time, we want to have numerous providers that are competing on cost and innovation to drive down costs and increase access to space.

We just recently saw what happens when we can dock a commercial Crew Dragon to the International Space Station with a reusable rocket provided by the private sector. Costs are going to go down, access is going to increase. We don't want to just do it with commercial resupply to the International Space Station, not just with commercial crew to the International Space Station, but actually with habitation in low earth orbit.

The purpose for this ultimately is so we can save resources and use the precious dollars that this committee and the Senate and the House give us, use those precious dollars to go to the Moon where there is not yet a commercial marketplace but for which we believe there will be a commercial marketplace.

Our goal is to retire risk, commercialize, and go further and do more, and I do believe the date very well could be 2025 and that's my goal and I'm going to be very clear. My goal is to move us to a day where in 2025 we are completely commercialized, but it's important to note that what we're talking about now is the development of a new funding model.

Senator CRUZ. Well, and I want to commend the Administration for listening to Congress, that we had long had bipartisan agreement that we will continue America's leadership in space and listening to Congress is an important part of maintaining that consensus.

Another avenue to potentially ensure that we have the funding both for the ISS and for exploration is having our partners and allies pay their fair share.

Can you give your thoughts in terms of how much does the United States currently contribute to the fund to operate the ISS and how does that compare to the contributions of our international partners?

Mr. BRIDENSTINE. Yes, sir. So right now, when you think about the International Space Station, the United States of America is a partner at about a—well, talking about the United States segment of the International Space Station.

There's the U.S. segment and then there's the Russian segment. The United States segment, we have international partners on there, Japan, the European Space Agency, Canada, and, of course, the European Space Agency includes 11 different nations right there.

So on that partnership, the United States of America contributes about 77 percent. The balance is provided by the rest of those partners. The highest, I think, is around, you know, 10 percent and then 8 percent, and Canada is around 3 percent.

I don't want to suggest that this is a bad deal because what we get for our commitment, there's rights and responsibilities. Our responsibility is at the 77 percent level. Our rights are at the 77 percent level. That includes astronauts. It includes experiments on the
ISS. So while we are, you know, paying a bigger percentage, we are also receiving a bigger benefit from it. That being said, for the future, when we think about the entire architecture between low Earth orbit and the Moon and eventually Mars, we have to change that paradigm.

If the United States of America is going to be a 77 percent contributor that in my view is not the right approach and it won't be sustainable. My charge is to create the sustainable return to the Moon which means we need more partnership from more nations. At the same time, we need to take our partners that we currently have and have them increase funding, as well, as the United States of America already has done and will continue to do with your leadership, of course.

Senator CRUZ. Thank you.

Mr. BRIDENSTINE. Thank you.

The CHAIRMAN. Administrator, if China were looking for partners in an international space station, they might be willing to kick in 87 percent, might they?

Mr. BRIDENSTINE. I would argue that they might be willing to kick in a hundred percent in order to have the influence. Yes, sir.

The CHAIRMAN. There would be a pretty unreliable partner, but to some countries out there, it might seem to be worth it.

Mr. BRIDENSTINE. In fact, sir, it is already happening. Our European partners right now, there are Europeans in China training to become Taikonauts for the upcoming, you know, Chinese Space Station. So China is moving very rapidly to entice the world to join them in their efforts in low Earth orbit.

The CHAIRMAN. And I want to thank Senator Cruz for his leadership in this regard.

Senator Peters, and then Senator Fischer.

**STATEMENT OF HON. GARY PETERS, U.S. SENATOR FROM MICHIGAN**

Senator Peters. Thank you, Mr. Chairman. I want to thank Senator Cruz, as well, for the leadership on the Space Station. I'm a backer of it, as well, working with Senator Cornyn on legislation, with you to make sure that we keep the station operating to 2030. We've made a substantial investment in that station. It's critical to maintain our partnership, all the things that we have heard.

But what I hear from you, Administrator is that you have set a goal and believe that it's possible that commercial activities will be able to pick up that cost by 2025, which certainly seems very ambitious, and so my question is for Mr. O'Connell.

Do you believe the commercial space industry would actually start making that all up in 2025? Is that even realistic or should we be thinking about something else?

Mr. O'CONNELL. Senator, thank you.

We are seeing a number of industry partners come forward, partly to understand the roles that they can play on the Space Station, the extent to which they can access it.

So far we're seeing relatively small applications for the Space Station, but we're hoping to encourage others for larger applications, as well. We also see companies coming in the market that
believe they can create a wholly commercial space station, as well, but the transition period is going to be critical.

Senator PETERS. And five or six years is ambitious to say the least?

Mr. O’CONNELL. It would be ambitious.

Senator PETERS. The other question for you, Mr. O’Connell. You’ve talked about orbital debris and as a critical problem that I know Mr. Bridenstine believes, as well, NASA is very concerned about. The Department of Defense, and pretty much across agencies and as we get more constellations of satellites, it’s going to be a bigger and bigger problem, probably growing exponentially in the years ahead.

You talked about some of the efforts being made in the Department of Commerce to attract this. I know there’s a debate going on among agencies as to who should be in charge and I think whenever you have a big problem, you’ve got to have somebody who’s actually in charge. You can’t have everybody pointing fingers at each other and it’s a complex web from the Department of Transportation, FAA, Commerce, DoD.

Who do you—now I know where you work, but give me the argument as to why Commerce is best to do this job and why not the Department of Transportation and the FAA, which has quite a history of tracking objects in the air?

Mr. O’CONNELL. So let me focus on what we’ve been doing and the extent to which it relates to what the problem has been described here.

General Hyten came to us last year, Secretary Ross, Administrator Bridenstine testified about the nature of the space debris problem and its urgency. Part of the logic for us was that General Hyten thought that it was proper that because we were going to be interacting with a whole range of commercial actors in space that it was logical for the Commerce Department to actually take on that responsibility.

So let’s talk about what we’ve done since that time.

Senator PETERS. Please. The FAA obviously deals with a lot of commercial actors in the air, as well.

Mr. O’CONNELL. Absolutely, Senator. What we have done since that time, though, when people say why Commerce, I would give a couple of answers.

Number 1, we have technical organizations, like NOAA, the organization that I sit in, as well as NIST, very much self-interested. There’s a group at NOAA that pays very careful attention to the space debris impact on NOAA weather satellites and others, as well as NIST.

Secretary Ross would talk about the fact that 40 percent of the data that the U.S. Government shares with the American people actually comes out of the Commerce Department. So a wide range of organizations internally actually have models for sharing information of the kind we’ll need with the space debris problem.

Most importantly, I talk about our interactions with the supply and demand aspects of space debris. On the supply side, we are routinely interacting with a wide range of new companies that are coming into the market—I mentioned this in my remarks—new sensors and a very diverse set of sensors, new analytic tools that
will increase the accuracy of the data that’s shared with operators and new visualization platforms. That’s the supply side.

But we’re also routinely interacting with the companies that will effectively change what information is required in space. So when we consider CubeSat constellations, mega constellations, they will need new kinds of information from an SSA perspective. So we’re seeing both dimensions of that.

And then obviously the open architecture data repository that we talked about. We’re interacting with a wide range of industries, I’ll call them adjacent industries, not necessarily space industries, artificial intelligence, cloud computing, that can greatly affect how this changes and again by all sense, it’s got to change very quickly.

Senator Peters. Well, thank you. I have one final question, Mr. O’Connell.

The commercial space industry, as it’s growing, there’s also expanding interest in launch capabilities in other places around the country. In my home state of Michigan, for instance, the Michigan Launch Initiative is working to develop a space port for the potential launch of low orbit polar satellites and our geographic position is well suited for that.

The question is, what is the Department of Commerce doing to work with organizations, like the Michigan Launch Initiative, to develop private space ports and increase our national capacity to support commercial space as a result of that?

Mr. O’Connell. So we’re routinely asked to meet with space port leaders, organizations that relate to building new space ports.

One of the questions that the Secretary likes to ask is how many space ports is the right number of space ports in the country. That will absolutely relate, Senator, to the extent to which the vision that we’ve laid out for space, that the Administration has laid out for space comes true.

The extent to which we can manage the air space integration piece that is very much an FAA, Department of Transportation responsibility, but the vision beyond that that we can actually achieve.

We’re more than happy to meet with everyone who is in the process of building a space port.

Senator Peters. Great. Thank you so much.

Mr. O’Connell. Yes, Senator.

The Chairman. Thank you very much, Senator Peters.

Senator Fischer.

STATEMENT OF HON. DEB FISCHER, U.S. SENATOR FROM NEBRASKA

Senator Fischer. Thank you, Mr. Chairman.

Administrator and Mr. O’Connell, both of you spoke in your testimony about the need for the United States to be competitive in commercial space.

Does NASA and/or the Department of Commerce have a definition or a standard by which they consider the United States to be competitive? In other words, what are some of the factors that each of you would view as being an indication that the United States is competitive?
Mr. BRIDENSTINE. I would start, Senator, with the—I think the question for me is, what nation on the planet is the preferred partner of choice and right now, the United States of America is that preferred partner.

We talk to our international partners and they are keenly interested in partnering with us on a whole host of missions and while they are willing to partner with other nations, they’re generally more interested in us because we bring more capability, we are more open and transparent with the discoveries, and it gives them prestige in the world in fact to partner with the United States of America.

So I think that’s a key metric, but I think also just achievement in general. In the last year, we have landed InSight on Mars. We are the only nation on the planet that has ever landed a robot on another world and we’ve now done it on Mars eight times successfully. This time when we landed Insight, we did it with international partners that brought technology to the table. So that’s a very good thing.

And then, of course, over the holiday, we had a flyby of Ultima Thule which was the same spacecraft that flew—it was with New Horizons, which is the same spacecraft that flew by Pluto back in 2014.

We’re talking about four billion miles from Earth, a mission that has been going on for years and it’s just delivering stunning images and science and, of course, now over the same holiday, we entered orbit around Bennu, which is an asteroid in deep space, and OSIRIS-REx, which is the robot, the satellite, if you will, that is currently in orbit around Bennu, it will be bringing samples home from that asteroid.

Our capabilities as a nation are stunning. People want to partner with us. It is important for us to stay at the cutting edge of this. I will tell you——

Senator FISCHER. What specifically do our industries do to provide for that? You know, as a government, we’re not necessarily the ones that are achieving it. It’s businesses. It’s industries. What makes them so unique? What makes it the cutting edge?

Mr. BRIDENSTINE. Well, I think there are a couple of things. Number 1, we have the best university system in the world and when we want to do a mission to OSIRIS-REx is run by the University of Arizona. We’ve got another mission that’s coming up where we’re going to go to an asteroid in the Asteroid Belt. It’s not even an asteroid. It’s a huge steel ball that might be the core of a planet that got destroyed or maybe the core of a planet that’s currently being developed. I don’t know. Nobody else knows either, but that’s a mission that’s being run by Arizona State University.

In Oklahoma, they’re doing a mission called GeoCarb to study the Earth. So we have amazing scientists and engineers and technicians and students even that get involved because we have such an amazing university system and then those universities partner with industry to help develop the technology and capability.

Senator FISCHER. I’m going to stop because I’m running out of time.

Mr. O’Connell, you can feel free to jump in here, as well. When we look at programs, like the Space Grant, the NASA Space Grant
that supports future scientists, future engineers, how is NASA ensuring its educational programs are going to support the future needs that we see in commercial space programs that are coming up? I have just a short period.

