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**Before the Committee on Science, Space, & Technology
Subcommittee on Space & Aeronautics
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Chairwoman Horn, Ranking Member Babin, and distinguished members of the Subcommittee—thank you for inviting the Commercial Spaceflight Federation (CSF) to discuss our members’ views on the state of the U.S. commercial space industry. We appreciate the Subcommittee’s interest in exploring the commercial space landscape, and in developing policies that will allow the industry to keep expanding, innovating, and creating jobs. Given the increase in the cadence and diversity of U.S. launches, technological advances like reusability and networked smallsats, and the expanding scope of commercial space activities, this hearing is timely and necessary.

CSF is the leading national trade association for the commercial space industry, with more than 85 member companies and organizations across the United States. Founded in 2006, CSF is focused on laying the foundation for a sustainable space economy and democratizing access to space for scientists, students, civilians, and businesses. CSF members are responsible for the creation of thousands of high-tech domestic jobs driven by billions of dollars in investment. Through the promotion of technology innovation, CSF members are guiding the expansion of Earth’s economic sphere, bolstering U.S. leadership in aerospace, and inspiring America’s next generation of engineers, scientists, and explorers.

The United States established its leadership and dominance in space with government-funded and government-controlled space exploration. When President Eisenhower founded NASA and President Kennedy outlined a goal to send Americans to the Moon, there was no other choice; NASA literally had to invent whole new fields of technology, not just new hardware. The agency’s accomplishments are a marvel for the ages, progressing from sending an American into space for the first time in 1961 to landing a crew on the Moon just eight years later.

Thanks to Congress’ foresight and to NASA’s leadership, pathfinding, and partnerships with the private sector in the decades since, the United States is undergoing a renaissance in space, led by commercial enterprise. NASA has co-invested in private development, used its purchasing power to serve as an anchor customer, and enabled private companies to develop, own, and operate their own human spaceflight hardware to serve both public and private needs. Because of the agency’s partnerships with commercial industry, American companies today support critical space exploration and national security needs today, in addition to the commercial marketplace. And,

with this confidence in the market, investors have supported 476 private space companies with over \$22 billion of private capital since 2009 alone.¹ NASA is leveraging that private capital to deliver key capabilities at great savings to taxpayers.

As NASA continues to drive the frontier outward with groundbreaking research in space, the commercial sector is making space affordable and accessible. To be precise: commercial space is underpinned by pay-for-performance, fixed-price contracts, agile and innovative development processes, flexibility and some level of risk tolerance, private capital co-investment, and more intensive innovation. By contrast, commercial space is not about cost-plus contracting, staid solutions, or routine requirements creep.

We are in the defining moments of the next era of space exploration and development. As commercial industry continues to develop new technologies at an accelerated pace, it is critical that we work together to improve our policy environment to ensure continued U.S. leadership in space. Accordingly, I offer the following recommendations:

1. Streamline federal regulations.
2. Expand NASA's use of COTS-like partnerships with commercial industry in its Moon to Mars effort and other programs.
3. Support a smooth LEO commercialization process that grows the LEO market over the long term, rather than sacrificing long-term growth for short-term revenue from the private sector.

I expand on each of these recommendations in the sections below.

I. A Brief History of Commercial Space Policy

- In 1984, the Commercial Space Launch Act (CSLA) designated the Department of Transportation's (DOT) Office of Commercial Space Transportation (now FAA/AST) to encourage, facilitate, and license commercial expendable launch vehicle activities. CSLA set out statutory requirements for commercial space launch regulation and licensing. The Act defines the path for a commercial operator to receive a license if it meets defined requirements to surrounding public safety and safety of property, national security, and the foreign policy interests of the United States, but also that when they meet these requirements, the government shall issue them a license.
- In 1985, Congress updated the NASA Act of 1958 to specify that one of the agency's core missions is "[t]o seek and encourage, to the maximum extent possible, the fullest commercial use of space." This objective and the partnerships with industry that stemmed from it are a critical part of NASA's ongoing success in Earth orbit and beyond.
- In 1988, Congress amended the CSLA to establish the current third-party risk sharing regime between industry and the federal government. This "indemnification" regime represents a balance of protecting government and third parties from damage claims resulting from a failed launch, while also providing assurance to the industry, subject to appropriations. Indemnification allows companies to purchase reasonable insurance

