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**before the**

**United States Senate Committee on Commerce,
Science, and Transportation**

**Subcommittee on Science, Space, and Competitiveness**

**on:**

**Reopening the American Frontier: Exploring How the Outer Space Treaty**

**Will Impact American Commerce and Settlement in Space**

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Mr. Chairman, Senator Nelson, members of the Committee,

It is an honor to be invited to speak with you today about reopening the American frontier and unleashing the innovative power of the U.S. commercial space industry as a driver of the nation's space economy and settlement. Although our lives are dominated with the everyday challenges of life on Earth and with each other, these matters are ultimately trivialized by the challenge of securing humanity's future through our expansion into space, utilizing the practically infinite energy and resources of space, and ultimately becoming a multi-world species.

Our need to expand humanity into space is not in question, to consider otherwise would put an expiry date on the human species. What is in question is the way we will expand into space, and which nations will set the standards of freedom of human endeavor and reward as we enter these new frontiers. As a country built on the foundations of Earth's frontiers, the United States stands unique in all the world with the opportunity to focus the power of its entrepreneurial history and enterprising vision to open up the space frontier, and in so doing, create a peaceful, prosperous and boundless future for all humanity.

**PERSONAL JOURNEY**

My personal journey has been vested in creating international institutions and enterprises necessary to create a peaceful and prosperous spacefaring civilization. As a student in the 1980's, I co-founded

Students for the Exploration and Development of Space, today still the largest student-run global space organization; the Space Generation Foundation, whose follow-on Advisory Council works with the United Nations to inspire and enable global youth to pursue their dreams in space; and the International Space University, which since its founding in 1987 has instructed thousands of graduate level students from both our main campus in Strasbourg, France, and our Space Studies Programs hosted around the world. Many graduates of this program today are in positions of leadership in the global space arena. More recently in 2008, I co-founded Singularity University, which has become a hub of global entrepreneurial innovation from our campus in Silicon Valley, tackling some of the worlds grand challenges with exponential technologies.

I have also had the honor of working with NASA on the successful delivery of a robotic spacecraft to the north pole of Mars, a scientific mission that added much to our understanding of the Red Planet, and with the U.S. Air Force on the demonstration of technologies in Earth orbit that enable new capabilities in autonomous rendezvous and proximity maneuvers.

Today, I address you as Founder and CEO of Moon Express, a privately funded commercial space company created to seek and unlock the resources of the Moon through a progressive series of commercial robotic missions, starting with our maiden voyage scheduled to launch late this year.

**THE MOON – OUR EIGHTH CONTINENT**

I look on the Moon as Earth's eighth continent; a new world with a total land mass approximating North and South America combined. Thanks largely to the terabytes of data generated by the NASA's Lunar Reconnaissance Orbiter, we know the Moon has vast resources, accumulated through billions of years of asteroid bombardment that enriched the Moon much the same way as Earth, except for one key difference: accessibility. Unlike Earth, these lunar resources are largely on or near the lunar surface, relatively accessible except for the challenging economics of retrieving them when all the energy to do so needs to come from the Earth's surface. But this too has now changed…

Perhaps one of the greatest practical discoveries of our generation is the presence of vast quantities of water on the Moon, verified by NASA in 2009. The discovery of water on the Moon is a game changer, not just for the economic viability of lunar resources, but for the economics of reaching Mars and other deep space destinations.

Water is the oil of the solar system, and the Moon will become a way-station in the sky. With private sector interest emerging in economic activity outside of traditional Earth orbit, the question of how the U.S. will enable and protect its national interests and non-governmental players is now timely and serious.

**'MISSION APPROVAL' FOR THE 1ST PRIVATE VENTURE TO THE MOON**

To date, all spacecraft that have ventured beyond Earth orbit on pre-authorized missions have been government spacecraft, and therefore were de-facto compliant with the Outer Space Treaty's (OST) Article VI requiring government authorization and supervision. The U.S. has always believed that the private sector would be a growing part of our national space enterprise, and U.S. negotiators of the OST

insisted on recognition for non-governmental actors in space. In its 'Mission Approval' framework, Moon Express recognized the requirement to comply with the treaty's framework as a U.S. company, and is honoring that commitment while pursuing a vital commercial role in our human space future.