Mr. BRIDENSTINE. Yes, ma’am. So the key is Space Grant is a good program that NASA takes advantage of right now and what we’re looking toward doing is engaging students in our activities. So we partner with universities. We partner even now—I was just at an event where we were—it was a robotics competition called First Robotics, thousands of students that are in high school that are building robots. This is the next generation of the engineers, the technicians that will build our robots that go to Mars and on to other destinations.

So we are keenly aware of developing that talent, the necessity to develop that talent, and we’re committed to it.

Mr. O’CONNELL. May I just make a brief comment? I would echo everything that Administrator Bridenstine said.

We have been talking a lot about the trillion dollar space economy and what the building blocks are to get there. Part of it is continued innovation in things that are already commercialized space while other capabilities come to market.

I mentioned the role of the private sector and private capital very, very important, but even inside the Commerce Department, we actually have two grant-making organizations, the Economic Development Administration and the Minority Business Development Agency, which just celebrated its 50th Anniversary.

Both of those organizations have space commerce grants and in fact the first space commerce grant out of MBDA is actually a grant to travel around the country and attract traditional and new entrepreneurs to the space business. People, in short, Senator, are still very excited about going to space.

Senator FISCHER. Thank you both very much.

The CHAIRMAN. Thank you, Senator Fischer.

Senator Sullivan.

STATEMENT OF HON. DAN SULLIVAN, U.S. SENATOR FROM ALASKA

Senator SULLIVAN. Thank you, Mr. Chairman, and thank you for holding this hearing.

I want to thank the witnesses for your leadership on this important issue.

What I want to actually talk to both of you about is an issue that you haven’t really raised that much but it’s the power of inspiration for the next generation of Americans with regard to all that NASA and others are doing with regard to space exploration.

Now I’ve asked this before in other hearings relating to space exploration but since I have you here, Administrator, have you seen the movie The Martian?

Mr. BRIDENSTINE. I have.

Senator SULLIVAN. OK. How about First Man? I saw that just the other day.

Mr. BRIDENSTINE. I have.

Senator SULLIVAN. And so how about you, Mr. O’Connell?

Mr. O’CONNELL. No.
Senator SULLIVAN. So here's my question. These are great movies and I don't normally plug Hollywood, but I think these are really inspirational and I have three daughters and they've seen them and they love these movies because they inspire us, right, and what they do is they inspire us, particularly young people who can do great things.

You talked about the universities in America. I actually agree that that's a huge strategic advantage, but what is NASA doing to kind of bring that can-do inspirational culture but also inspiration to the next generation of Americans? It's not just the scientists but it's also the—you know, like the movie The Right Stuff. There's courage. There's adventure. There's sacrifice, you know. The First Man, that movie, highlights that.

What are you doing to help us regenerate that as a country because I think we can do better than anyone else but there's an intangible that relates to NASA and space exploration is so much more important than competing with the Chinese or commercial technology. It's really the inspiration of a nation and the next generation of Americans and you guys can do that.

I think NASA, to be honest, has lost that a little bit, but I think you can redo it. Hollywood's being helpful in this regard with some of their movies, but can you talk to that issue because I think it's probably one of the most important things you can do for our Nation.

Mr. BRIDENSTINE. Yes, Senator. So I would argue that the key thing we need to do as a nation is do stunning things. We need to do things that capture the imagination of the American public and in fact capture the imagination of the world.

I tell people frequently, you know, I wasn't around during Apollo 11. We're celebrating the 50th Anniversary of Apollo 11.

Senator SULLIVAN. You weren't born?

Mr. BRIDENSTINE. I was not yet born.

Senator SULLIVAN. All right.

Mr. BRIDENSTINE. But I will tell you this. I remember exactly where I was in fifth grade, Ms. Powers' English class, when the Space Shuttle Challenger exploded. I remember her walking into the room. I remember tears coming down her face. I remember the students being like what's wrong with Mrs. Powers? I remember her gathering up all of the other teachers and bringing in the TVs and turning them on. Those are the moments that are emblazoned in the memories of my generation.

We need to change that, Senator.

Senator SULLIVAN. Yes.

Mr. BRIDENSTINE. We need to have those moments where this generation sees people walking on the Moon. This generation sees people making the advancements necessary to get to Mars and in fact this generation could see people walking on Mars.

Senator SULLIVAN. Let me give you just a quick example. We have a program in Alaska called ANSEP, which is Alaska Native Engineering Program for young high school kids going into college. Then they do it into college.

I was at their annual dinner the other night and we had an astronaut speaking at the dinner back in Anchorage. It was very, very inspirational.
One of the young kids came up to me and he had been hired recently by NASA to work on the rocket that’s going to go to Mars.

Mr. BRIDENSTINE. Nice.

Senator SULLIVAN. And, I mean, it was just incredible. This inspiration of this young kid who worked really hard, gotta earn it, right, but we want to be able to help you do this in a way that I think changes the culture.

As you mentioned, the idea of the Challenger exploding, which was a horrible tragedy, is not the image we want. It’s Neil Armstrong. I think it’s your greatest asset. We want to be able to help you with that, but we really do need to inspire the next generation of Americans.

Mr. O’Connell, do you have any thoughts on how Congress can help you with that or what you can do? I think partnering with media, like I said, Hollywood, on some really, really good movies lately just to bring that inspiration is something that we should look at taking advantage of. What do you think?

Mr. O’CONNELL. Absolutely, Senator, and I would not underestimate the power of private enterprise here where you can do cool things and also make money in the process.

There’s sometimes it’s viewed that science and commerce are incongruous.

Senator SULLIVAN. So I’m assuming you’re kind of endorsing capitalism? Oh, that’s a whole other issue.

Mr. O’CONNELL. Indeed, I am. I am from the Commerce Department.

Senator SULLIVAN. We’re debating that now, believe it or not, but I endorse capitalism, as well. But as part of exploring the cosmos, you think that’s a powerful thing that NASA can be doing for this generation of Americans?

Mr. O’CONNELL. Not just NASA but also at Commerce, we’re talking to a number of universities around the country who want to develop a space commerce curriculum in the business schools, for example. So we have our own role in the education area, as well.

I’ve mentioned the MBDA Grant and again their Space Foundation under that grant is actually traveling around the country to attract not just the traditional entrepreneurs to the business but people of other walks of life who are interested in space, may not have the technical skills, but saying, boy, I’m interested, maybe this is something I can do here.

So we want to attract a wider audience. What I like to say sometimes is that we’ll never get to the trillion dollar space economy if space is left only in the heads of the technical people. We need a much wider community of people to participate in that.

Mr. BRIDENSTINE. I know we’re over time,——

The CHAIRMAN. Go ahead.

Mr. BRIDENSTINE.—but I’d like to make two quick points that are critical here because Kevin is working on the commercial stuff. We are helping with commercial stuff, as well.

We just saw a commercial vehicle, the Dragon, dock to the International Space Station. Everybody in the world saw that. I was on the phone yesterday with our international partners. They’re all congratulating me. They’re thrilled about it. It’s going to drive down costs, increase access, enable us to go to the International
Space Station with more capability, more people to do more experiments, and drive down costs. So all of that’s very positive. So that’s a good thing.

The other thing is when we landed InSight on Mars, an important point here, we were on the cover of every newspaper worldwide. Children in Tehran were basically reading good stories about the United States of America landing on Mars. That’s the kind of influence that NASA brings to the table, the inspiration, the idea that we can reshape or transform the image of the United States for people all around the world.

When we talk about the instruments of national power, diplomatic, information, military, economic, that information piece is what NASA brings to the table, and, by the way, that’s our history and tradition going back to Apollo 8 and Apollo 11.

The whole world sees our stunning achievements and it inspires everybody.

Senator SULLIVAN. Great. Thank you very much. We want to help you with that mission, too.

The CHAIRMAN. Senator Sullivan endorses capitalism and Hollywood.

[Laughter.]

The CHAIRMAN. Senator Capito.

**STATEMENT OF HON. SHELLEY MOORE CAPITO, U.S. SENATOR FROM WEST VIRGINIA**

Senator CAPITO. Thank you, Mr. Chairman, and thank both of you for being here today, and I appreciate what you’re doing and certainly have learned a lot.

Europe, China, and Russia are all developing a wide array of space-based robotics and satellite systems, and we haven’t really gotten into this discussion on the question, but, Mr. Administrator, we’ve talked about this before.

I believe it’s vital that we develop the technology to repair, refuel, and refurbish those satellites and systems so that we can enhance their capability, their lifetime, their operational lifetime. You’ve talked about space debris. I think this leads into that.

In the West Virginia Robotic Technology Center, our state is making a significant contribution to ensure that the U.S. does not fall behind in our global competition in an area that is critical to science, commerce, and our national security on the repair, refurbish, and refueling of our existing satellites.

Could both of you talk about what you’re doing in NASA and then also at the Department of Commerce to ensure that we’re leading the way in this and give us an update on where you see this going?

Mr. BRIDENSTINE. So right now, NASA is developing Restore-L, which is a mission that is going to basically refuel a LandSat satellite operated by USGS, which is, it’s a great mission for NASA. Robotic servicing of satellites is a capability and a technology that I think will have an effect that drives down costs.

Satellites are extremely expensive and if we can extend their life, use them longer, it drives down costs and increases our ability to do things. So I think robotics is a key piece of that.
I think as we move forward, what we have to be focused on are technologies, going to the commercial piece, technologies that can be commercialized. NASA does not want to operate a fleet of satellites running around the globe servicing, whether it’s——

Senator CAPITO. Right.

Mr. BRIDENSTINE.—doing maintenance or refueling satellites. What we want to do is develop the technologies, develop the capabilities, license or transfer those technologies to commercial industry and let them operate the fleets, so that NASA can continue doing the things that NASA is good at, which robotics is one of those things. So we’re happy to be a partner in this effort.

Senator CAPITO. Thank you.

Mr. O’CONNELL. Senator, thank you for the question.

The satellite servicing and the robotics industries are critical to changing, as the Administrator said, the entire economics of space and so we’re routinely talking to this.

I think your question, though, pushes me toward the question of how we’re going to regulate companies that come forward in the market. We’re familiar with how to regulate remote-sensing communications navigation companies. I’m very interested in how we’re going to take on new companies that come forward with brand-new capabilities that we have no experience with before.

When I talked about this in my remarks, the need for, if you will, regulatory efficiency, especially given that other countries around the world already have lighter regulatory regimes and will attract—are trying to attract new talent, new companies to their spaces, as well. So it’s very important that we pay attention to those capabilities early as they come forward in the market.

Senator CAPITO. That leads me to my next question. I know West Virginia University’s been participating with NASA on these issues and I’m so glad somebody brought up the university partnerships that you both have because I think that’s critical not just for the next generation. It’s an economic driver for many states, mine certainly is one of those.

I’m wondering. Do you have any—are there any roadblocks or have you experienced any difficulties in forming these partnerships with universities? Is there something that we can do to increase those capabilities?

Mr. BRIDENSTINE. NASA has really amazing partnerships with a lot of universities. I don’t know of anything offhand that would prohibit us doing that more, but, you know, I think one of the areas as it relates to robotics, when we talk about the regulatory regime, you know, we hear in international fora about the requirement under the Outer Space Treaty to provide authorization and continuing supervision for activities that are non-traditional and activities in general, but when it comes to robotics servicing of satellites, some countries around the world see that as very provocative.

And so creating a regulatory regime, which we’re doing now for the first time, where we can provide that authorization and continuing supervision for those robotics activities and ultimately give confidence to international partners and even international competitors that this is not being something that is being utilized for any kind of hostile purposes, that’s, I think, a key component for
the robotics that I know that the Commerce Department right now is moving out on under the direction of Space Policy Directive-2 from the President.