¹Proprietary Data, Space Angels, Q2 2019 Space Investment Quarterly.

policies that protect the federal government and themselves while competing against state-sponsored launch providers around the world that do not purchase insurance. In the 31 years since indemnification became law, no FAA-licensed commercial launch or reentry has ever resulted in casualties or substantial property damage to third parties, and therefore the government has never been asked to seek appropriations to pay any excess third party liability claims.

- In 1992, the Congress enacted the Land Remote Sensing Policy Act, creating a framework for the National Oceanic and Atmospheric Administration’s (NOAA) licensing of commercial earth observation satellites.
- In 2000, Congress authorized in statute of the Office of Space Commerce within the Department of Commerce.
- The Commercial Space Launch Amendments Act (CSLAA) of 2004 further evolved space transportation regulations by defining suborbital launch systems, solidifying the process for licensing such vehicles, and allowing paying individuals to fly into space at their own risk. This legislation further ensured that FAA would continue its focus protecting public safety, while providing an extended period for the commercial spaceflight industry to innovate new approaches to human spaceflight without the fear of uninformed preemptive regulation to protect parties involved in the activity. Congress most recently extended this moratorium period in the Commercial Space Launch Competitiveness Act of 2015.

In addition, Democratic and Republican administrations have stressed the importance of the commercial space sector to the national interest. The current National Space Policy, issued by President Obama in 2010 and only slightly amended by Space Policy Directive 1 in 2017, directs the U.S. government to “purchase and use commercial space capabilities and services to the maximum practical extent,” “refrain from conducting United States Government space activities that preclude, discourage, or compete with U.S. commercial space activities, unless required by national security or public safety,” and “minimize, as much as possible, the regulatory burden for commercial space activities and ensure that the regulatory environment for licensing space activities is timely and responsive.”²

In 2018, Space Policy Directive 2 began an active process of modernizing decades-old regulations for both space launch and reentry and commercial remote sensing. Those efforts are still underway, but industry appreciates both the Administration’s and Congress’ efforts to improve our regulatory regimes.

II. America’s Commercial Space Sector Today

The United States is undergoing a renaissance in space, with commercial space enterprises playing a leading role. The commercial space industry’s recent major milestones include:

- Last year, U.S. commercial space companies achieved an unprecedented 32 licensed orbital and suborbital launches as well as 14 licensed reentries. SpaceX conducted the

² [Http://www.space.commerce.gov/policy/national-space-policy/](http://www.space.commerce.gov/policy/national-space-policy/)

