THE COMMERCIAL SPACE LAUNCH INDUSTRY: SMALL SATELLITE OPPORTUNITIES AND CHALLENGES

HEARING BEFORE THE SUBCOMMITTEE ON SPACE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY HOUSE OF REPRESENTATIVES ONE HUNDRED FOURTEENTH CONGRESS SECOND SESSION April 19, 2016 Serial No. 114–73

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THE COMMERCIAL SPACE LAUNCH INDUSTRY: SMALL SATELLITE OPPORTUNITIES AND CHALLENGES

TUESDAY, APRIL 19, 2016

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

The Subcommittee met, pursuant to call, at 10:02 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Brian Babin [Chairman of the Subcommittee] presiding.
The Commercial Space Launch Industry: Small Satellite Opportunities and Challenges

Tuesday, April 19, 2016
10:00 a.m.
2318 Rayburn House Office Building

Witness

Mr. Elliot Pulham, Chief Executive Officer, Space Foundation
Mr. Eric Stallmer, President, Commercial Spaceflight Federation (CSF)
The Commercial Space Launch Industry: Small Satellite Opportunities and Challenges

HEARING CHARTER

Tuesday, April 19, 2016
10:00 a.m.
2318 Rayburn House Office Building

Purpose

The Subcommittee on Space will hold a hearing titled The Commercial Space Launch Industry: Small Satellite Opportunities and Challenges on Tuesday, April 19, 2016, at 10:00 a.m. in Room 2318 Rayburn House Office Building. The purpose of this hearing is to examine the current state of the small satellite commercial launch industry.

Witnesses

- Mr. Elliot Pulham, Chief Executive Officer, Space Foundation
- Mr. Eric Stallmer, President, Commercial Spaceflight Federation (CSF)

Background

Origins of the U.S. Commercial Space Launch Industry

Between 1963 and 1982, U.S. expendable launch vehicle (ELV) manufacturers produced vehicles only under contract to the National Aeronautics and Space Administration (NASA) or the Department of Defense (DOD). In the early 1970s, when private companies and foreign governments purchased communications satellites, they had to contract with NASA to launch their payloads. Through NASA, launches could be procured on any one of four ELVs: Titan, built by Martin Marietta; Atlas, built by General Dynamics; Delta, built by McDonnell Douglas; and Scout, built by LTV Aerospace Corporation. NASA would purchase a launch vehicle through traditional government procurement practices, and the launch would be conducted by a private-sector contractor under NASA supervision. The U.S. government essentially served as the only provider of space launch services to the Western world. Seeing an opportunity to provide launch services, the European Space Agency developed its own ELV, Ariane, which became the first competitor to NASA for commercial launches. The first Ariane

In the late 1970s, the U.S. government decided to phase out all ELVs, except Scout, in favor of the U.S. space shuttle. The shuttle would take all U.S. government satellites, as well as commercial satellites, into orbit. NASA declared the shuttle, which made its first flight in 1981, operational in 1982, and government funding of ELV production ceased in 1983. It quickly became evident, however, that the flight schedule of the shuttle could not meet all of the U.S. security, civil, and commercial launch requirements. The need grew for more launches than NASA could handle, some launch vehicle manufacturers expressed interest in offering commercial launch services. In 1982, the first successful private launch in the United States took place—a test launch of the Space Services’ prototype Conestoga rocket. The procedures required to gain approval for that launch, however, proved time-consuming and led to the introduction of legislation to make it easier for companies to pursue commercial launch activities. A bill (HR 1011) introduced in the House by Congressman Daniel Akaka (D-HI) would have designated the Department of Commerce as lead agency, while the Senate bill (S 560), introduced by Ernest “Fritz” Hollings (D-SC), intended to give the lead role to the Federal Aviation Administration (FAA). Others suggested the lead go to the Department of State or NASA. While Congress debated the efficacy of its legislation, on July 4, 1982, President Ronald Reagan issued national security decision directive (NSDD) 42, “National Space Policy,” stating that expansion of U.S. private sector involvement in civil space activities was a national goal.

On May 16, 1983, the President issued NSDD 94, “Commercialization of Expendable Launch Vehicles.” This stated the “U.S. Government fully endorses and will facilitate the commercialization of U.S. Expendable Launch Vehicles. The U.S. Government will license, supervise, and/or regulate U.S. commercial ELV operations only to the extent required to meet its national and international obligations and to ensure public safety.” Congress affirmed and expanded these actions through the Commercial Space Launch Act, enacted on October 30, 1984. This legislation addressed three substantive areas: licensing and regulation; liability insurance requirements; and access of private launch companies to government facilities.

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3 During this time, there was also considerable objection to what was seen as a NASA monopoly on the commercial launch market. For more see the June 20, 1984 paper by Milton Copulos, “The Perils of a NASA Space Monopoly,” published by the Heritage Foundation. Retrieved at: http://www.heritage.org/research/reports/1984/06/the-perils-of-a-nasa-space-monopoly. (Last Accessed on April 4th, 2016).


5 A copy of the Commercial Space Launch Act (P.L. 98-575) can be found at: https://www.gpo.gov/fdsys/pkg/STATUTE-98/pdf/STATUTE-98-Pg3855.pdf.
State of the Commercial Space Launch Industry Today

Since the passage of the Commercial Space Launch Act (P.L. 98-575) in 1984, global commercial space launch services are estimated to account for about $6 billion in annual revenue. Most of this launch activity is presumed captive; that is, the most payload operators have existing agreements with launch service providers or do not otherwise “shop around” for a launch. About a third of this $6 billion represents internationally competed, or commercial, transactions. In 2014, U.S. launch service providers accounted for about $2.4 billion in total revenues or 41 percent of global launch services. In 2014, the FAA Office of Commercial Space Transportation licensed launches accounted for $617 million of the $2.4 billion. Globally, the commercial space launch industry revenue is experiencing growth, estimated at 9 percent growth in 2015 as compared to 2014, in part due to higher numbers of European and U.S. launches of commercial satellites.

NASA’s Relationship with the Commercial Space Launch Industry

NASA’s Launch Services Program

The Launch Services Program (LSP) was established at Kennedy Space Center for NASA’s acquisition and program management of expendable launch vehicle (ELV) missions. The principal objectives of the LSP are to provide safe, reliable, cost-effective and on schedule launch services for NASA and NASA-sponsored payloads seeking launch on ELVs. The Launch Services Program is responsible for NASA oversight of the launch service including launch vehicle engineering and manufacturing, launch operations and countdown management, and providing added quality and mission assurance in lieu of the requirement for the launch service provider to obtain a commercial launch license. Since 1990, NASA has purchased ELV launch services directly from commercial providers for its missions. In September 2010, NASA’s Launch Services (NLS) contract was extended by the agency for 10 years, through 2020, with the award of four indefinite delivery/indefinite quantity contracts to United Launch Alliance (ULA), Space Exploration Technologies (SpaceX), Orbital Sciences Corporation (now Orbital ATK), and Lockheed Martin Space Systems. Part of LSP’s duties include managing the Venture Class Launch Services (VCLS) contracts. NASA’s Venture class missions are small- to medium-sized missions that can be designed, built,
and launched in a short period of time. NASA explains the VCLS contract as "a Firm-Fixed Price contract for a dedicated launch service for U-Class satellites with NASA having sole responsibility for the payload on the launch vehicle. NASA’s LSP supports the CubeSat Launch Initiative (CSLI) by providing launch opportunities for CubeSats that are currently on the manifest backlog."14

For example, in October 2015, the LSP awarded multiple VCLS contracts to provide small satellites (also called SmallSats, CubeSats, microsats and nanosatellites) access to low-Earth orbit. The launch-provider companies and the value of their NASA contracts are listed below:

- Firefly Space Systems Inc. of Cedar Park, Texas, $5.5 million
- Rocket Lab USA Inc. of Los Angeles, California, $6.9 million
- Virgin Galactic LLC of Long Beach, California, $4.7 million

According to NASA, "LSP is attempting to foster commercial launch services dedicated to transporting smaller payloads into orbit as an alternative to the rideshare approach and to promote the continued development of the U.S. commercial space transportation industry... VCLS is intended to help open the door for future dedicated opportunities to launch CubeSats and other small satellites and science missions."15

Commercial Crew and Cargo

Commercial Crew: Currently, the Russian Space Agency, Roscosmos, provides crew transportation to the International Space Station (ISS). This contract is worth $490 million through 2018.16 However, NASA is funding U.S. private sector development of crew transportation capabilities to the ISS on domestic launches that can then be procured on a fixed price contract after certification by NASA.17 NASA hopes to demonstrate this capability in 2017.