Mr. O'CONNELL. That's correct.
Senator CAPITO. All right. Thank you.
The CHAIRMAN. Thank you very much, Senator Capito.
Senator Moran.

STATEMENT OF HON. JERRY MORAN,
U.S. SENATOR FROM KANSAS

Senator MORAN. Chairman, thank you. Thank you both for being here, Mr. McConnell and Administrator.

To follow up on the conversation you were just having with the Senator from West Virginia, Senator Warner and I, the Senator from Virginia and I are working on reintroducing our Aeronautics Innovation Act designed to boost the attention and resources and it really is hoping to provide a guide to NASA's Aeronautics Research Mission Directorate, and I'm happy to have you—I think maybe you answered the question when Senator Capito asked about what are the impediments, what can be done to make some changes.

But we're working to make certain that the congressional support for research in aeronautics is enhanced, not diminished, and we look forward to working with you in that regard.

Administrator Bridenstine, I'm mostly here to tell you thank you for your visit to Kansas and to highlight something for you. We'll have additional conversations about the importance of STEM education when we have a budget conversation, appropriations conversation, but I wanted you to know that just a few weeks ago in my office was a student who participated in our STEM event in Wichita, at which you spoke and an astronaut spoke, and we rekindled his boyhood dream of going to Mars and he now has decided that this is the career that he wants to pursue.

I'd just point out that those efforts at NASA, your efforts in particular in Wichita, but you and an astronaut have such a capability of changing a person's life. I'm of the view we change the world one person at a time and I want you to know that we want to make certain that NASA remains that agency that inspires another generation and highlighting just one student who was affected by what you had to say, I wanted you to be aware of that.

Mr. BRIDENSTINE. Well, Senator, thank you for saying that, and NASA has a long history and tradition of this. We have employees that visit all kinds of museums and institutions as we visited to do just that and that's ultimately how we create that next generation of scientist, technician, engineer, mathematician, and I'm proud to do that.

I would also say that trip to Wichita was transformative for me. Understanding and seeing for the first time what a digital twin is of an aircraft and now, you know, NASA is actually—we have commercial partners that are using digital twins of spacecraft.

In other words, we can stress the digital twin in a computer model just as the spacecraft itself has been stressed in space and the reason we do that is so we can make assessments as to the
health of the spacecraft and how long it’s going to last and whether or not we should fly it again, those kind of things.

And so I will tell you, I enjoyed the trip very much. I learned a lot and it has applicability that goes beyond aviation and into space. I think that is why when we think about NASA, the National Aeronautics and Space Administration, first A in NASA is Aeronautics, it is directly applicable to what we do in space.

Senator Moran. I’ve tried to explain dual twin to many people here in my legislative role and I may just start quoting you, Administrator. Thank you.

I’m shuffling this morning between Defense Appropriations and here. The Air Force is in front of our committee today and the tremendous challenges we face in space and the defense of our country. We need to make certain that we’re doing everything in the defense on the civil side of aerospace and space for purposes of the safety of our country and the common denominator there is attracting a workforce with talent, skill, and intellect, and you play a significant role in that regard.

Thank you.

Mr. Bridenstine. Yes, sir.

The Chairman. Thank you, Senator Moran.

Senator Blackburn.

STATEMENT OF HON. MARSHA BLACKBURN, U.S. SENATOR FROM TENNESSEE

Senator Blackburn. Thank you, Mr. Chairman, and what a pleasure it is to see you in this room, Mr. Bridenstine, and——

Mr. Bridenstine. Yes, ma’am. What a pleasure it is to see you in that role.

Senator Blackburn. I appreciate that. For those that don’t know, when he was a freshman member of the House, he was on the hallway where I had my office. We had a lot of freshmen there and it was like I was the chief mama in charge of helping with all these freshmen.

You’re doing such a great job and I think last week’s success was indicative of the energy that you’re bringing. So we appreciate that.

Mr. O’Connell, I’ve got a question for you specifically. As you look at commerce and space and consider commercialization, kind of a new frontier, let’s talk about spectrum. It is valuable, and I want to hear from you what you Commerce is doing right and what they could be doing to make certain that we do not waste any of this spectrum.

Mr. O’Connell. Thank you, Senator, for the question, and, indeed, spectrum is one of the critical dependencies for both space as well as the Administration’s 5G strategy and so some of the debates have been intense, they’re deeply technical, and what we have been concerned about with regard specifically to the space industry is making sure that we’re bringing the proper data into the discussion relating to economic value of either technical decisions or future applications.

Our worry on the space side, of course, has been that the taxpayer has invested billions of dollars in capabilities related to either world-class weather prediction, everyone’s ability to navigate leaving this hearing via GPS, and Administrator Bridenstine’s ca-
pability to beam back from billions of miles away with fascinating scientific experiments.

And so we're really trying to make sure that the space community is well advocated for as part of an overall administration strategy on 5G.

Senator BLACKBURN. And I would add into that, you're probably looking at drones and the commercial utilization of drones?

Mr. O'CONNELL. Absolutely. There are both drones and then there's a whole new class of—

Senator BLACKBURN. Satellites.

Mr. O'CONNELL. Underneath satellites, there's something that are called high-altitude platforms, as well.

Senator BLACKBURN. Correct.

Mr. O'CONNELL. So there are a lot of things in that vertical spectrum that have to be considered when we think about spectrum.

Senator BLACKBURN. And it needs to be done in an orderly process.

Mr. O'CONNELL. Yes, ma'am. Absolutely.

Senator BLACKBURN. And we will look forward to you all coming back to us with some recommendations on that. You know, as we work on the 5G issue, I continue to remind people this is going to be as transformative as when we went from analog to digital.

Mr. O'CONNELL. Yes, ma'am. Absolutely.

Senator BLACKBURN. And I think that our hopes are very high for what this is going to do, but we've got to be mindful of how we use and slice and pack that spectrum and not have any of it going to waste.

Senator MORAN. Absolutely. And under Space Policy Directive-2, obviously there's a report that's coming due immediately that you'll be made aware of on how we think about the space component of that.

Senator BLACKBURN. Right. Absolutely. One question for you, Mr. Bridenstine.

The public/private partnerships are going to end up being more important, certainly for each of you, but I think for NASA, as you kind of give it a new footing, if you will, and kind of help it find priorities.

So I wish you would talk for just a moment about what we could do to help you in that realm as we expand these public/private partnerships and as you reprioritize the activity of the agency and reshape that agency.

Mr. BRIDENSTINE. Yes, ma'am. So as you're aware, what we're trying to do, where there are commercial marketplaces, we want to be a customer rather than the owner and operator of hardware, which, of course, is very expensive. So if we become one customer of many customers, costs go down.

At the same time, we don't want to get in the position where we are a customer and we have a single provider of services because then we're going from having a government monopoly to a commercial monopoly which isn't the right approach either.

So we need a marketplace where we're a customer, there are other customers, but also have numerous providers and those providers compete on costs and innovation to do things that are very similar to what they would do commercially.
So when it comes to low earth orbit, we are on the International Space Station right now with commercial crew capability almost. We've demonstrated at least a test flight at this point, but we've been doing commercial resupply to the International Space Station for a number of years.

This capability has driven down costs, it increases access, and ultimately it will enable us to have, you know, basically one customer of many customers. The engineering cost gets spread across numerous different partners.

What we'd like to do, Senator, as we move forward, is replicate that model for commercial habitation in low earth orbit. So we talk right now about the International Space Station, critical capability for the United States of America. Using the Space Station in order to test commercial habitats, we could create an entire commercial, you know, I guess, domain of space exploration in low earth orbit where NASA is a customer.

Then we can use the very precious resources that you give us to go to the Moon where there's not yet a commercial marketplace but there could be a commercial marketplace, given the resources available at the Moon, namely the water ice that we discovered back in 2008.

So when we think about this, we're looking at building this architecture, a new paradigm, where we have commercial and international partners side by side with NASA, you know, accomplishing new things that nobody could do on their own but collectively we can do all more.

So authorities to do that kind of activity would be very helpful and I'm looking forward to working with you on that as days go by.

Senator Blackburn. Excellent. We look forward to it, also, and I will say user fees funding needed research. That's always a good platform that works.

Mr. Bridenstine. OK.

Senator Blackburn. Yield back. Thank you, Mr. Chairman.

The Chairman. Thank you, Senator Blackburn.

Senator Klobuchar.

STATEMENT OF HON. AMY KLOBuchar, U.S. SENATOR FROM MINNESOTA

Senator Klobuchar. Thank you very much. Welcome to both of you.

You know what a leader the U.S. has been when it comes to space and as you also know, we're facing competition from other nations. China has planned to construct its own space station in low Earth orbit, the China Space Station or CSS, and the CSS may launch as soon as this year, and China's already begun inviting other countries to apply to conduct experiments aboard it. The European Space Agency is reportedly working with China.

How are NASA and the Office of Space Commerce planning to ensure that the U.S. remains competitive in space explorations?

Mr. Bridenstine. Senator, we continue to move out doing stunning achievements, going to the International Space Station where we have our international partners already onboard, and as we go to the next step, which is to the Moon, this time when we go to
the Moon to actually stay and that means using our international partners, having them join us in our effort to go to the Moon keeps them in our sphere, which I think is important.

I can tell you right now, as the head of the agency, I meet with our international partners regularly and they are very excited about going to the Moon with us, which has never been done before, where we go to the Moon with international partners. So I think that's a critical capability to achieve.

So there are, I think, good stories to tell right now, but you are right.

Senator KLOBUCHAR. OK. Mr. O'Connell, along these same lines, in your testimony, you highlight the need for strong protections of U.S. intellectual property rights for cutting edge space technology. A recent study found that China's using foreign investment as a means to transfer technology assessed at approximately $300 billion a year. It's a clear threat to our U.S. intellectual rights protections.

What's your agency doing to address this issue?

Mr. O'CONNELL. So may I respond first, Senator, to your first question?

Senator KLOBUCHAR. Sure.

Mr. O'CONNELL. We're in our advocacy work, we are actually trying to understand the value of the ecosystem that will support the space exploration that NASA has.

In December, we held a Space Investment Summit where Secretary Ross was essentially asking what's the longer-term investment climate for the space industry from even beyond where it is now. Just last week, we held a Space Insurance Summit——

Senator KLOBUCHAR. And what do you think are the main barriers to growth for the commercial space sector?

Mr. O'CONNELL. I spoke in my remarks about regulatory efficiency, the extent to which companies need to come to different places when they come to town for licensing.

We have an idea, a vision for something we call a one-stop shop where companies come to one place at the office, ideally a bureau at some point, where they can come to one place. We have detailers from other agencies that can actually provide——

Senator KLOBUCHAR. OK.

Mr. O'CONNELL.—authority on those issues.

Senator KLOBUCHAR. All right. Do you want to quick do the intellectual property because I have one more question?

Mr. O'CONNELL. Absolutely. So we're relying heavily on NIST, another component organization in the cybersecurity framework, and some of the things that they're doing in broad cyber terms to apply that to space, as well, giving companies notice of some of the challenges that we're seeing in the market, as well as listening to what they're seeing in the market when their systems are threatened or vulnerable.

Senator KLOBUCHAR. Very good. I worked with Senator Heller on the Inspiring the Next Space Pioneers, Innovators, Researchers, and Explorers Act. That was our bill to authorize NASA to encourage women to study in STEM fields and also a different one we did together to make sure women researchers can get their ideas into
the commercial world. Both bills were signed by the President in 2017.