- majority of those licensed activities, with 21 launches and 12 first stage landings. American commercial providers of medium-to-heavy lift launch services now represent a supermajority of global commercial launches each year.
- Over the past few years, there has been a surge of progress from dedicated small orbital class launch vehicles. In 2018, Rocket Lab conducted the first successful launch of its *Electron* rocket. Rocket Lab has already launched three more times in 2019, orbiting 35 satellites—including two for U.S. Special Operations Command. Relativity Space is building an autonomous rocket 3D printing factory in Mississippi, expanding capabilities at NASA’s Stennis Space Center. Vector Launch and Vox Space (a Virgin Orbit subsidiary) have been selected to compete for DARPA’s Launch Challenge. Virgin Orbit has completed several captive carries and one drop test of its LauncherOne vehicle with a 747 aircraft in preparation for launches to space in the near future.
 - This growing demand has spurred the growth or emergence of commercial spaceports across the country, including Mid-Atlantic Regional Spaceport in Virginia, the Mojave Air and Space Port in California, Spaceport America in New Mexico, Colorado Air & Space Port, Camden County Spaceport in Georgia, and Space Florida’s facilities at Cape Canaveral and NASA/KSC.
 - A growing number of companies are restoring and expanding America’s human spaceflight capabilities. This year SpaceX—in close partnership with NASA—will launch American astronauts to space on an all-American system, ending the country’s drought in orbital human spaceflight capability left by the retirement of the Space Shuttle in 2011. Already, SpaceX and NASA conducted a successful flight qualification mission of the Crew Dragon spacecraft in March. Virgin Galactic successfully launched three spaceflight participants on its spacecraft—SpaceShipTwo—into space for the first time, reaching an apogee of 51.4 miles. Blue Origin has conducted a series of uncrewed suborbital test flights on its New Shepard vehicle and plans to conduct a crewed flight with crew soon. Both companies plan to fly spaceflight participants to space for revenue by the end of the year.
 - American companies continue to make significant progress commercializing the International Space Station (ISS) and LEO.
 - Sierra Nevada Corporation’s (SNC) Dream Chaser spacecraft—in an uncrewed cargo configuration—passed a key milestone in its development to be the third commercial cargo vehicle for the International Space Station.
 - NanoRacks is the largest private investor in the ISS, investing over \$40 million to date. They have supported more than 800 payloads on the ISS to-date and has deployed over 230 cubesats through their commercially developed dispenser, in coordination with NASA. The company is also building the first-ever commercial airlock, which is manifested to launch on SpaceX-21, and planned to be operational within weeks of launch.
 - The ISS National Lab has facilitated more than \$150 million in external, non-NASA funding to support the full ISS National Lab portfolio—a 50 percent increase in FY18.
 - Axiom, Bigelow Aerospace, and NanoRacks are developing commercial space habitats, and each has made major technical progress over the past year.
 - Made In Space, TechShot, and Space Tango continued to demonstrate additive manufacturing and other valuable commercial applications in microgravity.
 - Planet, Blacksky, and Maxar Technologies deployed dozens of new commercial remote sensing satellites to orbit.

- Southwest Research Institute (SwRI), University of Colorado Boulder, and Maxar Technologies were selected by NASA to build three new lunar science and technology payloads to fly on future flights through NASA’s Commercial Lunar Payload Services (CLPS) project. NASA selected three commercial Moon landing service providers that will deliver science and technology payloads under CLPS as part of the Artemis program.
- The first licensed flights to space of two American suborbital reusable launch vehicles: Blue Origin’s New Shepard and Virgin Galactic’s SpaceShipTwo. I emphasize the word licensed, because a license allows the company to earn revenue from the flight, unlike an experimental permit.
- World View performed its longest flight to date of its stratospheric balloon, demonstrating its ability to carry out missions traditionally reserved for satellites.
- And, in May, NASA has entered into partnerships with 11 companies—including CSF members Blue Origin, SpaceX, Sierra Nevada, and Maxar Technologies—to conduct advance development on human lunar lander concepts.

These recent achievements are just a few of many by the commercial spaceflight industry, and they set the stage for even greater accomplishments the rest of this year and beyond for a broad set of stakeholders.

III. Regulatory Framework

Launch and Reentry Regulatory Reform

Today’s increasing rates of launches and reentries, together with innovative operations and continued industry diversification, are bringing to light new non-technical challenges. The first of these is the obsolete, burdensome, and duplicative body of regulations for launch and reentry. Today’s rules were mostly crafted in the 1980s and 1990s, and they take a very narrow, prescriptive approach that does not support innovation in technology and operations, including changes that improve safety, efficiency and mission capacity.

Thanks to Space Policy Directive 2, last year the Federal Aviation Administration (FAA) Office of Commercial Space Transportation (AST) undertook an important and significant effort to revise its commercial space launch and reentry regulations. Last March an Aviation Rulemaking Committee (ARC) was chartered on Streamlined Launch and Reentry Licensing Requirements. This was an important step, because many industry experts believe that the best way to rewrite these regulations would be via a negotiated rulemaking. Unfortunately, the FAA only gave the ARC about 40 days to do its work, and then ignored the draft regulatory outline a majority of ARC members endorsed.