NASA awarded contracts to two of the final competitors in the Commercial Crew Program, the Boeing Company (Boeing) and SpaceX. The final phase of the program, Commercial Crew Transportation Capability (CCTC) provides significant government funding to finalize designs, test various elements, and certify each of the crew systems. The firm-fixed price contract guarantees each company at least two flights to the ISS and as many as six for a total of 12

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possible flights. The potential contract value is $4.2 billion for Boeing and $2.6 billion for SpaceX. 18

Commercial Cargo- NASA began funding commercial space transportation services to the ISS in 2006 by funding multiple companies to develop systems for transporting cargo to the ISS with an eye towards eventually having multiple carriers compete for the resupply contract. This was accomplished through the Commercial Orbital Transportation Services (COTS) and Cargo Resupply Services (CRS) programs. NASA purchases cargo transportation to the ISS under the CRS contracts with Orbital ATK and SpaceX and under the CRS2 contract with Orbital ATK, Sierra Nevada, and SpaceX. 19

In 2008, NASA signed two CRS contracts. The original SpaceX contract was valued at $1.6 billion for 12 missions and the Orbital Sciences contract was valued at $1.9 billion for 8 missions. Through contract extensions, NASA has since awarded SpaceX eight additional and Orbital-ATK two additional space station cargo-supply missions. While the SpaceX contract includes a down-mass capability (returns cargo to Earth), Orbital ATK’s Cygnus spacecraft (like the European Space Agency’s ATV or the Japanese Space Agency’s HTV) has no down-mass capability (by design). In January, 2016, NASA awarded the CRS-2 contracts to SpaceX, Orbital ATK, and Sierra Nevada Corporation. The CRS-2 awardees are to each fly at least six cargo missions, between 2019 and 2024.20

Commercial Launch Market Demand

The Federal Aviation Administration’s Commercial Space Transportation Forecast is published every year by the FAA’s Commercial Space Transportation (AST) office and the Commercial Space Transportation Advisory Committee (COMSTAC). In the April 2015 publication, COMSTAC predicts a “healthy” demand for commercial launch services to geostationary orbit. It projects that the number of commercial launches to geostationary orbit will be 17 launches in 2015 and 18 launches in 2017. The report only forecasts up to 2017 for commercial geostationary launches due to realignment of issuance dates of the report.

For non-geostationary orbit (NGSO) launches, the report predicts a global average of 13.1 launches per year over the next ten years. It forecasts a peak of 19 launches in 2016 due to completion of the Iridium constellation. Once complete, launches will decline to 10-11 per year.21

The report takes into account an expected jump in small satellite constellations to be launched in the coming years. "From 2015 – 2018 the report forecasts a number of small commercial satellites to be launched as Iridium, ORBCOMM, Planet Labs, and Skybox all deploy their constellations." 22

Table 1: NGSO Launch History and Projected Plans

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<td>18</td>
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<td>22</td>
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<td>42</td>
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<td>48</td>
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</tbody>
</table>

Source: FAA, "2015 Commercial Space Transportation Forecasts."

Commercial Telecommunications and Earth Observation Services Demand

Launch service revenue derived from private sector customers is dominated by commercial telecommunication satellites, but there are an increasing number of commercial Earth observation satellites purchasing launch services. To put the respective size of the telecommunication and Earth observation services sector in perspective: mobile, fixed, and consumer telecommunication satellite servicing revenues account for 98.5 percent of global satellite services ($121.3 billion), with the remaining 1.5 percent derived from commercial Earth observation ($1.6 billion). 23

According to the Satellite Industry Association’s "2015 State of the Satellite Industry Report," Earth observation services grew by 9 percent and mobile satellite services grew by 25 percent in 2014. 24 The major growth in mobile satellite services, according to the report, is due to an increase in data services for aviation customers. Overall, satellite services reported a growth of 4 percent in 2014. In the same year, the launch industry grew by 9 percent as a result of more European and U.S. commercial satellite launches than in 2013. 25

22 Ibid., 3.
24 Ibid., 13.
25 Ibid., 9.
Small Satellite Demand

Technological advances in computer hardware and sensors allow satellite manufactures to put more capabilities in smaller spacecraft. Small satellites are generally considered those that weigh less than 500 kilograms. Due to their size and low mass, it is much easier to build and launch small satellites than larger satellites. The drawback of small satellites is that they usually do not have the same capabilities as larger satellites. Also, due to the relatively low orbit at which they are deployed, small satellites encounter more atmospheric drag and do not stay in orbit for as long as satellites in higher—like geosynchronous—orbits. On the other hand, constellations of small satellites can be launched more frequently and their hardware can be updated more often. Some estimates have suggested that over the past decade $2.5 billion has been invested in small satellite development.29 Table 3 shows the significant increase of small satellites launched over the past three years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Consumer(^{26})</th>
<th>Fixed Satellite(^{27})</th>
<th>Mobile Satellite(^{28})</th>
<th>Earth Observation</th>
<th>Total</th>
</tr>
</thead>
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<tr>
<td>2014</td>
<td>$100.90</td>
<td>$17.10</td>
<td>$3.30</td>
<td>$1.60</td>
<td>$122.90</td>
</tr>
<tr>
<td>2013</td>
<td>$98.10</td>
<td>$16.40</td>
<td>$2.60</td>
<td>$1.50</td>
<td>$118.60</td>
</tr>
<tr>
<td>2012</td>
<td>$93.30</td>
<td>$16.40</td>
<td>$2.40</td>
<td>$1.30</td>
<td>$113.50</td>
</tr>
</tbody>
</table>

27 Transponder Agreements and Managed Services.
28 Voice and Data.
In June 2015, the Science and Technology Policy Institute, a Federally Funded Research and Development Center (FFRDC), published a study sponsored by the National Aeronautics and Space Administration (NASA) and Office of the Director of National Intelligence (ODNI) study titled Global Trends in Outer Space. According to this study, small satellite demand for launch services has been increasing and is forecasted to increase significantly over the next few years.

Small satellites are not a fundamentally new concept—even the first artificial satellite, Sputnik-1, fits most definitions of a modern small satellite. However, the high cost of launch into space and importance of operational missions has, over time, driven the production of larger, more capable, longer lived, and rigorously reliable satellites. While these satellites are highly capable, they have high production costs. Recently, there has been interest in developing small, low-mass satellites, which have more limited capabilities but cost less to produce.

