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before the

United States House of Representatives'

Committee on Science, Space and Technology

Subcommittee on Space Hearing

on:

Private Sector Lunar Exploration

Thursday, September 7, 2017

Chairman Babin, Ranking Member Bera, and members of the Subcommittee: It is an honor to be invited to speak with you today about the efforts of U.S. commercial space industry in pioneering new business models for lunar exploration and development.

Only a few decades ago, Earth orbit was an economic frontier and the singular domain of government space agencies. Today, private sector satellites generate billions of dollars of commerce annually in a mature, well established economic sphere that impacts our everyday lives and has immeasurably improved life on Earth. Now commerce looks beyond Earth orbit to the lunar frontier, which has also been the realm of governments, but over the last decade, a combination of exponential technology advance and private space investment has brought the Moon within reach of the commercial sector.

The Moon is Earth's 8th continent, a new frontier for humanity with precious resources that can bring enormous benefits to life on Earth and our future in space. Private sector entrepreneurship will help expand our economic sphere to the Moon and create new opportunities for business markets to arise supporting science, exploration and discovery, but also horizons of infinite opportunity for creative entrepreneurs to unlock the energy and resources of a whole new world.

PERSONAL JOURNEY

My personal journey has been vested in creating international institutions and commercial space enterprises driven by the vision of a peaceful and prosperous spacefaring civilization. Along this journey, I co-founded the International Space University and more recently, Singularity University, to help inspire and educate new generations of leaders to take on bold new challenges of space exploration while caring for our home planet and each other.

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

MOON EXPRESS

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 next year.

I founded Moon Express with "dotcom" pioneers Naveen Jain and Barney Pell in 2010. We are a Silicon Valley born and backed enterprise, with investors ranging from billionaires to venture funds to celebrities. We began our life at the NASA Ames Research Park in Mountain View, California, and in 2015 relocated to Cape Canaveral on Florida's Space Coast, where we are currently refurbishing the historic Launch Complexes 17 and 18 for our spacecraft engineering, test and mission control facilities.

THE MOON – OUR EIGHTH CONTINENT

The Moon is a new world with a total landmass approximating North and South America combined. The Moon has only been reached by government superpowers, but new advances in technology are bringing the Moon within reach of the private sector. Next year Moon Express' robotic explorers will set sail to Earth's 8th continent, seeking new opportunities for commerce, knowledge and adventure.

RESOURCES FOR HUMANITY

Like the Earth, the Moon has been enriched with vast resources through billions of years of bombardment by asteroids and comets. Unlike the Earth, these resources are largely on or near the lunar surface, and therefore relatively accessible. Moon Express is blazing a trail to the Moon to seek and harvest these resources to support a new space renaissance, where economic trade between countries will eventually become trade between worlds. All Moon Express expeditions will prospect for materials on the Moon as candidates for economic development and in-situ resource utilization.

WATER

One of the greatest practical space discoveries of our generation is the presence of vast quantities of water on the Moon, verified by NASA in 2009. Water (H_2O) not only supports life but its constituents, hydrogen and oxygen, are energetic and clean rocket fuel. 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 humans reaching Mars and other deep space destinations. Water is the oil of the solar system, and the Moon can become a gas station in the sky to fuel human space exploration, development and settlement of the solar system. Moon Express will begin prospecting for water resources on the Moon with its very first expedition.

OUR LONG-TIME PARTNERSHIP WITH NASA

Moon Express has been honored to partner with NASA since the inception of our company. In 2010, we entered into a Reimbursable Space Act Agreement with NASA Ames Research Center that allowed us to invest private dollars into the refurbishment and recommissioning of NASA's Hover Test Vehicle (HTV) and test facility, where we got our lunar lander training wheels and advanced our spacecraft control software. That same year we won our first data purchase contract from NASA Headquarters under the Innovation Lunar Demonstrations Data program.

In 2012 we entered into a Reimbursable Space Act Agreement with NASA's Marshall Space Flight Center allowing us to invest in access to the 'Mighty Eagle' lander test vehicle. With NASA's support, we successfully conducted the first free flight demonstrations of our autonomous spacecraft software on the Mighty Eagle in Huntsville in 2013, validating our Guidance, Navigation and Control (GNC) flight software and proving the value of public-private partnerships for lunar capabilities. In 2014 we were selected as one of three industry partners for NASA's Lunar CATALYST program, established to spur commercial cargo transportation capabilities to the surface of the Moon. Later that year, supported by Lunar CATALYST, we conducted test flights of our own lander test vehicle at the Kennedy Space Center Shuttle Landing Facility, beginning a long-term collaboration with KSC, which continues today. In 2015, thanks to the welcoming support of Kennedy Space Center, Space Florida and the U.S. Air Force's 45th Space Wing, we relocated and consolidated our staff and company operations to the Space Coast, where we have licensed the historic Cape Canaveral launch complexes 17 and 18 from the U.S. Air Force as our new home. We are currently investing in the reconditioning and construction of these historic facilities to support our spacecraft development, test and mission operations.