Ten months later, the FAA released its Notice of Proposed Rulemaking (NPRM), which is still open for public comment. The objectives for the NPRM were outlined in Presidential Space Policy Directive No. 2 (SPD-2). It stated, in relevant part:

The Secretary of Transportation shall consider the following:

- (i) requiring a single license for all types of commercial space flight launch and re-entry operations; and

(ii) replacing prescriptive requirements in the commercial space flight launch and re-entry licensing process with performance-based criteria.

Importantly, neither SPD-2 nor the resulting NPRM has changed the level of public safety required for spaceflight activities. Nobody in industry (or government) is asking for a lower level of safety. The goal of SPD-2 and the NPRM is only to streamline the regulatory process and create a performance-based approach to regulating an innovative, evolving industry while encouraging it to become even safer.

We compliment the FAA for getting the proposed rule out fairly quickly, delayed only by the government shutdown. Unfortunately, instead of a giant leap forward, the FAA seems to have taken at best only a cautious half-step towards the regulatory regime America needs to enable the growth and diversity of new space transportation providers and their current and prospective users. The 580-page NPRM, plus over a thousand pages of supporting documents, is very complex and frequently confusing. It references several future Advisory Circulars which might explain some of the regulatory text, but these were not provided. Its preamble includes many of the right goals, but the actual proposed regulations do not achieve them. Worst of all, inputs that reflected the consensus position of a majority of the ARC's members were not included; indeed they were disregarded and the NPRM falsely claims they had only minority support.

Most current and prospective American commercial space licensees have determined that the FAA's NPRM is a regression from today's problematic regulations. As such, the Commercial Spaceflight Federation, and other entrepreneurial companies we have talked with, support the development of a Supplemental Notice of Proposed Rulemaking, and the active use by the DOT of many available appropriate mechanisms for interaction with stakeholders in developing this revised draft set of rules.

- **The NPRM is not performance-based.** Stakeholders recommended setting a performance level that would be supported by guidance documents (i.e. Advisory Circulars) that provide means of compliance that can be easily tailored to a diverse set of vehicles and operations. Instead, the NPRM includes highly-prescriptive requirements, such as for software and flight termination systems, that may undermine industry efforts to implement innovative approaches to improve safety.
- **The NPRM adds burdens and cost.** It contains a number of new regulations and requirements that do not appear to replace existing rules, but will increase the cost and effort necessary to comply rather than reduce and streamline the process - all without improving safety.
- **The NPRM is confusing and relies on missing documents.** Stakeholders have already highlighted in public comment dozens of areas where the rule lacks adequate clarity, supporting information (i.e. guidance documents), cost analysis, and adequate justification of new prescriptive regulatory requirements.
- **The NPRM lacks flexibility.** The rule misses the mark on allowing an applicant to work with the FAA to "tailor" the requirements to specific programs or to allow for new technology. The agency's approach risks being quickly outdated and discouraging innovation.

- **The NPRM is anti-competitive.** Technical requirements lack the clarity for even experienced launch operators to understand their purpose, while new and prescriptive requirements favor experienced operators to the detriment of new entrants. The NPRM also discourages operations from USG Ranges, thereby favoring operators who locate elsewhere, including outside the U.S.
- **The NPRM attempts to “fix” things that were not broken.** The NPRM’s collision avoidance analysis process does not work with the current Air Force practice. This is one of many examples where the FAA’s proposed rule conflicts with parts of the current licensing process that function effectively.

Historically, AST’s regulations have been very specific and prescriptive.. The rules for expendable rockets were written that way partly because they were based on, or referenced, the Air Force’s detailed safety procedures at the federal ranges, which go back to the days of the earliest ballistic missiles. But those same range rules are tailorable to the specific vehicle and mission proposed by a range user, while FAA regulations are not. As published, the NPRM creates active conflict between the FAA’s rules and the Air Force’s practices.

On the other hand, the regulations written in 2005 for reusable vehicles instead examines the safety of the launch or reentry system as a whole, independent of the specific technologies or operations concepts proposed. Whereas in 2017 and 2018 industry asked the FAA to expand on the performance-based reusable rules and provide guidance for different kinds of vehicles (e.g. expendable vs. reusable) – which would allow the current expendable rules to become guidance, and therefore not burden existing licensees – it appears that the FAA attempted to merge the prescriptive expendable and the reusable rules together, creating the flawed draft we have today.