Following the welcome enactment of the Space Resource Exploration and Utilization Act of 2015, we weighed the risks of seeking funding from investors for the final development and maiden launch of our first spacecraft with one critical question unanswered: would the U.S. government actually give us permission to fly? In early 2016, after visiting a number of federal agencies involved in the interagency review of launch licenses, it became clear that although any of the agencies could potentially say "no", no one agency had the independent authority to say "yes". We needed certainty to attract further funding from our investors, within a timeline desired by our customers, so we began seeking an answer.

In the absence of any prescribed process or clarity of regulatory authority, we proposed a 'Mission Approval' framework, intended as an interim 'patch', that built on the existing payload review process of the Federal Aviation Administration Office of Commercial Space Transportation (FAA/AST) with a series of additional 'voluntary disclosures' intended to help satisfy U.S. obligations under the OST. We worked independently with all stakeholder federal agencies, who in turn worked collaboratively and creatively to find a way to approve our ad hoc approach, even as Congress and the Administration determine a more formal framework.

As a result of our initiative and the federal agency efforts, on July 20th, 2016, Moon Express became the first commercial entity to receive formal U.S. government approval to send a robotic spacecraft beyond traditional Earth orbit and to the Moon. This was in fact the first time in history that any government signatory to the Outer Space Treaty exercised its rights and obligations to formally authorize and supervise a commercial entity to fly a mission beyond Earth orbit. So let us be clear: for our 'Mission Approval', the United States government has more than complied with Article VI. But let's also be clear that what we received was qualified as a "one-time only" authorization, because it was made clear to us that the positive determination does not extend to future missions by Moon Express or similar missions from other entities. We are therefore still contending with regulatory uncertainty for future missions.

We can only be thankful for the efforts of the FAA's Office of the Associate Administrator for Commercial Space Transportation, and in particular George Nield, Shana Dale and Laura Montgomery, who championed our 'Mission Approval' application through an enhanced payload review process. Aided in particular by the concerted interagency efforts of Tom Kalil and Ben Roberts at the White House Office of Science and Technology Policy, Brian Israel and Ken Hodgkins at the State Department, Robin Frank at NASA, Doug Loverro at the Department of Defense, and many others who worked with them or at other agencies, we were able to secure a consensus approval, communicated to us by the FAA Office of Commercial Space Transportation, so Moon Express could move forward with our mission plans. Equally as important, this approval allowed us to solidify our private financing which had been hampered by the uncertainty regarding federal permission to undertake our mission.

**THE MISSION APPROVAL AS PRECEDENT FOR A FUTURE REGIME**

In 1983 Congress began the long effort to craft and enact the Commercial Space Launch Act of 1984, which gave the Department of Transportation sufficient authority to become a one-stop shop for launch

licensing. Three decades later, this committee helped write the Commercial Space Launch Competitiveness Act, which directed the previous administration to propose a long-term solution to authorizing and supervising commercial space ventures beyond launch, telecommunications, and remote sensing.

The effort for our 'Mission Approval' came at a huge cost of company executives' time and expense, triggered exhaustive interagency deliberations, and delayed our fundraising and our mission. We're glad we were able to do this, but it wasn't an easy path and we were never assured success. To some extent we believe our 'Mission Approval' framework was accepted because we were proposing a fairly simple, short-duration mission. Lacking any further federal clarification of approval process, we plan to use our 'Mission Approval' framework again, and we need to be able to use it again soon, as we have follow-on lunar missions already in the works for 2019 and 2020. We are hopeful that the Congress and Administration, in consultation with industry, can apply principles like those we based our approach on to craft a more permanent system for companies like us, and the many companies that are yet to be born who will join us in expanding U.S. commercial space activity to the Moon and beyond.

**SUPPORTING A REGULATORY FRAMEWORK WITH MINIMAL BURDEN AND MAXIMUM CERTAINTY**

We support a process that focuses and streamlines the regulatory framework, limits the government's role to a light touch, promotes American innovation and investment, and satisfies our international obligations. We believe this could be accomplished with a "presumed authorization within predefined boundary conditions" approach to non-traditional commercial space activities beyond Earth orbit.