While small satellites have lower component, launch, and development costs, they have significantly less power and functionality on a single platform. Because of these characteristics, small satellites often have higher mission and component risk tolerances and lower lifetime expectations. The lower costs make it simpler to build additional platforms—whether for a constellation or for replacements.

The lower cost of smaller satellites is allowing new entities to build, launch, operate, and support satellites, especially in low Earth orbit. In turn, the greater number of interested parties results in a more competitive market for goods and services, driving down costs further. The result has been a spike in the number of small satellites below 50 kilograms in the last few years, which has been projected to increase significantly over the next few
years based on mission plans and launch manifests. From 2013 to 2014 alone, the number of microsatellites launched in the range of 1–50 kilograms increased 72 percent. Large communication microsatellite constellations have been announced by SpaceX and OneWeb, consisting of 4,023 and 648 satellites, respectively (SpaceWorks Enterprise, Inc. (SEI) 2015). This growth is in sync with an increase in the available market of component and payload suppliers and developers, as well as for launch and satellite service providers for launch, launch integration, ground-station construction or management, and so forth. However, the long-term viability of this market of parts, a sustained demand for missions, and commercial returns on investment are all interlinked claims that remain to be observed.30

Commercial Launch Market Supply

Current U.S. Orbital Launch Service Providers

Orbital ATK- The Dulles, Virginia-based Orbital ATK offers three different launch vehicles: the Antares, Minotaur and Pegasus rockets. It is currently developing a medium- to heavy-class rocket that uses solid propulsion.31

SpaceX- Space Exploration Technologies (SpaceX) is a Hawthorne, California-based company that offers the Falcon 9 launch vehicle. SpaceX’s heavy-lift vehicle, the Falcon Heavy, is scheduled to launch later this fall.32

ULA- United Launch Alliance, a joint venture of Lockheed Martin Space Systems and Boeing Defense, Space and Security, is headquartered in Centennial, Colorado and currently operates three different launch vehicles (Atlas V, Delta II and Delta IV). ULA’s next launch vehicle, the Vulcan, is currently under development to replace the Atlas V.33

U.S. Small Satellite Launch Services

Several new launch vehicles are being developed specifically to address what some believe is latent demand among small satellite operators.34 These rockets are designed to launch payloads

with masses under 500 kg (1,102 lb) to low Earth orbit (LEO). Though the price per kilogram may remain high relative to larger launch vehicles, presumably there will be additional value in scheduling; small satellite operators, especially those with constellations of many satellites, can have greater control over the orbits their satellites are placed rather than simply being a “piggyback”, rideshare secondary payload for a larger satellite. New launch vehicles are in various stages of development, like the Electron by Rocket Lab and LauncherOne from Virgin Galactic.35

Foreign Launch Service Providers

China- The China Great Wall Industry Corporation (CGWIC) aggressively pursues international clients via package deals that include satellite manufacturing and launch. However, these CGWIC launch contracts are not internationally competed. China conducted 19 launches in 2015.36 Also in 2015, China introduced two new small-class launch vehicles, the Long March 6 and the Long March 11.37 The country continues to develop the Long March 5 and Long March 7, both of which are expected to be launched in 2016 from a new launch site on Hainan Island.38 Finally, China’s human spaceflight program continues development, while the Chinese National Space Agency (CNSA) carries out robotic missions to the Moon. These activities point to an expansion of China into the international commercial launch market.39

India- The Indian Space Research Organization (ISRO) and its commercial arm, Antrix Corp., are expanding India’s domestic launch capabilities and seeking new commercial opportunities. ISRO’s Polar Satellite Launch Vehicle (PSLV) has completed 25 operational missions and India has funded 15 more launches to be completed before 2020.40 In February of this year, ISRO Chairman, A.S. Kiran Kuman, said that ISRO plans to “largely privatize” the PSLV by 2020 and to increase its launch rate from 12 to 18 per year.41 India has also developed its Geosynchronous Satellite Launch Vehicle (GSLV) and intends to launch a GSLV Mark-3 (also known as the LMV3) with its new, Indian-made Cryogenic CE-20 engine on the upper stage in December of

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39 Federal Aviation Administration, “The Annual Compendium of Commercial Space Transportation: 2016”.
2016. On the GSLV Mark-3’s maiden voyage in 2014, it demonstrated re-entry and recovery of an experimental crew capsule.

Russia- On January 1, 2016, Russia’s Federal Space Agency Roscosmos was dissolved and all of its responsibilities transferred to the Roscosmos state corporation. Roscosmos’ two main launch vehicles, the Soyuz and Proton, launch regularly. The Proton had 8 launches in 2015. Among its capabilities, the Soyuz is currently used to bring astronauts and cosmonauts to the International Space Station. The Soyuz rocket also launches from the European Space Agency’s Guiana Space Center in South America. The Proton launch vehicle is used for both Russian government and commercial satellites launches. Russia intends to phase out the Proton rocket by 2025 and replace it with the Angara A5, which completed a successful first test flight in 2014. Russia is also planning to phase out its Dnepr launch vehicle, which was based on decommissioned Russian intercontinental ballistic missiles, and its Zenit medium-class rocket.

European Space Agency (ESA)- In addition to the Soyuz, ESA uses the Ariane 5 launch vehicle and the Vega small launch vehicle. The French-based company Airbus Defense and Space is the Ariane 5’s prime contractor. The Italian Space Agency, in cooperation with ESA developed the Vega launch vehicle that is used to launch small satellites. In August 2015, ESA committed over $3 billion to upgrade both the Ariane and Vega launch vehicles. The Ariane 6 and the Vega-C are expected to debut in 2020 and 2018, respectively.
<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Provider</th>
<th>Country</th>
<th>kg to LEO</th>
<th>kg to GTO</th>
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<td>Cab-3!</td>
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Data taken from ESA 2016 Compendium and respective launch service provider’s website. Numbers reflect maximum lifting capabilities.
Reusable Vehicles

A majority of launch costs is vehicle hardware. For some launch providers, the first-stage engine alone makes up to 65 percent of the total launch cost. To drive down launch costs, many companies are looking at ways to reuse launch vehicle components, rather than discarding them after launch. Some estimates say that reusing such launch components could reduce costs by a factor of 100. With the possibility of dramatically reducing launch costs, some launch companies are investing in reusable launch vehicle technologies. The Space Transportation System (Space Shuttle) was partially reusable as well; however, inspection, maintenance, and refurbishment of reusable components for a human-rated launch system proved to be more far expensive than originally planned.

SpaceX and Blue Origin have demonstrated the ability to land and recover the first stage of a launch vehicle. SpaceX has landed and recovered their first stage after delivering its second stage to an intended orbit. Blue Origin has landed and recovered their first stage after delivered a suborbital payload. The goal of recovering the first stage of a launch vehicle is to refurbish and reuse the first stage for future launches. ULA has proposed a method to detach the engine of a launch vehicle after the first stage and float it back to the Earth with parachutes where a helicopter can then catch the hardware. Airbus has proposed a similar method where the engine, avionics, and propulsion bay of the first stage detach and glide back to Earth with winglets and land on a runway.

Key National Policy Issues

Use of Excess ICBM Motors

Since 1998, national policy is that excess U.S. intercontinental ballistic missiles or their components should not be used for commercial launch services. The 2013 National Space Transportation Policy states: “Excess U.S. ballistic missiles [or their components] shall either be retained for government use or destroyed,” and that departments and agencies may use them on a

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“case-by-case” basis. The policy also directs that agencies should only use ICBMs in a way that “limits the impact on the U.S. space transportation industry.”