The Administration’s eagerness to advance this regulatory reform process is greatly appreciated; however, the FAA must prioritize substance over speed and respond to stakeholder’s requests for significant revisions with a Supplemental NPRM. The FAA should take the time to interactively engage with stakeholders so they understand why this draft rule is such a disappointment before they publish a second draft. With a little time, and a lot of two-way communication, this reform effort can still create a regulatory regime that will keep our commercial space transportation industry on a safe and successful trajectory.

Remote Sensing Reform

Commercial Remote Sensing was born in the U.S. just as we were coming out of the Cold War, and the law and regulations the industry lives under were written with that mindset. Even so, the government all-too-often fails to live up to even those rules. In some cases, the government has taken years to respond, or has even never responded, to applications to use an innovative sensor, to improve available resolution, or sell data to a particular nation. Here, both the underlying statute and regulations need to be massively revised so that the government’s actions are appropriate and transparent. CSF’s members strongly support the approach taken by this Committee in 2017 with HR2809, the American Space Commerce Free Enterprise Act.

At the same time, we commend NOAA for not only issuing an initial set of proposed reforms to current remote sensing regulations, but for actively listening to industry, and in particular its Federal Advisory Committee, the Advisory Committee on Commercial Remote Sensing (ACCRoS). With that said, the proposed rules by the Department of Commerce fails to address issues that would ensure U.S. leadership. For example:

- License requests can take months or years to approve, and there is little transparency into the decision making process.
- Current regulations allow for retroactive changes, creating uncertainty for U.S. companies.
- American firms must wait months for government approval to enter into large foreign imagery sales agreements, which results in a competitive disadvantage.

Not only does the NPRM not address current issues, but increases regulation and bureaucratic reporting. This is a step backwards for the industry.

Non-traditional Commerce

Finally, it's time for the federal government to create a minimalist process for approving new commercial space activities by U.S. companies that go beyond launch and reentry, telecommunications, and remote sensing. Again, HR 2809 provides a narrowly-tailored approach to government oversight of those activities, which is why CSF has repeatedly endorsed its passage.

IV. A Sustainable Deep Space Exploration Program

To ensure a sustainable, long-term civil space exploration portfolio that includes the Moon and Mars, the United States must further leverage the capabilities offered by the commercial space sector, including commercial heavy lift launch vehicles, the development of capable landers, the operation of robust deep space habitats and communications facilities, and routine transportation of astronauts and large cargo.

As this Subcommittee looks at how best to ensure the country's ongoing leadership in space, it must carefully review development and acquisition efforts to ensure responsible use of taxpayer dollars and to encourage, rather than hamper, rapid innovation. Specifically, public-private partnerships represent the most rapid and cost-effective path to expand the market in LEO and to develop and operate some elements of the exploration architecture to return to the Moon.

In these partnerships, NASA outlines high-level mission objectives and safety requirements, but does not dictate system designs. Companies are required to compete for awards and to self-invest; and they are paid on a fixed-price basis only upon achieving milestones. Further, these industry-led partnerships allow NASA to be one customer of many, stimulating a vibrant, commercial lunar economy. Already, due in part to the stability to the market that NASA brings

as a customer, numerous private companies are developing lunar systems and signing commercial business with customers around the world.

The Subcommittee should consider the Commercial Cargo program and its development effort—Commercial Orbital Transportation Services (COTS)—as the ideal model as it looks to structure its lunar lander and habitat programs. Specifically, a COTS-like program would:

- **Establish high-level requirements and encourage companies to execute against them** with creative, innovative, and cost-effective solutions, reducing “requirements creep” and encouraging new thinking. The COTS program required companies to meet a clear set of established safety and interface ISS requirements and high-level milestone requirements, rather than implementing overly-specified and ever-changing detailed Government requirements. This requires the Government customer to tell companies what they need to be done, rather than prescribing how to do it.
- **Use firm, fixed-priced, pay-for-performance, milestone based agreements or contracts**, creating proper incentives on the companies to execute toward successful conclusion, and discourage continuous Government requirement changes that add costs and delay schedules. Pay-for-performance creates proper incentives on both sides of the Government/company relationship.
- **Maximize competition**, which is critical to drive value and performance, and improve quality of service to the customer.
- **Require a significant private capital contribution to the overall program.** The COTS agreements required commercial partners to share costs and provide a significant percentage of the overall total investment, resulting in lower costs to the Government and high incentives for commercial firms to drive toward operational success to generate revenue and recoup their investment.
- **Tolerate programmatic risk, and allow easy termination for failure.** The flexibility to terminate contracts and rapidly “stop the bleeding” on non-functional programs is one that is largely lost when applied to traditional FAR-based contracts.
- **Encourage new, non-traditional companies to work with NASA.** Due to the complexity and cost associated with conforming to traditional FAR-based contract requirements, start-up companies with small teams and less experience interfacing with the complex regulatory and contractual environment associated with U.S. Government are often deterred from participating at all. As a result, the Government is often not at the cutting edge of new commercial technology offerings. The use of COTS-like contracts can help enable such firms to do business with the Government.
- **Facilitate the development of new markets**, and leverage market-driven pricing to support U.S. Government requirements and missions.

By even the most conservative independent evaluation, the COTS Commercial Cargo public-private partnership saved the agency hundreds of millions of dollars and allowed NASA to redirect those savings towards funding its other priorities, including earth observation and deep space exploration.

Numerous independent reviews of the program have repeatedly praised this partnership for its significant savings for the taxpayer. In August 2011, NASA, using the NASA-Air Force Cost Model (NAFCOM), determined that had the agency saved between \$1 billion and almost \$4 billion by using the COTS model as compared to a traditional procurement approach.

A 2014 NASA report further praised the program's use of innovative, flexible Space Act Agreement (SAA) development arrangements: "[b]ecause these were partnerships, not traditional contracts, NASA leveraged its \$800M COTS program budget [for both providers combined] with partner funds. This resulted in two new U.S. medium-class launch vehicles and two automated cargo spacecraft and demonstrated the efficiency of such partnerships."³ A 2017 NASA Cost Analysis review was more direct: "the COTS development and later the operational Commercial Resupply Services (CRS) are significant advances in affordability by any measure."⁴ Simply put, this approach works. That is why NASA is using a similar approach to the Power and Propulsion Element for Gateway.

Not only must NASA plan prudently to save money, it likely must also anticipate and plan for funding levels below its requests to Congress, due to budget issues entirely unrelated to the agency. Indeed, it appears that NASA is already anticipating and planning for such a scenario. When faced with budget shortfalls, NASA often attempts to make up for the shortfalls by: 1) cannibalizing one part of the agency to pay for another part of the agency; and 2) deferring, de-scoping, or discontinuing lower priority programs and activities within agency. Both options are demonstratively bad choices and lead to even worse results for the agency – undermining support for the Moon initiative, destabilizing other programs and missions, and leading to increased costs and schedule delays across the agency.⁵ Rather than risks this all-but-guaranteed outcome, Congress should direct NASA to opt for a third option – public-private partnerships.

True commercial partnerships for development and operation of some elements of the exploration architecture represent the most rapid and cost-effective path to return to the Moon. Pay-for-performance creates the proper incentives on both sides of the Government/company relationship. Here, the GAO has reported: "[f]irm-fixed-price contracts place the onus on the contractor to provide the deliverable at the time, place, and price negotiated by the contractor and the government. In addition, firm-fixed-price contracts place the maximum risk on the contractor as well as full responsibility for all costs and any resulting profit or loss."⁶

It is now time for the United States to advance its national space exploration program. To do so, CSF recommends the following:

³ NASA, "Commercial Orbital Transportation Services: A New Era in Spaceflight," February 2014. Available at: <https://www.nasa.gov/sites/default/files/files/SP-2014-617.pdf>

⁴ Zapata, Edgar. An Assessment of Cost Improvements in the NASA COTS/CRS Program and Implications for Future NASA Missions. American Institute of Aeronautics and Astronautics, 23 Oct. 2017, <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170008895.pdf>, pp. 1.