In essence we believe that a commercial space activity should enjoy "deemed authorization" unless there is a clearly evident or meaningful demonstrable impact on national security, U.S. obligations under international treaties, or harmful interference with others.

Our premise is that the U.S. government should in principle enact laws that assure freedom of enterprise in space, making it illegal for the government to deny or restrict private sector space activity, provided the activity satisfies three fundamental axioms that should be the foundations of any U.S. policy governing non-traditional space missions in or beyond Earth orbit:

1) no meaningfully demonstrable negative impact on national security

2) no harmful interference with existing space infrastructure or activities

3) does not breach U.S. obligations under international treaties

And otherwise, whatever federal body that is in charge of the application/registration has no legal right to object to it. In other words, it is "presumed authorized within predefined boundary conditions", and only if those boundary conditions are shown to be violated would the application go to an interagency 'secondary review' cycle in which the onus would be on the government to prove that the boundary conditions are breached in order to deny the application/registration, accompanied by a proposed enabling solution, which then would be subject to revision, appeal, etc. We also suggest that a legally binding timeframe would be imposed on both the first and secondary reviews, after which the presumed authorization would prevail.

**PUBLIC-PRIVATE PARTNERSHIPS**

One of the reasons it is vital for the U.S. government to create policy clarity and streamline regulatory burdens for commercial lunar and other nontraditional space business ventures is because in almost every case, some federal agency is likely to want to directly or indirectly purchase a space good or service from these companies.

In our case, we have benefitted from many Space Act Agreements with NASA which allowed us to learn from the agency and jointly develop new capabilities based on historic ones. Most of our early Space Act Agreements with NASA involved us paying NASA for access to technologies and facilities, but that has evolved in recent years into the use of no-exchange of funds Space Act Agreements that involve mutual value. In particular, NASA's Lunar Cargo Transportation and Landing by Soft Touchdown (Lunar CATALYST) program has provided us significant access to NASA technologies, facilities, and expertise that is accelerating our initial mission. The reason NASA is doing this is because they need less expensive ways to conduct robotic lunar exploration and seek to spur commercial cargo transportation capabilities to the surface of the Moon with competitively selected industry partners.

Over the years NASA has funded many existing "orphan" payloads from U.S. scientists that need a ride into lunar orbit or to the surface. Recent U.S., Indian, Japanese, and Chinese missions to the Moon have only wetted the appetite of lunar scientists. Given NASA's primary focus on Mars exploration, it is not likely that NASA will send another large dedicated spacecraft to the Moon, but it could purchase rides from commercial providers such as Moon Express.

We are therefore particularly happy about recent announcements by NASA of potential interest in commercially-provided robotic systems for science and exploration investigations of the Moon. Extending the public-private partnership model of commercial transportation services beyond Earth orbit will enable new growth in U.S. industrial capacity and capability while introducing the economics of private sector competitive innovation to deep space and planetary exploration.

As Moon Express' capabilities grow, we can bring back samples from geologically interesting lunar sites. Eventually, as we grow to begin to harvest lunar water ice and turn it into liquid hydrogen and oxygen for propellant and commercial uses, one of the largest customers may be NASA's human missions to Mars. If NASA (or another agency) wishes to accelerate a specific capability on our roadmap, then a public-private partnership such as that used so effectively on cargo resupply o the International Space Station could deliver results much sooner and cheaper than a traditional contracting approach.

Public-private partnerships are much more fundamental to the U.S. government's goals in space than just serving as a more efficient procurement method. NASA's organic law mandates that the agency "promote the fullest commercial use of space". The vision that Chairman Cruz has set for these hearings is one of the government opening the space frontier to commerce and settlement by private citizens. Therefore, whereas a traditional procurement may or may not develop technologies with some potential commercial application, a public-private partnership fosters the emergence of privately-owned, largely privately-capitalized space goods and services providers who can and will seek out new markets beyond government customers. That economic infrastructure which grows out from the

government's legal and regulatory framework and limited public sector investments is what promises our broader society a hopeful future as our nation leads the expansion of humanity into space.