According to Federal law, departments and agencies may use such excess ballistic missile assets, including rocket motors, to launch payloads into orbit on a case-by-case basis with the approval of the Secretary of Defense and notification to Congress that: (1) the use would result in cost-savings to the Federal Government when compared to the cost of acquiring space transportation services from United States commercial providers; (2) meets all mission requirements for the agency, including performance, schedule, and risk; and (3) is consistent with the international obligations of the United States. Federal law also requires the Federal Government to acquire space transportation services from United States commercial providers whenever such services are required in the course of its activities, subject to a number of exceptions. Launch vehicles derived from excess ballistic missiles are subject to this requirement and can only be acquired if an exception is determined.

There are examples of companies that use excess ICBM assets. In 1997, for example, the U.S. Air Force awarded its Orbital/Suborbital Program (OSP) contract to Orbital Sciences Corporation (now Orbital ATK), which helped the company develop its Minotaur line of launch vehicles that use decommissioned ICBM rocket motors in combination with commercially built upper-stage motors. Orbital ATK continues to develop and use such launch vehicles. In 2013, NASA launched the Lunar Atmosphere and Dust Environment Explorer (LADEE) to the Moon on a Minotaur V. In total, the Minotaur family has launched 25 variants since 2000, all successfully. In July 2015, the Air Force awarded Orbital ATK a $23.6 million contract to launch a small satellite aboard a Minotaur IV rocket in 2017. The Aerospace Industry Association claims that using ICBMs as launch vehicles is only marginally cheaper than using other vehicles on the market. This is due to costs associated with storing, maintaining and converting the missiles to usable launch vehicles.

Indian Launch Services
The United States has a long-standing policy of not supporting the development or acquisition of space transportation systems in non-Missile Technology Control Regime (MTCR) countries. The Missile Technology Control Regime is an informal and voluntary association of countries which share the goals of non-proliferation of unmanned delivery systems capable of delivering weapons of mass destruction, and which seek to coordinate national export licensing efforts aimed at preventing their proliferation. The MTCR was originally established in 1987 by Canada, France, Germany, Italy, Japan, the United Kingdom and the United States. Since that time, the number of MTCR partners has increased to a total of thirty-four countries, all of which have equal standing within the Regime. India is not a member of the MTCR. However, U.S. policy is to support India’s entry to the MTCR. India formally submitted an application in June 2015, with active support from the United States. This submission is still under consideration.

According to Foreign Policy:

India has applied for MTCR membership as a part of its efforts to integrate itself with the global non-proliferation community… the efforts began right after its nuclear tests in 1998, when India expressed its support for the basic objectives of the NPT—marking a complete turnaround from the approach it had previously demonstrated. The United States, one of the founding designers of the existing global non-proliferation architecture, realized that while India would not join the NPT, it could play a crucial role in strengthening other non-proliferation and export control bodies. This was the premise of the India-U.S. nuclear initiative which began in 2005, and over the years, the importance of integrating India with the global non-proliferation architecture has now been realized by many other governments, including Australia, Canada, France, Germany, Japan, Russia, South Korea and the United Kingdom.

On July 20, 2009, the United States and India signed a Technology Safeguards Agreement which changed U.S. Government (USG) policy to permit the launch of civil or non-commercial satellites containing U.S. ITAR-controlled components on Indian space launch vehicles. However, this agreement did not include permission to launch commercial satellites. On a case-by-case basis, U.S. companies must receive a license to export satellites to India for launch that waives the non-MTCR compliant acquisition of launch services policy prohibition. In 2015, Spire Inc. of San Francisco, California, was the first company to have its cubesats to launch from India.

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67 Ibid.
68 Ibid.
India. Skybox Imaging of Mountain View, California, owned by Google’s Alphabet, has contracted for multiple commercial imaging satellites to launch on the PSLV. PlanetQ of Boulder, Colorado, has contracted for a late 2016 launch, and Airbus Defence and Space of Europe has launched commercial Spot 6 and Spot 7 Earth observation satellites, both with U.S. components, on PSLV rockets.

According to the United States Trade Representative (USTR), some satellite operators and manufactures are asking for increased access to Indian launch services due to what they see as a shortage of U.S. launch capacity. Others, including the Commercial Space Transportation Advisory Committee (COMSTAC), have warned against increasing access because “India’s state-owned and controlled launch providers whose pricing structures and related costs are not able to be confirmed as market-based hold the potential to distort the conditions of competition.”

Hosted Payload/Ride Share Challenges

A hosted payload is a module that connects to a commercial satellite. The module shares the host satellite’s power supply but operates on its own, independent of the host. Commercial satellites launch regularly and the modular design of hosted payloads in principle makes them easy to install. Some in the U.S. space industry see hosted payloads as an efficient method of launching Federal Government payloads, such as the Space Based Surveillance follow-on mission, but raise concerns that the DoD and other government agencies have resisted committing to hosted payloads.

Another option for launching small payloads exists in the form of rideshares. Sometimes, launch service providers will have extra room in a launch vehicle and open up the space for secondary payloads. These slots are often filled by small payload that ride along with the primary payload.

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6) COMSTAC Observations, Findings, and Recommendations to the Associate Administrator for Commercial Space Transportation (January 29, 2016).


but are deployed separately. Rideshares are subject to launch delays encountered by the primary payload and are bound to whichever orbit the primary payload chooses.
Chairman BABIN. The Subcommittee on Space will come to order. Thank you for being here.
Without objection, the Chair is authorized to declare recesses of the Subcommittee at any time.
I recognize myself for five minutes for an opening statement.
The commercial space industry truly is an amazing industry. It generates hundreds of billions of dollars of economic activity, serving both the private and public sectors, all while pushing the boundaries of innovation and fostering the United States as the global leader in space.
Part of this innovation is a new space spin-in phenomenon. Computer, data analytics, and IT technologies having their origin in our space program but more recently developed outside of the space sector are being reapplied for space-specific purposes.
Significant research and development investments are also being made in the United States to create and manufacture new types of small satellite technologies and application. One of the largest barriers to that small satellite companies—that they face is the cost of launch. Launch often accounts for a significant portion of a small satellite’s overall mission cost.
Recent government incentives for launch vehicle development may allow small satellite operators greater access to space. New launch vehicle test flights present great opportunities for small satellite operators to launch secondary payloads if the companies are willing to accept the primary payload schedule, mission profile, and mission risk.
The development of a small satellite industry is also attracting investment for a new class of launch services to serve the specific needs and requirements of smaller satellites and associated on-orbit constellations. A number of American companies in various stages of development plan on offering dedicated launch services to the small satellite industry in the next few years. These companies hope to fulfill the unmet demand of the small satellite market. They also promise to provide more flexible launch services such as delivery to unique orbits and rapid replenishment.
There is a lot of change going on in the small satellite and launch services industry. Winston Churchill once said, “There is nothing wrong with change if it is in the right direction.” From my point of view, the investment and innovation occurring in the small satellite and launch industry is good for America, and it is an important step in the right direction.
But change often presents both challenges and opportunities. Companies are seeking to supply the demand for greater small satellite launch capability in many unique and innovative ways. Some solutions carry more risk than others. Some solutions are easier to implement than others. Some solutions require government action and some do not.
Today’s hearing gives us the chance to explore these challenges and opportunities. One policy challenge is excess intercontinental ballistic missile motors. It is longstanding national policy that excess U.S. ICBMs or their components should not be used for commercial launch services. This policy is established in the 1998 Com-
mercial Space Act and reiterated in the 2013 National Space Transportation Policy, which states: “Excess U.S. ballistic missiles or their components shall either be retained for government use or destroyed,” and that departments and agencies may use them on a case-by-case basis.