Administrator Bridenstine, can you provide an update on NASA's efforts? I know we've talked about public/private partnerships, but how about efforts to increase the recruitment and retention of women and minorities, something that's so important, not just at NASA but in science as a whole?

Mr. BRIDENSTINE. Yes, ma'am. So NASA is very focused on this. It doesn't take long to walk around the NASA Headquarters in those areas that you mentioned and recognize that women are underrepresented.

Senator KLOBUCHAR. I think women are about half the workforce but about 25 percent in NASA.

Mr. BRIDENSTINE. Yes, ma'am, that's probably right, and in some——

Senator KLOBUCHAR. As we learned from Hidden Figures.

Mr. BRIDENSTINE. OK. And in some fields, it might even be less than 25 percent.

Senator KLOBUCHAR. OK.

Mr. BRIDENSTINE. So——

Senator KLOBUCHAR. No. It's 25 percent of STEM workers is what they are.

Mr. BRIDENSTINE. OK.

Senator KLOBUCHAR. But NASA probably has even less but, yes, keep going.

Mr. BRIDENSTINE. We are making great advancement in the science fields at NASA. We've had statistically significant improvements in recruiting and retaining women in these fields.

When it comes to the engineering, we're not where we need to be. We continue to make progress. Some of the things that we do and we're doing every day, we have, you know, American astronauts that are female and we're making sure that they're getting out in the public and doing engagement with young ladies.

At the same time, this month, this is a great story, we have the first all-female Space Walk. So we're going to have two women leave the International Space Station and do critical work on the outside of the International Space Station.

Senator KLOBUCHAR. And how about the minority front?

Mr. BRIDENSTINE. Yes, ma'am. So the same challenges apply there and we are working diligently to increase their representation, as well, through the same mechanisms, but I think the big thing that we can do is continue to make these—do these stunning achievements because that inspires everybody and gets everybody more activated.

Senator KLOBUCHAR. Well, thank you very much. Appreciate it.

The CHAIRMAN. Mr. Bridenstine, on the engineering, universities could help you there, too.

Mr. BRIDENSTINE. Yes, sir.

The CHAIRMAN. Thank you.

Senator Gardner.
STATEMENT OF HON. CORY GARDNER,  
U.S. SENATOR FROM COLORADO

Senator GARDNER. Thank you, Mr. Chairman. Thank you, Administrator, for being here. Mr. O'Connell, thank you very much for the testimony today.

I thank you, as well, for your recent visit to Colorado and the Deputy Administrator, as well. We celebrated the 70th Anniversary of the Last Space Physics Laboratory in Boulder, University of Colorado, great partnership between NASA. Colorado receives more NASA funding, I think, than any other state in the country, and the work that we do.

We'd love to talk to you about a NASA center perhaps in Colorado and the opportunities we have to continue engaging Colorado in the aerospace and space front.

LASPA is, I think, the only sort of university research control consortium in the United States that has sent products, technology, equipment to all eight planets and Pluto. That was a tough one for me to say, eight planets and Pluto, but things change.

Thank you very much for being here, and, Administrator Bridenstine, would you say that the United States is a healthy commercial launch industry capable of launching all NASA missions today?

Mr. BRIDENSTINE. I would say we are very healthy. I would also say that there's always room for more capacity. Sometimes, you know, launches get—you know, we step on each other sometimes. The different—you know, we've got the FAA that is responsible for commercial launches and we've got NASA responsible for its launches and NOAA responsible for its launches and when you think about the DoD, they, of course, have a whole lot of launches. So sometimes we step on each other, but at the same time, we are a——

Senator GARDNER. The commercial launch industry itself is healthy.

Mr. BRIDENSTINE. Yes,—

Senator GARDNER. We've got lots of people there——

Mr. BRIDENSTINE.—very healthy.

Senator GARDNER.—to do this job. Are you familiar with the requirement in current law that requires the use of commercial domestic launch providers for U.S. Government-funded payloads unless no such launch vehicle exists?

Mr. BRIDENSTINE. I am aware.

Senator GARDNER. It's my understanding, I think the understanding of many of my colleagues in Congress, that because NASA is paying for cargo delivery to the International Space Station, those are taxpayer-funded missions that must be flown by U.S. launch providers. Would you agree with that assessment?

Mr. BRIDENSTINE. Yes.

Senator GARDNER. Yes. And I think we've got to strongly enforce these provisions to make sure that we are ensuring that that domestic competition remains strong. We're the only nation in the world that can support multiple competitive large commercial launch providers, just like you laid out.
We should not starve competition by shipping those taxpayer-funded missions overseas to state-subsidized launch providers. I think that’s something we have to——

Mr. BRIDENSTINE. Yes, sir, and, Senator, I’ll tell you I’ve had that conversation with our international partners who are very interested in launching basically spacecraft built in the United States, commercial spacecraft on their rockets, funded by the U.S. taxpayer, and I was very clear that that would probably receive a lot of resistance in the Senate. So I might have gotten ahead of you on that but we’ve had that conversation already with our international partners and, of course, and you know this, I will follow the law.

Senator GARDNER. Yes. Thank you, Administrator Bridenstine. Thank you very much.

As you know, Space Policy Directive-1 requires NASA to return to the Moon. I think you’ve had some discussions about that this morning already with commercial and international partners.

You know, what are the broader challenges that as we look at the Moon, as we look at the overall mission that ensure the U.S. remains a leader in that exploration of space?

Mr. BRIDENSTINE. So the key—I mean, I can’t say this enough. The key to making sure that we remain a leader is to do stunning things, to do things that other nations can’t do that entices other nations to partner with us to accomplish those objectives.

Space Policy Directive-1, as you just mentioned, we’re going to the Moon. The President said go to the Moon. He said go with commercial partners, go with international partners. There are now more space agencies on the face of the planet than ever before. We want as many of those as possible to be with us under the constraints of the law, of course, and at the same time, we’re going to for the first time utilize the resources of the Moon, the water ice that we 10 years ago discovered is there in hundreds of millions of tons. So water ice is air to breathe, water to drink, it’s certainly hydrogen and oxygen, which is rocket fuel. So it’s all there in mass quantities but we want to utilize it, and then, of course, retire risk and take those technologies and capabilities to Mars.

So what I can tell you is that as the head of the agency, when I meet with our international partners, they are extremely excited about partnering with us on these endeavors.

The idea that the next time we go to the Moon, yes, we will have American astronauts there with American flags on their shoulders, but it very well could be that we are there side by side with astronauts from other countries with their flags on their shoulders, American leadership.

So that ultimately is our objective, to provide that leadership, to make sure everybody stays with us in our sphere as we move forward.

Senator GARDNER. Thank you, Administrator. Thank you for your interest in the Space Symposium in Colorado, as well. They do a phenomenal job and we just appreciate your participation. Thank you.

Mr. BRIDENSTINE. Yes, sir, we’ll be there next month.

Senator GARDNER. Thank you.
The CHAIRMAN. Mr. Bridenstine, has our partnership with Russia been a success?

Mr. BRIDENSTINE. This is a tough question, and I understand there’s all kinds of trust, real challenges, geopolitical, between our two countries.

This relationship goes back to 1975, the height of the cold war. The Apollo Soyuz Program, when, you know, after Apollo 17, we brought our astronauts home, Russia decided that they wanted to partner with us instead of competing with us. So we moved forward with Apollo Soyuz.

From there, we had the Shuttle-Mir Program and now, of course, we’ve got the International Space Station Program and Russia is very interested in partnering with us when we go to the Moon.

What is fascinating about this relationship is that through all of the turmoil from 1973, probably, when the project began, all the way up until today, there have been terrestrial disputes and challenges and geopolitical issues and yet it has never spilled over—I wouldn’t say never. I would say that we have been able to work through the challenges in space, and I think that’s a unique capability. It’s a unique channel of communication.

The partnership that I have with the head of Roscosmos has been strong. They’ve been very helpful to us when we take our astronauts to the International Space Station on Russian Soyuz rockets. So it has been a strong partnership but certainly I understand it’s unique but it’s a good partnership for space.

The CHAIRMAN. Thank you very much.

Senator Blumenthal.

STATEMENT OF HON. RICHARD BLUMENTHAL, U.S. SENATOR FROM CONNECTICUT

Senator BLUMENTHAL. Thanks, Mr. Chairman.

I want to do exciting things in space and stunning things, like Americans going back to the Moon. My interest right now is on issues a little bit closer to Earth, aviation safety.

Mr. BRIDENSTINE. Yes, sir.

Senator BLUMENTHAL. And as you are very much aware, NASA’s responsible for maintaining the system that includes reports from pilots who encounter potential problems while in the air.

It’s called the Aviation Safety Reporting System or ASRS. It’s a confidential voluntary non-punitive repository for capturing confidential reports, analyzing aviation incidents, safety data, dissemination of vital information.

You know that in the last day or so, there have been absolutely killing reports about pilots reporting incidents in the sky involving the Boeing 737 Max 8 during critical moments of flight. They’ve been reported in the Dallas Morning News.

Last night on Rachel Maddow, very graphic and dramatic description of some of these reports by pilots for one United States incident in November 2018, a commercial airline pilot evidently reported that during takeoff, the autopilot was engaged and “within two to 3 seconds, the aircraft pitched nose down” in a manner steep enough to trigger the plane’s warning system which sounded “don’t sink, don’t sink.”
I’m asking you to make available to us all of those reports that have been submitted to you. You can redact the names. You can take out any identifying information. I’m asking you as the Administrator of the system to make available to us in Congress all of those reports from pilots. Will you do so?

Mr. BRIDENSTINE. I’d be happy to do that.

Senator BLUMENTHAL. How soon? Today?

Mr. BRIDENSTINE. I don’t know what the logistics are to make those available, but——

Senator BLUMENTHAL. As soon as possible?

Mr. BRIDENSTINE.—as soon as possible. Yes, sir.

Senator BLUMENTHAL. And you know that pilot groups have complained that Boeing in fact did too little to ensure that they and other airlines were aware of a new anti-stall feature relating to softwares and sensors or knew how to turn it off if it were malfunctioning or acting on faulty data.

I would like your view as to whether we should be asking more of Boeing at this point in terms of information they have.

Mr. BRIDENSTINE. I’ll be honest, Senator. At this point, I don’t have enough information to make that determination.

Senator BLUMENTHAL. But you want that information?

Mr. BRIDENSTINE. Yes, sir.

Senator BLUMENTHAL. And will you join in trying to seek it?

Mr. BRIDENSTINE. A hundred percent. I’m a pilot myself and, of course, I have flown with automatic flight control systems and autopilots. I’ve had autopilots malfunction and certainly I’ve had——

Senator BLUMENTHAL. Pretty scary, isn’t it?

Mr. BRIDENSTINE.—scenarios that are not good either. So it is in our interests as a nation to make sure that our equipment is safe and I’m committed to doing whatever is possible to do that.

Senator BLUMENTHAL. Would you have qualms about flying our 737 Max 8?

Mr. BRIDENSTINE. I wouldn’t.

Senator BLUMENTHAL. Why?

Mr. BRIDENSTINE. Well, I think——

Senator BLUMENTHAL. Because someone else is the pilot again?

Senator BLUMENTHAL. Well, no, I don’t know enough information right now, but at this point in time, I wouldn’t say that I’d—I mean, I’m going to be flying, you know, in the coming days and when I fly, if I’m on a 737 Max 8, I think I’d be perfectly OK and it wouldn’t bother me.

Senator BLUMENTHAL. But passengers who may have qualms should be able to choose another flight, wouldn’t you agree?