⁵ NASA Office of Inspector General, "NASA Cost and Schedule Overruns: Acquisitions and Program Management Challenges", June 2018. Available at: <https://oig.nasa.gov/docs/CT-18-002.pdf>

⁶ Government Accountability Office, "NASA: Acquisition Approach for Commercial Crew Transportation Includes Good Practices, but Faces Significant Challenges," December 2011, (GAO-12-282). Available at: <http://www.gao.gov/assets/590/587021.pdf>.

1. **Use flexible development agreements like SAAs** for development activities and firm, fixed-price contracts for services;
2. **Focus procurement approaches and requirements on an outcome-oriented integrated commercial service** rather than a government owned or operated systems;
3. **Use competitively awarded, firm, fixed-price contracts** with payment for meaningful deliverables and milestones, not just for effort;
4. **Maintain competition throughout programs.** Two or more companies should proceed through the flight demonstration phase for each program element and into follow-on service phase;
5. **Eliminate Cost Accounting Standards (CAS) when there is competition and fixed price contracting.** CAS degrades speed and adds costs without improving contract performance. Fixed-price milestone contracts place risk on the contractor for costs and schedule, obviating the need for cost reporting elements. Cost Accounting Standards also serves as a barrier to entry for non-traditional firms, artificially limiting the competitive pool; and
6. **Mirror commercial terms and conditions to the maximum extent.** Eliminate all other FAR-derived provisions that are not essential to incentivizing the core outcome.

V. Support a smooth LEO industrialization and commercialization process that grows the LEO market

As this Subcommittee looks to how best ensure the country's ongoing leadership in space, it must carefully review commercial LEO efforts to ensure responsible use of finite taxpayer dollars and to encourage, rather than hamper, rapid innovation.

Last month, NASA released guidance for its Low Earth Orbit Economy initiative. These plans and policies include pricing for facilities and resources that may be accessed on a reimbursable basis by commercial entities onboard the ISS; an announcement of opportunity and associated costs to fly private astronauts; calling for proposals on opportunities to stimulate demand, a commercial use policy for the ISS, and other initiatives. CSF commends Administrator Jim Bridenstine and the entire NASA team for recognizing the success of the commercial industry, incorporating best practices learned from the agency's years of partnership with private companies, and updating its strategic objectives to accelerate additional development of these important capabilities.

As NASA works to implement its Low Earth Orbit Economy initiative and expand human presence in space, CSF recommends the following:

- Encourage NASA to adopt the best elements of its successful efforts to commercialize space, such as the Commercial Orbital Transportation Services (COTS) program and the Commercial Crew program. Whereas traditional cost-plus contracts can perversely incentivize companies to run over budget and behind schedule, NASA properly structured its commercial partnerships to develop new space capabilities at a rapid pace by implementing milestone-based agreements for development and firm-fixed-price contracting for services.
 - The COTS Program to develop uncrewed cargo resupply capabilities has been a clear success for NASA. A 2017 NASA Cost Analysis review of the program

was direct in its assessment of the benefits of true public-private partnerships: “the COTS development and later the operational Commercial Resupply Services (CRS) are significant advances in affordability by any measure.”⁷