But should this policy be changed to allow greater use of excess ICBM motors for commercial launch services? This isn’t a black-and-white issue, and the policy outcomes associated with either keeping or modifying existing policy will create winners and losers.

And those in favor argue that many U.S. small satellites have launched on Russian DNEPR vehicles derived from Russian ICBMs and that, by modifying existing U.S. policy, U.S. launch services could compete with Russia and bring this business back to America.

Those in favor also argue that there is a cost to the taxpayer associated with storing excess ICBMs. By allowing the U.S. commercial launch industry to use excess ICBMs, you not only lower the tax burden but also create potential revenue derived from the sale of these motors.

Those that oppose the policy change raise legitimate concerns that allowing excess ICBMs to be used for commercial launch purposes could distort the market in the United States, undermine future investment, and delay innovations that are on the horizon.

Access to foreign launch services is also a policy challenge for the U.S. small satellite industry. And I’ve heard from a number of companies that build and operate small satellites that there isn’t enough capacity in the market at a price they can afford to meet their needs.

India has stepped in and offered to fill, in part, this demand and is launching smaller satellites on their PSLV vehicle. The Administration has provided a number of export waivers on a case-by-case basis for these launches, in part because India is becoming a strategic ally in South Asia. Unfortunately, the Administration seems to lack a clear long-term policy to guide access to PSLV launches. What should U.S. policy be with regard to Indian and other foreign launch vehicles?

Another factor that may impact the small satellite market is reusability. We all watched with great awe the accomplishments of Blue Origin and SpaceX when they launched and recovered their first stages. ULA and Ariane are now planning partially reusable systems as well. Will partial reusability of launch systems lower launch costs significantly and will it be the panacea for small satellite operators? Will they be able to overcome many of the past issues with reusability such as refurbishment and maintenance costs? Only time will tell, but I’m excited about these recent transformative developments.

Finally, are there any artificial government barriers to expanding opportunities for secondary payloads, hosted payloads, and rideshares? Is there anything that can be done to assist in the aggregation of small satellites on—a—on larger vehicles so as to benefit from economies of scale? Are there technologies or policies that could allow for greater utilization?

There is a great deal of promise in the future of space, but if we fail to provide long-term solutions to the issues that our nation
faces, we may well lose our leadership in space. China stands ever-ready to fill that leadership void at a national level. Russia and Europe will gladly fill that role from a commercial perspective once again.

We must provide a competitive legal, policy, and economic environment or other nations will happily step up. This would lead to an eroded industrial base, decreased national capabilities, declining international influence, and the loss of a skilled workforce. I, for one, will not allow that to happen on my watch.

I look forward to learning more about these critical issues facing our commercial space industry and finding common ground and responsible solutions that meet the needs of our nation, grow our economy, and maintain our leadership in space.

[The prepared statement of Chairman Babin follows:]
Statement of Space Subcommittee Chairman Brian Babin (R-Texas)
The Commercial Space Launch Industry: Small Satellite Opportunities and Challenges

Chairman Babin: The commercial space industry truly is an amazing industry. It generates hundreds of billions of dollars of economic activity, serving both the private and public sector, all while pushing the boundaries of innovation and fostering the United States as the global leader in space.

Part of this innovation is a new space “spin-in” phenomenon. Computer, data analytics, and IT technologies having their origin in our space program but more recently developed outside of the space sector are being re-applied for space-specific purposes. Significant research and development investments are also being made in the United States to create and manufacture new types of small satellite technologies and applications.

One of the largest barriers that small satellite companies face is the cost of launch. Launch often accounts for a significant portion of a small satellite’s overall mission cost. Recent government incentives for launch vehicle development may allow small satellite operators greater access to space. New launch vehicle test flights present great opportunities for small satellite operators to launch secondary payloads, if companies were willing to accept the primary payload schedule, mission profile, and mission risk.

The development of a small satellite industry is also attracting investment for a new class of launch services to serve the specific needs and requirements of smaller satellites and associated on-orbit constellations. A number of American companies, in various stages of development, plan on offering dedicated launch services to the small satellite industry in the near future. These companies hope to fulfill the unmet demand of the small satellite market. They also promise to provide more flexible launch services such as delivery to unique orbits and rapid replenishment.

There is a lot of change going on in the small satellite and launch services industry. Winston Churchill once said, “There is nothing wrong with change, if it is in the right direction.” From my point of view—the investment and innovation occurring in the small satellite and launch industry is good for America and is an important step in the right direction.

But change often presents both challenges and opportunities. Companies are seeking to supply the demand for greater small satellite launch capability in many unique and innovative ways. Some solutions carry more risk than others. Some solutions are easier to implement than others. Some solutions require government action, and some do not. Today’s hearing gives us the chance to explore these challenges and opportunities.

One policy challenge is excess intercontinental ballistic missiles (ICBM) motors. It is long-standing national policy that excess U.S. ICBMs or their components should not be used for commercial launch services. This policy is established in the 1998 Commercial Space Act and reiterated in the 2013 National Space Transportation Policy, which states: “Excess U.S. ballistic missiles (or their components) shall either be retained for government use or destroyed.” And that departments and agencies may use them on a “case-by-case” basis. But should this policy be changed to allow greater use of excess
ICBM motors for commercial launch services? This isn’t a black-and-white issue and the policy outcomes associated with either keeping or modifying existing policy will create winners and losers.

Those in favor argue that many U.S. small satellites have launched on Russian DNEPR vehicles, derived from Russian ICBMs, and that by modifying existing U.S. policy, U.S. launch services could compete with Russia and bring this business back to America. Those in favor also argue that there is a cost to the taxpayer associated with storing excess ICBMs. By allowing the U.S. commercial launch industry to use excess ICBMs, you not only lower the tax burden, but also create potential revenue derived from the sale of these motors.

Those that oppose the policy change raise legitimate concerns that allowing excess ICBMs to be used for commercial launch purposes could distort the market in the United States, undermine future investment, and delay innovations that are on the horizon.

Access to foreign launch services is also a policy challenge for the U.S. small satellite industry. I’ve heard from a number of companies that build and operate small satellites that there isn’t enough capacity in the market at a price they can afford to meet their needs. India has stepped in and offered to fill, in part, this demand and is launching smaller U.S. satellites on their PSLV vehicle. The Administration has provided a number of export waivers — on a case-by-case basis — for these launches, in part because India is becoming a strategic ally in South Asia. Unfortunately, the Administration seems to lack a clear long-term policy to guide access to PSLV launches. What should U.S. policy be with regard to Indian and other foreign launch vehicles?

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Finally, are there any artificial government barriers to expanding opportunities for secondary payloads, hosted payloads, and ride-shares? Is there anything that can be done to assist in the aggregation of small satellites on larger vehicles so as to benefit from economies of scale? Are there technologies or policies that could allow for greater utilization?

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I look forward to learning more about these critical issues facing our commercial space industry and finding common ground and responsible solutions that meet the needs of our nation, grow our economy, and maintain our leadership in space.

# # #
Chairman Babin. And now, I'd like to recognize the Ranking Member, the gentleman from Texas, for an opening statement.

Mr. Veasey. Thank you, Mr. Chairman.

And good morning, and welcome to our distinguished panel of witnesses.

I want to thank Chairman Babin, also a fellow Texan, for calling this hearing.

Before I begin, though, I would like to note that we received the final witness testimony statements and the hearing charter less than 24 hours ago, and this has made it very tough on member preparation and staff preparation likewise. And in the future, I hope that we can receive the testimony and charter in a more timely manner. That would be very, very helpful.