Senator BLUMENTHAL. Absolutely.

Senator BLUMENTHAL. Without any charge?

Mr. BRIDENSTINE. Oh, I don’t know about that. Certainly it’s a free market out there and if people want to ride on a different airplane, they should.

Senator BLUMENTHAL. Well, I welcome your willingness to share with us that information, that report because the American public really deserves to know from the folks who are closest to this problem, pilots who have dealt with these petrifying scenarios, as you’ve termed them, incidents where the planes just go out of con-
trol in effect, and the American public also needs to know what Boeing knew, when they knew it, and what they did as soon as possible on necessary corrections because they have a public trust and so does the FAA and the Secretary of Transportation.

Realizing that they’re not within your purview, I welcome your willingness to share with us your expertise as a pilot as well as the information in the Aviation Safety Reporting System. Thank goodness we have it.

Thank you, Mr. Chair.

The CHAIRMAN. Thank you. Thank you, Senator Blumenthal.

And I think we can all acknowledge this is a pretty high-profile issue and a very important issue. If you could just follow up, Mr. Administrator, where does your jurisdiction overlap with FAA and where are we on that?

Mr. BRIDENSTINE. So the system that the Senator referenced is an FAA program. It’s done at Ames Research Center out in California, the San Francisco Bay Area, and ultimately it’s administered by NASA. We have NASA employees engaged in it. It’s an FAA system. It’s an FAA program. It’s funded by the FAA.

The key to the whole thing is to get pilots to be willing to share things that they might not want to share with the FAA and that is why it’s housed at NASA and, of course, I’ve been familiar with the program as a pilot myself.

When it comes to malfunctioning autopilots, which I’ve had in the past, you turn them off and you fly the airplane. I’ve flown many hours without an autopilot.

As far as what caused these incidents, I would be very reluctant to jump into prescribing some kind of blame because there’s not enough information at this point.

The CHAIRMAN. Well, thank you, and I was glad to know this morning that the authorities had decided where to send the black box and reportedly that’s the United Kingdom, supposedly the nearest location where the expertise existed, and I certainly think I express the opinion of the entire Senate that we get that information.

Mr. BRIDENSTINE. I do. Senator Blumenthal, just point of reference. What we have to do is make sure that pilots have a place where they can share information that can be disseminated to the world where they won’t have retribution.

If people start feeling like their information is going to be shared or that they’re going to have some kind of retribution, maybe they didn’t do something perfectly right, but we all are human and we all make errors. Pilots need to feel like they have a place they can go to share information where they’re not going to be punished.

I just want to be really careful about how we go about making sure that our pilots are safe because if we diminish their willingness to do that, then we will be less safe, not more safe.

Senator BLUMENTHAL. And, Mr. Chairman, I welcome your comment about the black box and about the most recent news.

I just want to make clear, I said before, let me repeat it, you should redact the identifying information that would in any way endanger the pilots’ anonymity in making this report. I agree totally. We want to preserve the protection against any sort of reprisal or retribution. That is a very important point.
But as soon as possible, and my office will follow up with you, I hope you can provide the complete set of reports. I think it’s important for Americans and the world to know about the problems that pilots have encountered.

Mr. BRIDENSTINE. Yes, sir.

The CHAIRMAN. And, of course, soon we’ll be doing a hearing on aviation safety.

Thank you, Senator Blumenthal.

Senator Sinema.

STATEMENT OF HON. KYRSTEN SINEMA,
U.S. SENATOR FROM ARIZONA

Senator SINEMA. Well, thank you, Chairman Wicker, for holding this hearing, and thank you to our witnesses, Administrator Bridenstine, good to see you again, and Director O’Connell.

As Ranking Member of the Aviation and Space Subcommittee, I recognize the challenges we face as we try to maintain America’s leadership in space, and I look forward to working with our Subcommittee Chairman, Mr. Cruz, and the whole Committee on this important issue.

Our competitors across the globe continue to make significant advances in space exploration and development and we must address this challenge head on with strong bipartisan solutions.

America’s leadership in space strengthens our national security, it creates good-paying jobs across the country, and it spurs groundbreaking research and innovation.

In Arizona, NASA has a broad stakeholder community comprised of industry, universities, and support service providers, and I’m proud to represent a state that’s home to all of these actors: World View, Raytheon, Honeywell, Orbital ATK, Vector, Arizona State University, and the University of Arizona, and that’s just naming a handful.

Our universities, working together with businesses throughout the state, are pushing the space industry forward and creating a highly skilled workforce. These partnerships ensure America’s able to remain competitive as we enter into a new space race.

So my first question is for you, Administrator. Education, we know, is critical to maintaining America’s competitiveness in space, both at NASA and in the new space economy.

Could you speak a little bit about the challenges that are created by the aging workforce and retirements happening at NASA and what role can universities, such as Arizona State University, play to ensure that we’re building a capable and skilled workforce?

Mr. BRIDENSTINE. That’s a wonderful question. You are correct in identifying a very real challenge, which is—and it’s actually a good problem to have, I guess.

People love to work at NASA and when they work there, they stay. I think our turnover is somewhere around 4 percent annually and in fact in some key fields, like engineering and science, it’s less than 2 percent annually. So in a way, that’s really—that’s good news.

We’ve been rated the best place to work in the U.S. Government now for 6 years in a row. All of that is positive. The challenge is,
as you've identified, our workforce has aged and we now have this bow wave of retirements coming.

So we do look to universities to support that next generation of technologists, engineers, scientists that can fill those gaps.

The University of Arizona, of course, right now has an object in orbit around an asteroid in deep space called Bennu. OSIRIS-REx is their mission, and it has been so far a very successful mission, and we look forward to the day when they bring home a sample from that asteroid, which will be the first time in human history that has happened, led by a university, of course, in your home state of Arizona. That's a big mission for NASA. It's a big mission for the United States, a big mission for the world. The whole world is going to be watching that, and it'll make the covers of every newspaper when it happens. So that's, I think, an important capability.

Here's the thing that these universities do. Arizona State University, of course, is top among them. Getting students involved in the development and the research. So what we like to do is we like to go to the universities, engage them in, you know, their scientists, their engineers, getting involved in these projects, and then those universities engage their students in that activity.

When it comes to spectroscopy, Arizona State University is tops, highly recognized around the world, and, of course, because of that, they're on all kinds of missions that NASA currently has underway.

We think about the Psyche mission, which is a big object in the Asteroid Belt, a big steel ball, led by Arizona State University. So universities partnering with a lot of those industries that you just mentioned, to accomplish these objectives inspires students and it gives them the training and the background and the preparation to join NASA, and so this is why this is a unique capability in the United States.

We have the best university system in the world and NASA is a beneficiary of that capability. We want to keep doing those kind of activities so we can have that pipeline flowing, but you're right, we do have a bow wave coming. We have to have people prepared and we're doing what we can right now with the support of the universities to accomplish that.

Senator Sinema. Great. Mr. Chairman, I know I don't have much time left, but I do want to follow up on a question around a 2005 law that Congress passed directing NASA to detect all near-earth objects that are a 140 meters and larger that could threaten the Earth by 2020.

So scientists and engineers at the University of Arizona have been hard at work for decades, long before Congress passed this legislation, building the ground-based observing infrastructure, conducting critical research, and cataloging their discoveries, but we have reached our limits on what we can detect using ground-based observations.

So my question for you is, can you provide an update on what NASA's progress is toward meeting that 2005 mandate and how would this progress accelerate with the addition of things such as the NEOCam?
Mr. BRIDENSTINE. Wonderful question again. So when we think about that catalog, we assess that we have cataloged about a third of those objects that are 150 meters or larger and that’s a very positive thing and, of course, as you mentioned, the University of Arizona is at the center of those activities with a network of sensors around the world.

But you’re also right in the sense that sensing those objects that are that small from Earth is becoming very, very difficult.

We have right now in orbit a project called TESS, which is looking for planets around other stars and it’s, of course, been a very successful mission already. It will continue to be successful but here’s what we have found. We didn’t launch it for this purpose but it has demonstrated an ability to detect those objects that are a 140 meters or bigger in ways that we didn’t anticipate.

So we’re taking that capability. As you mentioned, we’re going to learn from that and then put together the project, as you mentioned, NEO, the Near Earth Object kind of project, to put a satellite in orbit for the purpose of bringing down that data so that we can finish out that catalog, ultimately to protect the Earth.

At the same time, we have the DART Mission underway right now, which is going to demonstrate that we can actually, if there is a risk to the Earth, we can actually maneuver an asteroid in deep space long before it becomes a risk to Earth.

I will say this. The evidence is clear that dinosaurs did not have a space program. We do. Therefore, we need to be prepared to do what is necessary to protect our planet and Arizona has been fantastic in helping us do that.

Senator SINEMA. Thank you so much, Administrator and Director. Thank you for being here.

Mr. Chairman, my time’s expired. Thank you.

Mr. O’Connell, can you briefly discuss these regulatory issues, the risk of dual regulation that will hinder American businesses, and a wide range of unfair practices in the marketing, including subsidies, dumping of space products, unfair provisions of space services, and other anticompetitive tactics that you mentioned on Page 2 and Page 1 of your testimony? What’s the solution there?

Mr. O’Connell. Absolutely, Senator. On the dual regulation, other countries are developing their own regulatory regimes as they think about the strategic value of space and also ways to capture their part of the space economy.

The risk is where, especially with friendly countries, we want some sort of a partnership between American companies and other elements in those other countries.

The CHAIRMAN. What needs to be done there?

Mr. O’Connell. Both—just we need to stay coordinated with the other countries so that we’re minimizing the regulations, harmonizing regulations across the two countries so that there’s minimal impact on the businesses.

The CHAIRMAN. Short of treaties?

Mr. O’Connell. Absolutely.

The CHAIRMAN. OK. Well, keep us posted on what we need to do there.

Mr. O’Connell. Yes, Senator.
The CHAIRMAN. Because you mentioned it early on in your testimony and you redoubled.

Well, gentlemen, thank you so much for your testimony, and I think people watching both here in Washington, D.C., and around the country will conclude that we are very well served and that we are on the verge of an exciting new chapter.

So I want to thank you all and I’ve got some words I’m supposed to read here.

The hearing record will remain open for two weeks. During this time, Senators are asked to submit any questions for the record. Upon receipt, the witnesses are requested to submit their written answers to the Committee as soon as possible.

We had 17 Senators attend this hearing today, 14 got to ask questions. I think it was a very fine hearing.

And we conclude the hearing with our thanks to the witnesses.

Mr. BRIDENSTINE. Thank you, Chairman.

[Whereupon, at 11:52 a.m., the hearing was adjourned.]
**APPENDIX**

**RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. ROGER WICKER TO HON. JAMES F. BRIDENSTINE**

**Question.** Administrator Bridenstine, commercial satellite broadband operators continue to build, launch, and operate increasingly high-capacity satellites. Does NASA intend on greater usage of commercial satellite communications to meet its communications requirements? Please share your perspective on the importance of ensuring that commercial satellite communications companies will continue to have reasonable access to critical spectrum bands.

**Answer.** NASA’s FY20 budget request initiates the Communications Services Program (CSP) to begin purchasing commercially provided satellite-based data relaying services to more efficiently meet future needs. As an initial activity, the CSP will pursue opportunities that will allow future NASA missions to deploy flight-qualified capabilities for near-Earth users to get support from commercial providers. Over a longer time horizon, the CSP will be responsible for the acquisition management of the next-generation operational communications capability as current Tracking and Data relay Service (TDRS) satellites and explore opportunities that are mutually beneficial to NASA and industry, and will develop an acquisition model for incorporating commercial communications services into operations.