CURRENT ACTIVITIES

We are currently building toward our maiden lunar mission next year, with our spacecraft systems in various stages of fabrication, assembly and test. Thanks to Lunar CATALYST, we have access to NASA facilities to test and validate our spacecraft propulsion, structures and avionics. We have contracted for up to five launches from Rocket Lab USA aboard their Electron rocket, which achieved a remarkable level of success during its maiden flight last May, and we expect to become operational later this year.

On July 12, just down the hall from this hearing room, we unveiled our spacecraft architecture and announced our first three lunar expeditions, beginning with an equatorial landing next year, a south pole flight in 2019, and a sample return in 2020, with a goal of proving out the technologies and legal premise of the first privately obtained lunar soil and rocks. Our MX family of robotic spacecraft are designed to collapse the cost of access to the Moon, introduce a new commercial paradigm for government missions, democratize lunar research and exploration, and blaze the trail for commercial space transportation and exploration beyond Earth's orbit.

Our first expedition will utilize our MX-1E robotic explorer to deliver a diverse manifest of scientific and commercial payloads to the lunar surface. Our customers for this mission include the International Lunar Observatory Association, the University of Maryland, The National Laboratories of Frascati, Celestis and Google.

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

On July 20, 2016, Moon Express become the first private company to receive authorization from the U.S. government for a private mission beyond Earth orbit and to the Moon, establishing a historic precedent of national and commercial compliance with the terms of the 1967 Outer Space Treaty (OST). This was in fact the first time in history that any government signatory to the OST exercised its rights and obligations to formally authorize and supervise a commercial entity to fly a mission beyond Earth orbit.

After recognizing the absence of any prescribed process or clarity of regulatory authority for our private lunar activities in 2015, we proposed a 'Mission Approval' framework to the U.S. government, intended as an interim 'patch' that built on the existing payload review process of the Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) with a series of additional 'voluntary disclosures' intended to help satisfy U.S. obligations under the OST, including covenants of non-interference with domestic or foreign activities or heritage sites. After several months of socializing our proposal with the White House, Department of State, FAA, NASA, NOAA, Department of Defense, and other involved federal agencies, our proposal was accepted.

While thankful for the positive determination that allowed us to solidify our private financing and move forward with our plans, I note that our 'Mission Approval' was qualified as a "one-time only" authorization that does not extend to future missions by Moon Express or similar missions from other entities. For this reason, I am very pleased that this Committee has developed and marked up the American Space Commerce Free Enterprise Act, which provides an excellent "light touch" to OST Article VI compliance.

EXPANDING CAPABILITIES WITH MULTIPLE EXPEDITIONS

Following our initial "Lunar Scout" expedition next year, we will offer payload accommodations on future voyages, planned at the rate of one per year. But we can also scale up and increase the frequency of our lunar flights to meet market demand and opportunity.

Our second expedition in 2019, "Lunar Outpost", will enable the first commercial presence and exploration of the lunar South Pole. It may in fact be the first-ever soft-landing at a lunar pole. The primary goals of this mission are to set up the first lunar research outpost at a "peak of eternal light", prospect for water and useful minerals, and accommodate a variety of research instruments for our expedition partners.

Our third expedition, "Harvest Moon", will take place by 2020 and includes the first commercial sample return, beginning our business phase of lunar resource prospecting and harvesting. The samples brought back will be the only privately obtained lunar materials on Earth, and will be used to benefit science as well as commercial purposes.

OUR VISION: OPENING THE LUNAR FRONTIER – FOR ALL OF US

Our vision is to open the lunar frontier with turn-key payload, data and services for missions to the Moon for a wide range of customers globally, including governments, NGO's, commercial enterprises, universities, and consumers.

We have developed a family of flexible, scalable robotic explorers that can reach the Moon and other solar system destinations from Earth orbit. The MX spacecraft architecture supports multiple applications, including delivery of scientific and commercial payloads to the Moon at low cost using a rideshare model, or charter science or commercial expeditions to distant worlds.

Our MX robotic explorer spacecraft are optimized for launch on existing and emergent rocket systems:

MX-1: A single stage spacecraft capable of delivering up to 30kg to the lunar surface.

MX-2: A dual-stage spacecraft that doubles the capability of the MX-1 and can reach the moons of Mars.

MX-5: A cis-lunar workhorse spacecraft that can deliver up to 150kg to lunar orbit or 50kg to the surface.

MX-9: A lunar prospector/harvester that can deliver up to 500kg to the lunar surface, including an embedded MX-1R spacecraft that can launch from the lunar surface and return lunar samples to Earth.