Now, again, as a Texas Member, ensuring the continued growth of the space industry and addressing the challenges within emerging sectors such as the commercial launch industry remain incredibly important to me and my fellow committee members.

Thanks to the Johnson Space Center in Houston, Texas. They have long been a leader on space issues. Now, as we move forward with commercial spaceflight, Texas is positioned to be a leader yet again with a growing presence of commercial tests and launch sites in Texas. Companies like Blue Origin and SpaceX are laying the groundwork for innovation and helping to inspire the next generation of scientists and engineers with their latest test sites in West and South Texas. The work of the private space industry is helping change the landscape for satellite launches by greatly driving down the cost of delivering a payload safely to space.

Small satellite, also known as smallsats are contributing to the emergence of new startup companies that aim to provide rapid turnaround in services and technology advancement to improve and expand services at a lower cost, especially in the area of Earth observation and data provision.

U.S. leadership in this emerging industry has the potential to both create jobs and economic growth for the nation and to serve as an important source of U.S. innovation in an increasingly competitive and changing global marketplace. Additionally, universities and government agencies are exploring the increased use of smallsats and for research, education and training, technology development, and conduct of government operations.

One of the major challenges that smallsats do face is developing and building the spacecraft—is finding a way to put the spacecraft in space and to do so in an affordable and reliable manner. Today, options for placing a small payload in space include the following: that is, using dedicated small launchers, ridesharing as a secondary payload on a large primarily conducted for another purpose, being a hosted payload on a commercial satellite, and being ejected from a commercial dispenser mounted on the International Space Station.

Unfortunately, smallsat users and operators are often constrained in their choice of launch options due to individual requirements, available budgets, and the unique characteristics of each option. As a result, smallsat users and operators must make tradeoffs between factors such as affordability, schedule, risk, and orbital placement. For example, since the primary payload customers dic-
tates launch conditions, users and operators of small satellites launched as a secondary payload have no control on either the launch schedule or the destination orbit of the launch vehicle. And while the secondary payload customers must accommodate any delay by the primary payload, they benefit from the lower launch cost.

On the other hand, smallsat customers who place a premium on when the launch must occur and to what orbit the satellite needs to be placed may opt to launch using a dedicated launch vehicle despite that option’s higher cost.

So it is not surprising that a number of providers are seizing on this opportunity to offer additional launch options to meet existing and projected demand by smallsats. Two recent proposals have been made. The first is to allow the Air Force to make its excess intercontinental ballistic motors available for purchase and later in use in commercial launches. The second is to facilitate U.S. commercial satellite operator access to Indian launchers.

I hope that we can have an objective discussion with the panel on the pros and cons of these proposals and identify possible unintended consequences as well. Such a discussion is critical because both of these proposals are likely to require changes in statute and policy, which this committee would have jurisdiction over.

However, we also need to hear from the relevant government agencies, and I hope Mr. Chairman that we will have the opportunity for a future hearing at which we can get the perspectives of affected federal agencies.

In closing, it is clear that we need a thoughtful discussion of these complex issues, one that will enable the United States to capitalize on the innovation and job creation that is sure to come from designing and building and using this very exciting technology.

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

[The prepared statement of Mr. Veasey follows:]
OPENING STATEMENT
Congressman Marc Veasey (D-TX))

House Committee on Science, Space, and Technology
Space Subcommittee
“The Commercial Launch Industry:
Small Satellite Opportunities and Challenges”
April 19, 2016

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U.S. leadership in this emerging industry has the potential to both create jobs and economic growth for the nation and to serve as an important source of U.S. innovation in an increasingly competitive and changing global marketplace.
Additionally, universities and government agencies are exploring the increased use of smallsats for research, education and training, technology development, and conduct of government operations.

One of the major challenges smallsat users face, after developing and building the spacecraft, is finding a way to put the spacecraft in space, and to do so in an affordable and reliable manner.

Today, options for placing a small payload in space include

1. Using dedicated small launchers,
2. "ridesharing" as a secondary payload on a launch primarily conducted for another purpose,
3. being a hosted payload on a commercial satellite, and
4. being ejected from a commercial dispenser mounted on the International Space Station.

Unfortunately, smallsat users and operators are often constrained in their choice of launch options due to individual requirements, available budgets, and the unique characteristics of each option. As a result, smallsat users and operators must make tradeoffs between factors such as affordability, schedule, risk, and orbital placement.

For example, since the primary payload customer dictates launch conditions, users and operators of small satellites launched as a secondary payload have no control on either the launch schedule or the destination orbit of the launch vehicle. And while secondary payload customers must accommodate any delay by the primary payload, they benefit from the lower launch costs.

On the other hand, smallsat customers who place a premium on when the launch must occur and into what orbit the satellite needs to be placed may opt to launch using a dedicated launch vehicle--despite that option’s higher costs.

So it is not surprising that a number of providers are seizing on this opportunity to offer additional launch options to meet existing and projected demand by smallsats.

Two recent proposals have been made.

The first is to allow the Air Force to make its excess Intercontinental Ballistic Missile motors available for purchase and later use in commercial launches.

The second is to facilitate U.S. commercial satellite operator access to Indian launchers.

I hope that we can have an objective discussion with the panel on the pros and cons of these proposals, and identify possible unintended consequences as well. Such a discussion is
critical because both of these proposals are likely to require changes in statute and policy, which this committee would have jurisdiction over.

However, we also need to hear from the relevant government agencies, and I hope, Mr. Chairman, that we will have the opportunity for a future hearing at which we can get the perspectives of the affected federal agencies.

In closing, it is clear that we need a thoughtful discussion of these complex issues, one that will enable the U.S. to capitalize on the innovation and job creation that is sure to come from designing, building, and using this exciting technology.

Thank you, and I yield back the balance of my time.
Chairman BABIN. Thank you, Mr. Veasey. I appreciate it.

I would like to thank the witnesses for being here today, and I’d like to introduce them. As you may know, last week was the 32nd Space Symposium in Colorado. Both of our witnesses have been extremely busy preparing for and attending the symposium, and so I very much appreciate that they were able to pull together their testimonies and attend this hearing on such a short notice and short turnaround.

The committee received a number of letters from stakeholders, and I ask unanimous consent to include them in the record.

[The information follows:]
The referenced document was not provided at the time of printing.
Chairman Babin. And let me introduce our witnesses. First is Mr. Elliott Pulham, our first witness today. He’s the Chief Executive Officer of the Space Foundation since 2001. In his role at the Space Foundation, Mr. Pulham leads a premier team of space and education professionals, providing services to educators and students, government officials, news media, and the space industry around the world.

Before joining the Space Foundation, Mr. Pulham was Senior Manager of Public Relations, Employee Communication, and Advertising for all space programs of Boeing, serving as spokesperson at the Kennedy Space Center for the Magellan, Galileo, and Ulysses interplanetary missions, among others. Mr. Pulham has a degree in journalism and mass communication from the University of Hawaii Manoa.

Second, Mr. Eric Stallmer, and we appreciate Mr. Stallmer being here today as well. He’s President of the Commercial Spaceflight Federation since 2014. In his role, Mr. Stallmer constantly promotes the industry and member companies through his outreach of high-ranking officials and high-profile media outlets. He also promotes the mission of CSF through participation in multiple industry conferences throughout the year.

Mr. Stallmer, has a master of arts degree in public administration from George Mason University and a bachelor of arts degree in political science and history from Mount St. Mary College.

I now recognize Mr. Pulham for five minutes to present his testimony.