NASA will define the acquisition strategy for transitioning near-Earth NASA users to suitable commercially provided services. This acquisition strategy could include commercial service contracts, hosted payloads, and/or public-private-partnerships. NASA expects to partner with multiple commercial entities to phase out reliance on NASA-owned and –operated systems. This will bolster American industry, significantly reduce the cost of communication services to NASA, and maximize interoperability between Government and commercial service providers while promoting a diverse commercial market.

As the Communication Services Program expands NASA’s use of commercially provided communications services, the spectrum used to support these services will become increasing important to the agency. Electromagnetic spectrum is a valuable and limited natural resource that all NASA missions require for communications, navigation, remote sensing, and data services in the areas of Earth science, space science, human space exploration, and aeronautical research. All forms of wireless communication systems used by the U.S. Federal Government or by commercial entities use the electromagnetic spectrum, so the spectrum must be carefully controlled and coordinated. The Human Exploration and Operations (HEO) Mission Directorate’s Space Communications and Navigation (SCaN) division is responsible for ensuring access to portions of electromagnetic spectrum necessary to support NASA’s mission needs. In both the domestic and international arenas, NASA continues to engage with the commercial sector to identify more flexibility in the use of spectrum resources that will meet mission objectives for the entire space community. SCaN will focus on planned agenda items at the World Radiocommunication Conference in FY20, and working within the U.S. Delegation, will seek to ensure continued access to the RF spectrum supporting NASA’s mission requirements, the U.S. Government space interests, and the U.S. commercial space community.

**RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN THUNE TO HON. JAMES F. BRIDENSTINE**

**Question 1.** Administrator Bridenstine, you mentioned the importance of international partnerships to NASA’s missions, especially those conducted in low-Earth orbit. Could you speak to areas where international partnerships benefit and support NASA’s satellite operations, particularly when it comes to Earth observation operations?

**Answer.** The NASA Earth Science Division (ESD) engages in, and in some cases pioneers, substantive partnerships and collaborations with other Federal agencies,
international agencies and coordination bodies, and with private sector and commercial entities. For international partnerships in particular, the collaborations provide mutual benefit to all parties.

More than half of the on-orbit NASA Earth research satellites, and a substantial fraction of the missions in development for launch over the next four years, involve significant hardware collaborations with international partners. A few examples include: the recently launched Gravity Recovery and Climate Experimental Follow On with Germany, the upcoming NASA-India Synthetic Aperture Radar mission and the Sentinel-6A/B ocean altimetry missions with the European Space Agency (ESA), the National Oceanic and Atmospheric Administration, the European Commission, and the European Organization for the Exploitation of Meteorological Satellites. Other parties in satellite mission development and/or operations include the space agencies of Japan, France, Germany and Canada. NASA ESD and ESA also coordinate activities related to research and field campaigns, interoperable data systems, and joint satellite mission activities through the NASA–ESA Earth Science Joint Program Planning Group.

Question 2. Administrator Bridenstine, the next satellite in the Landsat program, Landsat 9, is scheduled to be ready for launch in December of next year. This date was confirmed in a report last year by the Government Accountability Office, which determined that the Landsat 9 project was still on schedule for completion by December 2020. Are there any updates or schedule changes that would lead NASA to believe Landsat 9 will not be ready to launch on time?

Answer. The project continues working toward a December 2020 Launch Readiness Date (LRD), 11 months before the Agency Baseline Commitment for a November 2021 launch. The project’s next major milestones, Key Decision Point-D (KDP-D), is currently scheduled for December 2019.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. RICK SCOTT TO HON. JAMES F. BRIDENSTINE

Question. The space industry has long been an important and iconic part of Florida’s history and economy. In my eight years as Governor, I worked to position Florida as a national and global leader in space exploration by investing more than $230 million in spaceport projects, which supported the creation of more than 1,100 high-paying aerospace jobs since the end of the Shuttle program. Additionally, Florida’s Space Coast manufacturers and businesses continue to thrive due to the investments we have made in the space industry.

Administrator Bridenstine, can you discuss any new programs and infrastructure projects at Kennedy Space Center being built in conjunction with our commercial partners and explain their return on investment over the next year? How many new direct and indirect jobs will these projects support? What are some ways we can continue to bridge the gap between NASA and our commercial partners?

Answer. NASA Kennedy Space Center (KSC) recently executed three new land leases, utilizing NASA’s Enhanced Use Leasing authority, with major commercial partners—SpaceX, Blue Origin, and Florida Power and Light (FPL). Blue Origin’s lease will allow for expansion of its current Exploration Park facilities for the purpose of launch vehicle design, manufacturing, assembly, processing, and testing; flight crew and space flight participant training; public engagement and outreach; and mission control and engineering activities. Likewise, SpaceX’s lease will allow it to build facilities for the purpose of hardware and launch vehicle design, manufacturing, assembly, processing, and testing; and launch control. FPL’s lease will allow it to build a solar farm that will serve the public utility grid.

NASA KSC also has numerous other agreements that allow commercial space launch activities at KSC including SpaceX’s operations at the historic Launch Complex 39A, and Space Florida’s agreement to operate the historic Shuttle Landing Facility runway. Finally, NASA KSC, through its Space Act Authority, enables commercial space activity by making unique KSC resources and launch services available to its resident commercial partners including SpaceX, Blue Origin, Boeing, and United Launch Alliance (ULA). These partnerships could not operate or launch at KSC without this support.

NASA’s partnerships with commercial space and other compatible industry partners have served as an integral part of the success thus far in managing the challenges of maintaining and transforming the Agency’s aging infrastructure. NASA Centers such as KSC continue to seek avenues for mutually beneficial engagement with the commercial sector through agreements that align with and complement the Agency’s mission activities and support these infrastructure goals. A well-functioning, efficient and cost-effective infrastructure is necessary for the support of
NASA’s mission requirements, and is also important for remaining relevant and attractive to potential partners who may be considering relocation or co-location of operations, or investment in development of unutilized real property. The availability of sufficient resources for NASA to meet the challenges of sustaining its infrastructure remains more critical than ever. NASA’s FY 2020 budget request includes critical new funding to address these significant challenges with facilities at NASA Centers. This funding will be important to enable NASA Centers to undertake the actions that carry the Agency forward toward its infrastructure management objectives, including replacing obsolete capabilities with facilities that meet the demands of the missions of tomorrow.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO HON. JAMES F. BRIDENSTINE

NEOWISE. NEOWISE’s goal is to identify comets and asteroids that may potentially pose a threat to our world. However, there are concerns that much of the data that NASA collected is inaccurate due to a software bug that was not disclosed to public researchers for many years, significantly setting back their efforts to advance the NEOWISE mission. Additionally, there is a proposed mission to launch a new telescope into space to support the program known as the Near-Earth Object Camera (NEOCAM), which will cost about $600M. However, there’s a ground observatory, the Large Synoptic Survey Telescope (LSST), which is nearing completion in Chile. LSST will accomplish many of the same goals as NEOCAM, and will be up and running before NEOCAM’s planned launch. Needless to say, I have concerns about the management of this program. I want to make sure that the best possible science is being done on this issue, and that taxpayer resources are being used well.

Question 1. Can you address these concerns about a potential software bug?

Answer. The NEOWISE science team, in 2011, discovered an inconsistency in the mathematical model that was used to compute estimated sizes of observed asteroids, based on the infrared energy collected by spacecraft sensors. At times referred to as a “software bug”, in actuality this was a mathematical inconsistency in the size estimation software used. The NEOWISE spacecraft, its operations, or the infrared data it collected were not affected. Rather, this pertained to a small percentage of the observed object physical size estimates in the scientific analysis of the collected NEOWISE data. Size estimates are affected by many different factors; this effect was less than ±6 percent, well within the estimated accuracy of ±20 percent articulated by the NEOWISE science team. The NEOWISE team corrected this issue for the 2011 thermal model, thus it affected only some size estimate analyses that used data collected during the WISE prime mission (Jan. 2010–Feb. 2011). The NEOWISE team brought the issue to the attention of other researchers when updates to their estimated sizes were published in the NEOWISE database in 2014. Such corrections and updates are part of the normal scientific process; this being one of several thermal model improvements made over eleven years of project-work. Many other asteroid scientists have conducted independent studies of asteroid sizes and validated the NEOWISE results. NASA has no concerns regarding the efficacy of the science team, the data or any future mission that could go forward based on NEOWISE. In fact, experiences such as this confirm the invaluable service of NASA mission science teams, and only serve to improve the scientific results obtained by missions.

Further, NASA has funded an independent study by the National Academies of Sciences, Engineering and Medicine (NASEM) entitled “Near Earth Object Observations in the Infrared and Visible Wavelengths,” found here: [https://www8.nationalacademies.org/pa/projectview.aspx?key=51478](https://www8.nationalacademies.org/pa/projectview.aspx?key=51478). The investigation will (1) explore the relative advantages and disadvantages of IR and visible observations of near Earth objects (NEOs), (2) review and describe the techniques that could be used to obtain NEO sizes from an infrared spectrum and delineate the associated errors in determining the size, and (3) evaluate the strengths and weaknesses of these techniques and recommend the most valid techniques that give reproducible results with quantifiable errors. The study team is well into the investigation with the published report expected by early summer 2019.

With regard to the National Science Foundation (NSF) Large Synoptic Survey Telescope (LSST), NASA and NSF formed a joint study team to assess its potential contribution to the discovery of NEOs once LSST becomes operational in 2023. The team, which included members of the LSST science team, extensively examined the potential LSST capabilities and published findings in a March 2017 paper, found here: [https://www.nasa.gov/sites/default/files/atoms/files/joint_jpl-uw_whiteta per_27mar2017.pdf](https://www.nasa.gov/sites/default/files/atoms/files/joint_jpl-uw_whiteta per_27mar2017.pdf). The effort was conducted in parallel with a NASA Science Mis-
sion Directorate (SMD)-sponsored NEO Science Definition Team (SDT) that provided a non-advocate technical report in September 2017, found here: (https://www.nasa.gov/sites/default/files/atoms/files/2017_neo_sdt_final_e-version.pdf).

The NEO SDT assessed performance of current NEO survey assets and addressed options for optimizing the effort into the future. The SDT found that by the early 2030s current ground-based NEO search efforts will reach approximately 60 percent completeness of the statutory goal of finding at least 90 percent of NEOs greater than or equal to 140 meters. According to the joint NASA/NSF study, the LSST would accelerate the discovery rate to approximately 75–80 percent completeness of the goal in the ten years of planned operations by NSF (i.e., by the mid-2030s), and would improve this completeness by 1–2 percent for each year of additional operations. LSST would not be expected to achieve 90 percent completeness until well into the 2040s.

The NEOCAM mission concept has been studied for several years, but has not been approved to proceed. NASA is currently assessing whether a space-based survey capability such as NEOCAM is warranted. The SDT found that a space-based survey capability could accelerate reaching the statutory goal, and this capability also could provide a more accurate estimate of sizes if it operated in the infrared wavelengths, which cannot be done by ground-based survey telescopes.

Question 2. Will you commit to working with me and my staff to make sure this important mission is being managed in a way that successfully accomplishes its goals?
Answer. Yes, NASA is committed to the goals of our Planetary Defense Program and would be pleased to answer any additional questions you may have. The extent of NASA’s current efforts is delineated at https://www.nasa.gov/planetarydefense/overview, and daily progress at finding the NEO population can be tracked here: https://cneos.jpl.nasa.gov/stats/totals.html.