WHAT CONGRESS CAN TO DO HELP

To assure freedom of enterprise beyond Earth orbit, industry needs a regulatory framework that meets U.S. obligations under the Outer Space Treaty with maximum certainty and minimal regulatory burden.

I would recommend that Congress 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 international obligations. One possible approach is a "presumed authorization within boundary conditions", where U.S. policy would de facto allow non-traditional space activity in or beyond Earth orbit, provided there is:

1) no demonstrable meaningful negative impact on national security

2) no harmful interference with existing space infrastructure or activities

3) no breach to U.S. obligations under international treaties

I am hopeful that Congress and the Administration, in consultation with industry, can apply principles conducive to freedom of enterprise in space for companies like us whose success will result in the expansion of U.S. commercial space activity to the Moon and beyond. Enacting H.R. 2809, or something very like it, would go a long way to help business happen off-planet.

NEXT STEPS: A PUBLIC-PRIVATE PARTNERSHIP WITH NASA

As I have illustrated before, NASA has been an essential partner to Moon Express, providing access to expertise and technologies supporting our lunar lander development. We have benefitted from many Space Act Agreements with NASA centers that allowed us to learn from the agency and jointly develop new capabilities based on historic ones. Most of our early partnerships 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 provide 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 which have accelerated our first few expeditions, offering exactly the kinds of capability NASA wanted to see arise.

As a next step, we would like to see NASA transition from a partner-technology developer to a partner-customer, beginning with the purchase of cargo services from us for delivery of science and exploration instruments to 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.

Moon Express is flying spacecraft to the Moon next year. This means we can offer NASA an affordable way to carry small American experiments back to the Moon within this coming budget year. All of our development has been privately funded and we don't need a major public-private partnership program to fund our initial lander. Since we have a family of landers based on our core MX-1 spacecraft, we can offer NASA ongoing scalable capabilities on a fixed-price, milestone-based pay-for-services basis.

For NASA and U.S. lunar scientists to avail themselves of this near-term American return to the Moon, Congress would need to appropriate the money to fund experiments and purchase of cargo services from us. So our top priority request to enable the next step in our NASA lunar partnership would be for NASA to have the money set aside to actually buy lunar delivery services from the commercial marketplace.

If NASA wants Moon Express to accelerate the development of our family of landers, and perhaps grow our capabilities beyond our initial plans, we are ready and able to ramp up our current Lunar CATALYST partnership. Given how far we have come with private investments and no-exchange-of-funds Space Act Agreements, some competitively-awarded cost-sharing would help justify accelerating our investments into growing our capabilities to offer low cost lunar mission services that would advance NASA's interests and serve the taxpayers well.

Throughout history, varying forms of public private partnerships have been an effective approach to opening a new frontier. Recently, U.S. implementation of Commercial Orbital Transportation Services (COTS), Commercial Resupply Services (CRS), and Commercial Crew Development (CCDev) programs have demonstrated that private sector entrepreneurial approaches and investments can help NASA dollars go farther. Given similar program commitments for lunar mission and cargo delivery services, we can invest in solutions to fit NASA's needs. As NASA continues to flesh out its plans for human exploration of cis-lunar space and eventually Mars, commercial companies like Moon Express can complement mainstream NASA efforts like Orion and SLS and a Deep Space Gateway.

THE BIG PICTURE: Strategic commercial partnerships supporting deep space and NASA astronauts

The challenge of securing humanity's future through our expansion into space and ultimately becoming a multi-world species is both necessary and noble. But it's not just about boldly going; it's about boldly staying. To go to space to stay, it has to pay. While NASA pushes the boundaries of human knowledge and experience to new frontiers, partnerships with the private sector can help ensure that the engines of human imagination and discovery that drive forward those new frontiers are augmented by the engines of entrepreneurship and commerce that help make them permanent.

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 the lunar frontier to national, international and private sector interests, and in so doing, setting the standards of a freedom of enterprise supporting a peaceful, prosperous and boundless future for all humanity. Other countries have aggressive lunar programs underway with declared goals of resource exploitation and settlement that could eclipse American leadership, opportunity and security.

It's been 45 years since the United States left the surface of the Moon to the legacy of Apollo and a generation past. Moon Express is working to reopen the American frontier on the Moon and redefine what is possible for new generations.

The American flag is returning to the surface of the Moon next year, not because of a government program, but because of private sector investments into low cost rockets and smart, low cost robotic explorers that are collapsing the cost of lunar access. Together we will begin a new democratized paradigm of lunar exploration and make the Moon accessible to other entrepreneurs.

We are at the cusp of a glorious adventure, an epoch of evolution into space perhaps as significant as the evolution of life from the oceans onto land. One day, not long from now, a new generation will look up and see lights on the Moon, and know that they are members of a mutiworld species.

For the last half century, the United States has led the world in magnificent robotic and human achievements in space. The opportunity is at hand to continue that leadership with a focused and committed American return the Moon, this time to stay.

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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