- NASA’s Aerospace Safety Advisory Panel (ASAP), the most conservative and safety-focused group within the agency, identified the commercial, competitive structure used under the Commercial Crew program as a preferred model for NASA’s future development activities⁸ for human spaceflight systems, particularly in NASA’s return to the Moon.
- Maintain competition throughout a program’s life, instead of just during the bidding process, to encourage ongoing innovation and cost-reduction. Multiple operational providers also offer redundant capabilities to assure NASA’s access to space in the event of delays or technical challenges with one system.
- Support the full and complete utilization of the ISS through at least 2028, and a timely, seamless transition process towards commercial space stations to ensure that the United States maintains a continuous crewed presence in LEO. Continued industrial research and development activities on the ISS in the immediate term will identify new markets or new applications in space and inform future platform development.
- One of the most important things that the Government can do for the LEO economy is to provide certainty and predictability in the LEO marketplace by developing and communicating a clear plan for the transition to commercial systems. It also means that if NASA is going to charge for ISS-related services, those prices should change infrequently and with substantial advance notice. Above all, NASA must resist the temptation to try to make money now, at the expense of future LEO market expansion: this would be the very definition of “killing the goose that lays the golden eggs.” The ISS was created for non-economic reasons, and it should not now have to be justified entirely on its near-term economic value.
- Regularly engage with industry to understand and continually incorporate new commercial capabilities as they evolve, as opposed to requesting that business fit into solely within NASA’s plans.
- Support uses of the ISS that are based on scalable business models, and then support the scale-up of those models with consistent and plentiful access to upmass, operations, and downmass.
- Invest in “proof of potential” payloads and business models to identify potential markets for LEO commercialization.
- Grant users complete control over intellectual property developed on the ISS.
- Avoid competition with private industry. Simply put, the domestic commercial industry will not mature if the world’s largest and best funded space agency is competing with it. As a key example, NASA should not provide “free” space transportation to countries that are not already participants in the ISS program. These countries would otherwise commercially procure seats to space for their astronauts on American suborbital and orbital spaceflight systems.
- Support the increased use of ISS as a destination for private astronauts, as well as support for new commercial LEO platforms.
- Stress the importance of short-duration, “sortie” missions to the ISS. These missions, lasting one to two weeks in length, offer NASA the opportunity to conduct more frequent

⁷ Zapata, Edgar. An Assessment of Cost Improvements in the NASA COTS/CRS Program and Implications for Future NASA Missions. American Institute of Aeronautics and Astronautics, 23 Oct. 2017, <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170008895.pdf>, pp. 1.

⁸ <https://spacenews.com/safety-panel-calls-on-nasa-to-apply-commercial-crew-lessons-for-artemis/>.

- missions to space, promising greater scientific discovery and more opportunities for the astronaut corps to go to space than the current six month rotation missions allow. To reduce costs to the taxpayer, NASA should purchase seats on commercial missions to ISS to allow for a mixed NASA / commercial crew on these missions. Not only would this mission architecture better support NASA's objectives, it would also support the development of a marketplace for private passenger transportation to space.
- Establish a national microgravity policy initiative, informed by a Microgravity Decadal Survey. Microgravity research will stimulate the next technological and economic changes for the United States. As policy has recognized the importance of investment in artificial intelligence, similar policy needs to be established should foster the pursuit of innovation, technology development, and discovery where public.
 - Microgravity Decadal Survey – microgravity research and development is critical to American leadership, discovery, exploration, and the development of the space economy. NASA, the National Science Foundation (NSF), and the National Institute of Health (NIH), should jointly fund the National Academies of Sciences, Engineering, and Medicine to carry out a microgravity decadal survey.
 - Enhance utilization of the Flight Opportunities Program (FOP) for suborbital microgravity research. The Flight Opportunities Program enables low-cost access to environments where cutting edge research and development can be conducted. The Flight Opportunities Program is a key component of a microgravity R&D pipeline that contributes to the development of a robust low Earth orbit ecosystem. This pipeline can be strengthened by broadening the Flight Opportunities Program user community to include universities and academia, by allowing basic and applied science payloads to fly in addition to technology development payloads, and by enabling principal investigators (PIs) to fly alongside and tend to their payloads during flight.
 - Assume a long-term view of LEO commercialization and avoid “taxing” early commercial efforts as a means to fund ISS operations or deep space in the short term.

VI. Conclusion

These are exciting times in spaceflight. We should all be proud of what the American space enterprise—both the Government and the private sector—is achieving. The challenges we face to achieve our goals today are not small, but we have the ability and opportunity to address them in a thoughtful and impactful manner given Congress' and the Administration's support.

We are ready to take the next steps to expand America's commercial sphere of influence from the edge of space, to the Moon, Mars, and beyond, and we look forward to continuing to work together to advance the United States' leadership in space. Chairwoman Horn, Ranking Member Babin, I appreciate your invitation to testify before the Subcommittee today. Thank you for your attention, and I look forward to your questions.