Space Launch System—First Mission. You spoke about possibly flying Orion on a commercial vehicle. I am concerned that pushing SLS further out will kill the program. In March 2019, in an effort to ensure that NASA stays on track for the launch of Artemis 1 by 2020, the Agency explored the possibility of launching Orion and the European Service Module (ESM) to low-Earth orbit (LEO) on an existing rocket, then using a boost from another existing vehicle for Trans Lunar Injection. Among options considered were launching on: a single Delta IV Heavy; two Delta IVs; a Delta IV and a Falcon Heavy; and a Falcon Heavy with Interim Cryogenic Propulsion Stage (ICPS). Although the preliminary assessment showed that it might be possible to launch Orion on a single Falcon Heavy, such a configuration would also pose significant integration, procurement, and technical challenges. Therefore, the Agency determined that the best option was to work to accelerate development of the Space Launch System (SLS) to stay on track for an Artemis 1 launch in 2020. We are continuing to investigate commercial options for later missions. Having dissimilar redundancy (e.g., two launch vehicles) has been proven important to long-term safe operations. Examples include: Soyuz as a back-up to the Space Shuttle; Atlas V as a back-up to Antares.

Question 2. What can we do to ensure the Space Launch System (SLS) is ready to launch Orion in 2020?
Answer. The NASA and Boeing teams are working overtime to prevent ongoing delays to the launch schedule of the SLS from pushing the first launch into 2021. On March 4, 2019, NASA’s Human Exploration and Operations (HEO) Mission Directorate chartered an assessment of other activities needed to achieve a launch in 2020. After completion of the HEO assessment, an independent schedule risk review led by the NASA Office of the Chief Financial Officer (OCFO) will assess the proposed new plan. NASA leadership will review the results of these assessments in late spring 2019.

Question 3. Please explain the safety issues related to flying SLS for the first time with crew.
Answer. NASA is not planning for the first flight of SLS to be a crewed flight. The first flight of SLS will be the first crewed flight, Artemis 2, and NASA is executing a multi-step integrated test and training program to plan and execute this mission, and those that follow, with minimum risk to crew and mission objectives.

In addition to extensive ground testing of hardware and systems, NASA will test abort operations with the Ascent Abort test 2 (AA–2) in June 2019. The Artemis 1 test flight will provide additional critical data that will be used to validate the rocket design and refine mission operations prior to the crewed Artemis 2 flight.
NASA has designed Artemis 2 to minimize exposure to orbital debris before the Orion crew heads off for its trip beyond the Moon and back. NASA is conducting extensive training for its astronauts and ground crew that will enable coordinated responses to a host of contingency operations.

Space Launch System—Program Cuts. I am surprised that this budget cuts NASA’s key exploration systems, SLS and Orion, leading up to the first integrated launch in 2020. I am also concerned that NASA is deferring development of SLS’s Enhanced Upper Stage.

Question 1. How will these proposed cuts impact the planned once a year launch cadence for SLS and Orion and the long-term goals of the exploration program?

Answer. NASA’s baseline plan has been to launch Artemis 1 in 2020, followed by Artemis 2 in 2022, and the third flight in 2024 with launches once per year thereafter. The FY 2020 Budget provided the resources needed to achieve this launch cadence and the May Budget Amendment added over $600M to keep the program on track. NASA is committed to meeting the current launch manifest and is focusing efforts to overcome core stage first-time production issues, which have slowed efforts to procure hardware for the third flight and beyond. While NASA is resolving near-term core stage production issues, risk to the one-year flight cadence is being mitigated by funding long-lead procurements. NASA continues to evaluate and work these challenges to meet its manifest commitments, including the new challenge of landing astronauts on the Moon by 2024.

Question 2. Why is NASA deferring development of the Enhanced Upper Stage when this capability is needed to maintain robust and sustainable deep space exploration?

Answer. The development of SLS core stage has proven to be more challenging than previously anticipated. Therefore, the NASA and Boeing teams are currently focused on completing the SLS core stage and accelerating development of the launch vehicle overall in order to ensure that we can fly Artemis 1 in 2020. EUS can be an important future component of our cislunar and deep space capability, but it is critical to complete SLS in the near-term and stay on track with the launch of Artemis 1.

International Space Station. I’m disappointed to see the FY20 budget again includes the administration’s proposal to end direct Federal funding for the International Space Station by 2025. The NASA Inspector General has called it “highly unlikely” that by 2025 a private company will be able to take over significant portions of the ISS or field a private replacement.

Question. Given China’s plans to construct their own space station, are you concerned about what would happen to our international partnerships and U.S. leadership in space if we stop funding the ISS in 2025?

Answer. The Administration is committed to maintaining access to a platform in low Earth orbit (LEO). NASA intends to transition from the current Government-dominated model of human spaceflight activities in LEO to a model where Government is only one customer for commercial services. The Agency is increasing the breadth and depth of commercial and international LEO activities. NASA will expand partnerships in LEO to include new companies and additional nations beyond the ISS Partners, including working with commercial partners to support visiting crew.

NASA is leveraging the ISS Partnership to define technical interoperability standards for exploration that will allow expanded commercial and international partnerships in LEO and beyond. Our partners are interested in participating in the Gateway and in conducting activities on the lunar surface. While they are willing to work with other nations, the United States remains the preferred partner, given our existing leadership role and the capabilities we contribute to human and robotic space exploration.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. EDWARD MARKEY TO HON. JAMES F. BRIDENSTINE

Space Exploration—World Leader. According to a 2018 Pew study, almost 3 out of every 4 Americans believes that the United States must continue to be a world leader in space exploration, and 4 in 5 say that the space station has been a good investment for the country.

Question. Can you guarantee there will be absolutely no interruption of American scientific research in low-Earth orbit if NASA funding of the International Space Station ends after 2024?
Answer. The Administration is committed to maintaining access to a platform in low Earth orbit (LEO), so NASA has no concerns about interruptions to international partnerships, U.S. leadership, or scientific research related to the ongoing commercialization of activities in LEO. NASA recognizes the importance of maintaining continued operations and U.S. leadership in low-Earth orbit (LEO). The Agency is working to transition its work in LEO, including our international partnerships, to be based on commercially-provided space station services that help enable deep space exploration and private sector expansion in LEO. To support this transition, the International Space Station (ISS) will focus near-term activities on supporting commercial industry as well as meeting Government requirements in LEO. In parallel, NASA is creating a focused effort aimed at long-term American operations in LEO independent of the ISS.

It is also important to note that NASA is conducting scientific research in LEO and beyond through over 60 operating robotic missions managed by the Science Mission Directorate, including several science instruments on the ISS focused on Earth Science and Astrophysics research.

**NASA Budget Cuts and Existing Projects**—In a hearing last year, you said, “We are committed to studying planet Earth at NASA.” I am disappointed to see that the President’s Budget yet again cuts valuable Earth Science funding. It proposes to eliminate funding for two projects expected to provide critical new data for understanding climate change and the health of our planet: the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission and the Climate Absolute Radiance and Refractivity Observatory (CLARREO) Pathfinder project. In that same hearing, you said, “CLARREO and PACE are, because of the laws passed by this body, they are being built as we speak.”

**Question 1.** Are both these missions still currently under development, despite the Administration’s stated intention to cut funding for these programs?

**Answer.** Yes. PACE and CLARREO–PF are still proceeding as planned in accordance with the appropriated budget in the FY19 Consolidated Appropriations Act. CLARREO–PF’s Preliminary Design Review (PDR) will be held in May 2019, and its Key Decision Point C (KDP–C) is scheduled for July 9. PACE’s PDR will be held in June 2019, and its KDP–C is scheduled for August 15.

**Question 2.** Do you agree that it is important to maintain the United States’ leadership in Earth Science at the same time as we seek to keep our leadership in the deep space race?

**Answer.** Yes. The President’s Budget Request for FY20 provides for a strong program that will continue NASA’s and the country’s leadership in spaceborne Earth observations, Earth system science, and space-based applications. NASA’s Earth Science activities transform measurements and understanding into information products that are used widely to build national resilience, provide societal benefit, and improve lives.

The budget request continues full operations of NASA’s fleet of 22 Earth observing research missions in low-Earth orbit, geostationary orbit, Lagrange-1 orbit, and on the International Space Station.

**Statement from Past Year.** In a hearing last year, you said, “It is my goal as the Administrator of NASA to follow the decadal surveys that we get from the National Academy of Sciences, and that is my objective, to make sure that what we are doing is apolitical and nonpartisan.”

**Question.** The CLARREO mission was originally recommended in the 2007 Earth Science Decadal. Do you stand by your commitment last year to follow the recommendations of the decadal surveys?

**Answer.** Yes. The decadal surveys play a leading role in articulating the consensus-driven priorities and needs of the scientific communities we serve and in setting the goals of NASA’s Earth Science Division (ESD) satellite mission development. However, the decadal survey is not the sole source of recommendations. The decadal survey recommendations must be balanced with other priorities and constraints, including budget assumptions set by the Administration. The last two Earth Science decadal surveys have assumed budgets that were significantly higher than were eventually appropriation. In order to address these recommendations under constrained budgets, ESD is leveraging partnerships, work and ideas from the non-governmental and private sectors, as well as emphasizing competition.

**Uranium.** A recent white paper from the Los Alamos National Laboratory (LANL) advocated for the use of weapons-grade, highly enriched uranium (HEU) to fuel reactors to provide energy for space flight or on planetary surfaces. This would break longstanding U.S. policy to avoid the use of this uranium in non-weapons applications and it might make projects harder to fund and complete, compared to the use
of low-enriched uranium (LEU). It also contradicts the findings of several NASA presentations and fact sheets from preceding years.

**Question 1.** Is NASA reversing its position on the U.S. policy to minimize the use of HEU in civilian nuclear applications? If yes, why?

**Answer.** In coordination with DoE, NASA is in compliance with U.S. policy relative to the use of HEU for space applications.

**Question 2.** Has NASA explored using low-enriched uranium and, if so, why was this deemed an unacceptable alternative?

**Answer.** NASA continues to review and evaluate various nuclear technology options, including those that would employ either highly enriched uranium (HEU) or High Assay Low Enriched Uranium (HALEU). The Agency is presently evaluating two different nuclear reactor technology applications for space: (1) nuclear surface power, and (2) nuclear thermal propulsion. The use cases for space fission system technologies being developed by the two projects are significantly different from each other which may lead to different implementations.

Nuclear surface power systems, initially with power levels of perhaps a few kilowatts scaling up to several tens of kilowatts, would be delivered to lunar or other planetary surfaces on a lander that has very limited payload capacity. After deployment, the system would be expected to operate continuously for many years. Long-lived, continuous day and night power sources on the lunar surface are essential to promote in situ resource utilization-based propellant production, and to deliver enough power to support human surface sustained presence through multiple day-night cycles. The total mission power to meet near term needs is expected to be less than 10 kilowatts, potentially growing to tens of kilowatts for larger-scale implementations. In this power class, HEU systems offer a considerable mass savings compared to low enriched uranium (LEU) systems. Generally, the mass advantages of HEU-based systems relative to LEU-based fission power systems become significantly reduced as requirements for surface power systems are finalized and more detailed studies are completed, NASA will be in a position to select the fuel type to best support its missions.