TESTIMONY OF MR. ELLIOT PULHAM, CHIEF EXECUTIVE OFFICER, SPACE FOUNDATION

Mr. Pulham. Thank you, Mr. Chairman, and thank you, Members of the Committee. It’s a pleasure to be here today, and I thank you for the opportunity to testify on matters having to do with the space launch and satellite markets.

In addition to my testimony, I’d like to enter into the record a brief report on these markets, which is gleaned from our online research source, “The Space Report,” which has been included as an addendum to my remarks.

I’m here today to provide perspective and data on behalf of the foundation. We’re a 501(c)(3) nonprofit, nongovernmental organization, and we strive to be an entity that all stakeholders in the space policy realm can trust to provide fair, balanced, and well-researched information.

The easiest way to characterize the current international launch market is that it is highly competitive, abundantly supplied with a variety of launch systems, and with new systems and suppliers entering or attempting to enter the market virtually every day. In 2015, there were 39 different major launch vehicle models in operation, 39, and they accounted for 86 launches around the world. In simple math, this is less than three launches per vehicle, which is not commercially sustainable, and it means that some systems enjoy a backlog of orders while many, many launches depend upon government involvement of one kind or another.

Regarding the notion of permitting or prohibiting access to foreign launch services, our experience is it’s very hard to characterize
levels of government support for many competing systems because of the different cultures, economies, types of government, perceived societal roles, and so forth. But it is safe to say that there are very few launch systems in the world that have not had some kind of government support at one time or another, although I think this is certainly beginning to change with the advance in small commercial launch vehicles.

The issues I think we have to do with fairness to the satellite manufacturers of the United States and our allies, reasonable access to launch options, and attention to security concerns that do not constitute a broad or overly restrictive reach by regulators.

The impact of ITAR restrictions over the past 20 years has mostly been a body of unintentional consequences that have injured U.S. satellite manufacturers while promoting the development of so-called ITAR-free and no-U.S.-content satellites in Europe and Asia. Many of the satellite orders, once routinely filled by U.S. companies, are now filled by others. Even good friends and allies who really, really would like to buy American find themselves frustrated still. Significant changes to ITAR have been made, but implementation of the changes within the government has been slow.

Recently, there’s been some discussion about allowing U.S.-built satellites to fly on boosters such as the Indian PSLV. This kind of discussion has taken place before in the case of allowing U.S.-built satellites to fly on Chinese boosters, which was permitted but came to an end in the late 1990s with the failure of a Long March booster and the subsequent accident investigation, which resulted in the ITAR changes mentioned. Since then, no U.S. satellites have flown on Chinese boosters.

I think the concern about using Indian boosters is not so much the transfer of sensitive technology to a nation that’s a fellow democracy, but rather whether the Indian launches are subsidized by the government to a degree that other market actors would be priced out of the market. I would point to the chart that in my testimony that shows the launch rates for the past decade. India has not managed to launch more than a half a dozen times the year. They’ve also had some reliability challenges with their systems, and I do not see them as a clear and present danger to U.S. launchers quite yet.

Within the boom in small satellites, there is also a boom in the development of launchers dedicated to the small side—CubeSat, nanosat, whatever you want to call them—market. The boom has numeric interest, but its market impact remains to be seen. The total mass of nanosatellites launched in 2015 only equals one percent of the total mass launched. If it were not for the unique orbits required for various small satellite missions, all 120 of the nanosats launched in 2015 with a combined mass of less than 500 kilograms could have been orbited on a single Delta II launch vehicle.

As regards to these new constellations that we’re seeing, we’ve seen a similar story before when forecasts for thousands of new small satellites were envisioned for systems like Teledesic, which I had some experience with. These led to wildly ambitious launch forecasts in the ’90s, which did not materialize and have had a negative impact on national security space ever since.
Then, as now, there was enthusiasm for the spin-in of technology and management architectures from the non-space world. But space was and is hard. The ability to succeed in cellular communication did not translate into success in the satellite marketplace in the ’90s, nor does acumen in information technology necessarily equate to satellite success today. Many of the investments being made in small satellites are driven simply by the smaller costs of the spacecraft. Small cost and big capabilities seldom arrive hand-in-hand.

The other major policy considerations that accompany this proliferation of small satellites has to do with the necessity of getting our arms around a space traffic management regime which will ensure continued long-term access to space for operators of all sizes. And I’m sure you’ve all heard the three C’s. Space is congested, contested, and competitive, and it’s only getting more so.

I don’t want you to think that I’m not excited about this emerging sector or that it’s necessarily doomed to the fate of the Little LEO phenomena of the ’90s, but rather I’m saying we need to be cautiously optimistic and not overly bullish. At a recent House Armed Services Committee, General Hyten said it was incredibly difficult for the government to accurately forecast launch industry trends and say with certainty where the industry will be several years from now, and I would say it’s difficult for anyone to do that.

Technology improvements have resulted in better components, less expensive technology. I’m not saying it’s not as good as the other satellite stuff that’s out there. And the emerging players do offer technology advances such as rapid iteration, constantly increasing communication speed, bandwidth, et cetera. These capabilities may in many cases be complementary with legacy companies, products, and services. Pentagon’s recent outreach to Silicon Valley speaks to the recognition that there are new things to be learned.

Partially or fully reusable launch vehicles have been the Holy Grail in the space sector for ages. It is delightful to see progress being made towards reusability.

And then wrapping up because I’ve abused my time, I just want to finally address an issue that is larger than the focus of today’s hearing, which is the future of the country in space and how we ensure U.S. leadership in space. Last month, the Space Foundation, along with 13 other space-related associations, including Mr. Stallmer’s, released a paper, “Ensuring U.S. Leadership in Space.” The document is intended to be a nonpolitical statement from the space industry to inform candidates for office and educate them of how important and essential space efforts, technologies, and capabilities are for all Americans. I encourage you to read this document and ask that you insert it in the record of this hearing.

Again, thank you for allowing me to go a little bit over my time, and I look over to your questions.

[The prepared statement of Mr. Pulham follows:]
Testimony of Elliot Holokauahi Pulham  
Chief Executive Officer, the Space Foundation  
House Science, Space, & Technology Committee, Subcommittee on Space  
U.S. House of Representatives  
April 19, 2016  

"The Commercial Space Launch Industry: Small Satellite Opportunities and Challenges"

Chairman Babin, Ranking Member Edwards, Committee Members, Friends, and Staff, on behalf of the Space Foundation Board of Directors and the entire Space Foundation team, I thank you for the opportunity to testify today on matters having to do with the space launch and satellite markets. In addition to my testimony, I would like to enter into the record a brief report on these markets gleaned from our online research source, The Space Report, included as an addendum to my remarks.

I am here today to provide data and perspective on behalf of the Space Foundation, a 501(c)(3), nonprofit, nongovernmental organization. The Space Foundation strives to be an entity that all stakeholders in the space policy realm can trust to provide fair, balanced and well-researched information, and to help educate and advise, consistent with our mission: "To advance space-related endeavors to inspire, enable and propel humanity."

Last week in Colorado Springs, Colorado, we held the 32nd Space Symposium, the largest single space gathering in the world. More than 10,000 space professionals from all over the globe came together to talk policy and conduct business. I can say the energy at the Space Symposium speaks to the dynamism we are seeing in the space industry.