Therefore, creating the right policy environment is vital to achieving the full strategic benefits of American leadership on the space frontier. Our nation's entrepreneurs and engineers, students and scientists, teachers and tourists will follow NASA's pioneering steps into the solar system carrying American civilization with them.

The U.S. government needs to create a framework that allows and encourages U.S. enterprise to invest in utilizing these lunar resources, or other nations will do so.

**AMERICAN PREFERENCE**

One concern that has emerged in America's leadership on the space frontier is that NASA has typically tended to use international partnerships with other space agencies more than domestic public-private partnerships to carry out science missions. While Moon Express certainly supports the national security and foreign policy benefits to the U.S. from such cooperative scientific projects, it is important for policymakers to realize that these international efforts can preclude American commercial participation.

For example, if NASA spends its dollars on helping another nation learn how to land a spacecraft on the Moon, including the provision of hardware and launch services for the mission, instead of buying a ride from a commercial provider, then it is arguably subsidizing the creation of a foreign capability, while not utilizing a nascent or extent domestic commercial service. This choice is not a simple matter of "domestic preference" versus international diplomatic benefits, but one of pursuing space goals that are more relevant to U.S. commercial providers via public-private partnerships, while more advanced or purely scientific projects can be internationalized.

**THE BIG PICTURE**

So far, modern humans have been resident on Earth for a few thousandths of a percent of our planet's lifetime; a microscopic sliver of planetary history. Civilization as we know it has been around a 100 times less than that. In the last few frames of our planetary cinema, barely a subliminal flicker, the first artifacts of a technological civilization have left the atmosphere and can be found on our neighboring worlds. Some farther than that. If the story of humanity ended tomorrow, by natural or self-inflicted calamity, these extraterrestrial human artifacts might be the only remaining evidence that there was an emergent spacefaring species on the third rock from the Sun.

The key to our survival as a species, in fact the only key we hold in the long term, is to evolve into a multi-world species, harnessing the practically infinite energy and resources of space and easing the pressure on our planet.

Space is vast, and if we lived on a planet isolated like an island in an empty ocean, it would be very hard to develop space resources. But luckily, we are an archipelago with a sister world containing resources we can utilize. The Moon; our eighth continent, rich in resources, the gateway to the solar system, is also the gateway to our future.

Preservation of the Earth and our civilization is precisely the reason we need to expand our economic and societal sphere into space, beginning with the Moon and then beyond.

Sixty years ago we began our journey as a spacefaring species. We need to get a toe-hold back on the Moon, and this time not let go. Moon Express is dedicated to exploring and unlocking the resources of the Moon for the benefit of humanity. We're undertaking this goal with private investment, not on the backs of the taxpayer. The risk is ours. The rewards will become available to everyone. We will conduct ourselves responsibly and with respect to national and international laws. We will avidly support science and exploration of the Moon as we seek water and minerals. But we're going. And we're thrilled to have the laws of the United States protecting our activities and backing our efforts to find new resources that could one day help the economies of planet Earth and secure our future in space.

It's not just about boldly going; it's about boldly staying. It's about moving the economic sphere of Earth outward in a way that uses the material wealth of space to solve the urgent problems we now face on Earth: to bring the poverty-stricken segments of the world up to a decent living standard, without recourse to war or punitive action against those already in material comfort; to provide for a maturing civilization the basic energy vital to its survival… through freedom of commerce in space.

We are at the cusp of a magnificent adventure, an evolution of our species perhaps as significant as the evolution of life from the oceans onto land. Our emergence from Earth into space holds promise and opportunity, but also dangers of migrating conflict, and for the first time in human history, an opportunity to conquer a new world without conquering each other.

The United States has taken proactive measures to support its private sector and has interpreted the Outer Space Treaty in favorable ways to the Constitution and founding principles. While the Outer Space Treaty may appear antiquated in some ways, it is a remarkably visionary document with profound principles that have served the world well for decades. I believe time and energy is better spent in continuing to interpret the Outer Space Treaty in favor of international collaboration without constraining the rights and benefits of the freedom of U.S. commercial enterprise in space.

We aspire to the stars. Mars beckons as a second home for humanity. The Moon is our gateway.

Thank you for your time and the opportunity to present this testimony.

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