By contrast, a Nuclear Thermal Propulsion system, with a reactor power level of several hundred megawatts, could be used for the main propulsion of a large spacecraft, executing a few high-performance propulsive maneuvers with run times of several minutes to a few tens of minutes. A NASA use for a nuclear thermal propulsion system could be to depart one planetary body (for example, Earth) and capture into orbit around another (such as Mars). NASA’s Nuclear Thermal Propulsion project, which has adopted a high-assay low enriched uranium-based reactor design, is addressing key technical challenges related to developing an efficient propulsion system for deep space transit.

**Question 3.** Since a likely consequence of NASA’s use of HEU fuel would be to increase foreign countries’ use of HEU fuel and thereby increase the risks of nuclear proliferation and nuclear terrorism, has NASA included such national security costs in its evaluation of HEU fuel? Please provide any estimates, if so.

**Answer.** We recognize that the use of HEU would come with significant costs for security and could also raise broader nonproliferation concerns. As DOE will retain ownership of the HEU consistent with the Atomic Energy Act, any work done in support of design, fabrication, and transportation will fall under existing security postures at DOE sites. Regarding security costs at the launch location, NASA conducted a Nuclear Power Assessment Study in 2014 that examined the security costs for processing an HEU reactor at the Kennedy Space Center in preparation for launch. That study estimated approximately $30M (non-recurring) infrastructure investments and $40M (recurring) for a 9-month campaign that included the required security posture at the launch site. It should be noted that this study utilized conservative assumptions given the specific reactor design was not finalized, including the quantity and form of HEU. As the reactor designs and mission plans mature, NASA will continue efforts with DOE and other Federal agencies to develop a security plan with acceptable performance-based security measures, leveraging to the extent practical existing security programs to minimize security costs where appropriate. These assessments will be factored into the ultimate fuel reactor design decisions.

**Question 4.** Will using HEU mean that fewer commercial and academic partners would be able to participate in conventional space launches?

**Answer.** While LEU-based systems may facilitate the use of commercial and academic partners to lead the reactor development, an HEU-based reactor development would likely include both commercial and academic partners in support roles. In either case, NASA and DOE would oversee the development for any system employed in a NASA application.
For example, NASA has delivered a number of scientific missions employing nuclear power using commercial launch services, most recently the Mars Science Laboratory in 2011. This rover is successfully operating on Mars and was developed with a variety of international, academic and commercial partners. We anticipate future spacecraft, including those using fission-based reactors as their power source, would continue to support commercial and academic participation in providing scientific instruments, technology and launch vehicles.

**Question 5.** If yes, has NASA calculated the increase in cost that would come from excluding most potential commercial and academic partners in its valuation of HEU fuel? Please provide any estimates, if so.

**Answer.** Commercial and academic partners would be included in either LEU or HEU reactor developments, as stated above.

**Question 6.** As you know, facilities using and storing HEU must meet higher regulatory and security standards. Has NASA conducted any studies or estimates of the potential security, administrative, and regulatory costs associated with NASA’s potential use of HEU? Please provide any estimates, if so.

**Answer.** The possession and use of HEU falls under the Atomic Energy Act and, as such, DOE would retain ownership and custody of special nuclear materials. The development, testing, and transportation of a HEU power system would be conducted at DOE controlled locations that already possess the necessary security posture. As stated above, the 2014 study provided an initial estimate of the cost to secure HEU at the launch location and NASA would work with DOE and other agencies to refine that estimate once the reactor design is finalized.

**Question 7.** Will you commit to providing my staff more information about why NASA proposes to use HEU and how it reached this decision?

**Answer.** NASA continues to review and evaluate various nuclear technology options, including those that would employ either highly enriched uranium (HEU) or High Assay Low Enriched Uranium (HALEU). NASA is committed to supporting the Committee’s oversight.

**RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. ROGER WICKER TO KEVIN M. O’CONNELL**

**Question.** Mr. O’Connell, page 2 of your written statement notes that the Administration “proposed elevating the Office of Space Commerce to the bureau-level within the Department of Commerce” and also that Space Policy Directive-2 calls for the Department of Commerce (DOC) to undergo a reorganization to better promote space commerce. On December 20, 2018 the Senate passed the Space Frontier Act (S. 3277) by unanimous consent. Section 308 of S. 3277 created a Bureau of Space Commerce within the DOC headed by a Senate-confirmed Assistant Secretary. Please provide the committee with your perspective on the potential benefits of elevating your current office to a Bureau-level within DOC.

**Answer.** The global space economy is growing rapidly. Numerous sources estimate the global space economy with revenues of approximately $400 billion, with the United States claiming over 50 percent of the market. As the market grows to an estimated $1 trillion, or possibly as high as $3 trillion by 2040, we want to ensure that the United States positions itself as a leader in market for both economic and national security reasons.

As mentioned in my testimony, I assumed leadership of the Office of Space Commerce within the National Oceanic and Atmospheric Administration in July 2018. Given the strategic importance of this industry to U.S. economic and national security goals, I have been proud to reengage the office. However, I have found that the office’s success is constrained by the current organizational structure.

Elevating of the Office of Space Commerce (OSC) to the Office of the Secretary as proposed in the FY 2020 President’s Budget would address three critical needs:

- **Create a Platform from which to Promote the U.S. Commercial Space Industry:** This effort is consistent with the Administration’s reestablishment of the National Space Council and emphasis on space, especially its desire to harness the innovation of the U.S. commercial space sector.
- **Leverage the Entire Department of Commerce:** Putting OSC within the Office of the Secretary improves our ability to tap into the many different talents and expertise of Department of Commerce on behalf of the U.S. commercial space industry. This coordination is critically important as we continue to engage with industry, advocate, implement the Administration’s Space Policy Directives, and deepen our understanding of the space economy.
Improve Debate: The leadership of OSC within the Office of the Secretary allows for more equal footing for economic and commercial issues within interagency discussions and debates.

The Department has already taken a number of steps to elevate the profile of our commercial space activities and leverage the expertise from across the Department. This elevated platform has fostered partnerships between the Office of Space Commerce and various bureaus within the Department. We continue to work, for example, with the International Trade Administration, which advocates internationally for space companies, and the Bureau of Industry and Security (BIS), which regulates commercial space export licenses. In April, BIS and the Office of Space Commerce hosted Export Control Industry Day, a public meeting to discuss the National Space Council's ongoing review of space export controls and the new rule-making activities. Additionally, OSC collaborated with the National Telecommunications and Information Administration to produce the Space Policy Directive-2 (Streamlining Regulations on Commercial Use of Space)-mandated report, Driving Space Commerce Through Effective Spectrum Policy, on the importance of space spectrum and updated national and international policies.

Furthermore, OSC is working with the National Institute of Standards and Technology to develop standards for mitigating space debris and space congestion. We also are working with the Minority Business Development Agency as it administers grants in support of space commerce, and the Economic Development Administration, which promotes grant opportunities to commercial space companies that support regional development. Elevating the Office of Space Commerce to Office of the Secretary, however, would provide the opportunity to strengthen these partnerships.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN THUNE TO KEVIN M. O'CONNELL

Question 1. Mr. O'Connell, your testimony highlighted the importance of commercial and intergovernmental partnerships to sustaining U.S. leadership in operational Earth observation. One of these partnerships is the Earth Resources Observation and Science (EROS) facility—located in my home state of South Dakota—where NASA and USGS coordinate to provide critical remote sensing data used for numerous applications, including flood mapping and agriculture.

Based on the success of EROS and similar partnerships, do you have any suggestions for ways the Federal government can promote or improve these intergovernmental partnerships?

Answer. During the early 1990s, I worked with the Earth Resources Observation and Science (EROS) Data Center in connection with the declassification of the CORONA national security archive and experienced firsthand the importance of intergovernmental cooperation in ensuring the U.S. government's efficiency in creating new or modernizing government programs. Partnerships like the National Aeronautics and Space Administration (NASA)-U.S. Geological Society (USGS) EROS project that you cite are a good example of government agencies coordinating requirements, leveraging current operations, and minimizing infrastructure to perform a shared government mission. These are exactly the principles that the Department of Commerce is adopting as it undertakes its portion of the space situational awareness/space traffic management mission in partnership with the Department of Defense and other Federal agencies. The National Oceanic and Atmospheric Administration (NOAA) also participates in the USGS/EROS led Joint Agency Commercial Imagery Evaluation (JACIE) activity. An annual workshop showcases the work done by five government agencies—NOAA, NASA, USGS, the National Geospatial-Intelligence Agency, and the U.S. Department of Agriculture—and industry/academia partnerships to evaluate commercial sources of remotely sensed data and their ability to support Federal science needs. This year’s theme is “The Rapidly Evolving Remote Sensing Industry.” JACIE is a model for Government collaboration with the commercial remote sensing industry representing complementary roles in the larger Earth observation enterprise.

Question 2. As a follow-up, what can be done by the Federal government to encourage commercial sector partnerships that promote the U.S. as the first choice of location for satellite companies?

Answer. Under Space Policy Directive-2 (Streamlining Regulations on Commercial Use of Space) and Space Police Directive-3 (Space Traffic Management), the Department is undertaking a wide variety of efforts to advocate for the U.S. commercial space industry, including efforts to remove impediments to economic and technological growth. Deregulatory efforts in areas like spectrum, remote sensing, export
controls, and others reflect our keen understanding of the intensely competitive
global space market and the need to continuously adapt regulation in order to keep
America as the “flag of choice” for commercial space operators.

One key role we will be investigating, based on industry input, are the many di-

mensions of the U.S. government’s role as a customer. The U.S. government retains
tremendous buying power in the commercial space market. When the government
works with the commercial sector, particularly with smaller and upstart companies,
it allows these companies to experiment and innovate in a variety of areas, gen-
erally at a fraction of the cost of traditional government programs. This mechanism
is one of the many that we will be promoting is the public-private partnerships.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO
KEVIN M. O’CONNELL

Space Policy Directive-2. NOAA is required to make a determination on com-
mercial earth observation licenses within 120 days, but for years the department has
failed to meet that deadline—sometimes going years over the deadline. The presi-
dent’s second space policy directive tasked the Department of Commerce with con-
solidating the department’s space programs and advocacy within your office.

Question 1. How have things improved since the department’s space responsibil-
ities were consolidated in your office?

Answer. With the Administration’s leadership and the Department of Commerce's
emphasis on implementing the 2017 interagency Memorandum of Understanding,
“Concerning the Licensing and Operations of Private Remote Sensing Satellite Sys-
tems,” the average processing time has been reduced from 213 days in 2014, to an
average of 61 days in 2018. However, the

Department of Commerce’s responsibilities regarding commercial space activities
are not consolidated. We believe that elevating the office to the Office of the Sec-
retary, as proposed in the FY 2020 budget, will result in continued improvements
to the licensing process.

Question 2. What more needs to be done?

Answer. Elevating the Office of Space Commerce (OSC) to the Office of the Sec-
retary as proposed in the FY 2020 President’s Budget would address three critical
needs:

• Create an Elevated Platform from which to Promote the U.S. Commercial Space
  Industry: This is consistent with the Administration’s reestablishment of the
  National Space Council and emphasis on space, especially its desire to harness
  the innovation of the U.S. commercial space sector.

• Leverage the Entire Department of Commerce: Putting OSC within the Office of
  the Secretary creates the ability to tap into the many different talents and ex-
  pertise of Department of Commerce on behalf of the U.S. commercial space in-
  dustry. This is critically important as we continue our roles of advocacy, imple-
  mentation of the Space Policy Directives, industry engagement, and the deep-
  ening our understanding of the space economy.

• Meaningful Debate: The leadership of OSC within the Office of the Secretary
  allows for more equal footing for economic and commercial issues within inter-
  agency discussions and debates.