The easiest way to characterize the current international launch market is that it is highly competitive and abundantly supplied with a variety of launch systems, with new systems and suppliers entering, or attempting to enter the market, virtually every day. In 2015 there were 39 different launch vehicle models in operation, accounting for 86 launches around the world. In simple math this is less than three launches per vehicle, which is not commercially sustainable and means that some systems enjoy a backlog of orders, while many, many launches depend upon government involvement of one kind or another.
Regarding the notion of permitting or prohibiting access to foreign launch services, our experience is that it is very hard to characterize levels of government support for the many competing systems, because of the many different cultures, economies, types of government and their perceived societal roles, etc. It is safe to say that there are very few launch systems in the world that have not had some kind of government “support” or another over time, although this is beginning to change with some of the small commercial launch vehicles. The issues, I think, are fairness to the satellite manufacturers of the U.S. and our allies, reasonable access to launch options, and attention to security concerns that do not constitute a broad or overly restrictive over-reach by regulators.

The impact of ITAR restrictions over the past 20 years has mostly been a body of unintentional consequences that have injured U.S. satellite manufacturers while promoting the development of so-called “ITAR Free” and “No U.S. Content” satellites in Europe and Asia. Many of the satellite orders once routinely filled by U.S. companies are now filled by others. Even good friends and allies, who really, really would like to buy American, find themselves frustrated and buying elsewhere. Significant changes to ITAR have been made, but implementation of the changes within the U.S. Government has been excruciatingly slow.

In terms of launch pricing, foreign launch providers that are keen to create viable commercial space businesses will price as close to the top of market values as possible. It is in their interest to profit. Where you have disparity is in clearly government owned systems with no private investment. They have no profit motive, and one must, in each case, ask what the motive is.

Specifically, there has been some recent discussion about allowing U.S.-built satellites to fly on boosters such as the Indian PSLV. This kind of discussion has taken place before, in the case of allowing U.S.-built satellites to fly on Chinese boosters. This was permitted but came to an end in the late 1990s with the failure of a Long March booster and the subsequent accident investigation, which resulted in the ITAR changes already mentioned. Since then, no U.S. satellites have flown on Chinese boosters.
The concern about using Indian boosters is not so much the transfer of sensitive technology to a nation that is a fellow democracy, but rather whether Indian launches are subsidized by the Indian government to the degree that other market actors, for example American launch companies or those of allies, would be priced out the market. I would point to the chart that shows launch rates for the past decade. India has not managed to launch more than half a dozen times a year. They've also had some reliability challenges with their systems. I do not see India as a clear and present danger to U.S. launchers quite yet.
Demand for commercial satellites remains high, and the major operators continue to add capabilities and mass to their geostationary spacecraft. We are seeing an emerging sweet spot for what I would call small-"ish" satellites, special purpose spacecraft built at the size of a hotel refrigerator, and really well tuned to a specific task and, usually, a unique orbit.

With the boom in small satellites, there is also a boom in the development of launchers dedicated to the smallsat, cubesat or nanosat market. This boom has numeric interest, but its market impact remains to be seen. The total mass of nano satellites launched in 2015 only equals one percent of the total mass launched. If it were not for the unique orbits required for various small satellite missions, all 120 of the nano sats with a combined mass of less than 500kg launched in 2015 could have been orbited on a Delta II.

In the space economy, space transportation only accounts for one or two percent of total global space revenues per year, and the small sat segment only one percent of that. The technological advances we have seen in the past twelve months alone are astonishing. Constellations of small...
satellites will no doubt be a viable market for some, and we encourage you to support it, but not to over react to it.

We've seen a similar story before, when forecasts for thousands of new, small satellites, envisioned for constellations like Teledesic, led to wildly ambitious launch forecasts in the 1990s – forecasts that did not materialize and have had a negative impact on national security space launch capacity ever since. Then, as now, there was enthusiasm for the spin-in of technologies and management architectures from the non-space world. But space was, and is, hard. The ability to succeed in cellular communications did not translate into success in the satellite marketplace then, nor does acumen in information technology necessarily equate to satellite success today.

Many of the investments being made in small satellites today are driven simply by the smaller costs of these diminutive spacecraft. Small cost, and big capability, seldom arrive hand in hand. There are other major policy considerations that accompany the proliferation of small satellites – including the necessity of getting our arms around a space traffic management regime which will ensure continued long term access to space for operators of all sizes.

I do not want the committee to think that I am saying that this new flurry of emergent space systems is doomed to the same fate of the “Little LEO” phenomena of the 1990s, but rather I am saying we need to be cautiously optimistic and not be overly bullish. At a recent House Armed Services Committee hearing, Air Force Space Command Commander, General John Hyten stated that it was incredibly difficult for government to accurately forecast launch industry trends and say with certainty where the industry will be several years from now. The industry cannot accurately forecast the future trends, either, in fact – which is why we don’t try. What we at the Space Foundation endeavor to do is to synthesize data to show historical trends. Government policy should not become based on forecasts and predictions that in hindsight may be found to be off the mark. Instead, policies should enable all space companies to operate with the least amount of intrusive regulation and maximum ability to operate successful businesses.

Technology improvements since the 1990s have resulted in components becoming less expensive and utilized in new emerging satellite systems. I am not saying this technology is just as good as the most exquisite imagery or communications satellites out there, but it is good
enough for a market they think can exist and are trying to address. Emerging players in the satellite field offer technology advances such as rapid iteration, constantly increasing communications speeds and bandwidth, imagery resolution, and data integration. We have heard that these capabilities may be in many cases complementary and compatible with legacy companies' products and services. I think the Pentagon's recent outreach to Silicon Valley speaks to the recognition that there are new things to be learned.

Partially or fully reusable launch vehicles have been the "holy grail" of the space transportation sector for decades. We're seeing great work being done, and the economic models are promising. Again, however, this is harder than it looks. Our only true data point on a partially reusable system is the Space Shuttle program, a wonder of engineering that proved much more costly, and difficult, than originally imagined. We are seeing tremendous work on reusability, mostly borne by private investment, but the ultimate viability of these systems and their impact on overall launch costs remains to be seen. I believe these systems will prove their worth, but we have miles to go. I am excited to continue to watch the developments on the reusability front.

Finally, I want to address an issue that is larger than the focus of today's hearing. Last month the Space Foundation, along with 13 other space-related associations, including my colleague organization the Commercial Spaceflight Federation, with me here today released "Ensuring U.S. Leadership in Space." This document is intended to be an apolitical statement from the space industry to primarily inform the candidates for president as well as other candidates for elected office to educate them how important and essential space efforts, technology and capabilities are for all Americans. I encourage you all, as leaders in driving U.S. space policy, to be familiar with this document. Even if you may not have a direct "space constituency," for example a NASA center in your district, the people you diligently represent depend on space every single day. I would ask that you insert this document for the record of this hearing.

I thank the Committee and staff for the opportunity to testify today, and look forward to your questions.
Elliot Holokuauhi Pulham

Space Foundation Chief Executive Officer

Named chief executive officer of the Space Foundation in 2001, Elliot Pulham leads a premier team of space and education professionals providing services to educators and students, government officials, news media and the space industry around the world. He is widely quoted by national, international and trade media in their coverage of space activities and space-related issues.

Before joining the Space Foundation, he was senior manager of public relations, employee communication and advertising for all space programs of Boeing, serving as spokesperson at the Kennedy Space Center for the Magellan, Galileo and Ulysses interplanetary missions, among others.

He is a recipient of the coveted Silver Anvil Award from the Public Relations Society of America - the profession's highest honor. In 2003, the Rotary National Awards for Space Achievement Foundation presented him with the coveted Space Communicator Award, an honor he shares with the late legendary CBS News Anchor Walter Cronkite and former CNN News Anchor Miles O'Brien.

Pulham is chairman of the Hawaii Aerospace Advisory Committee, a former Air Force Civic Leader and advisor to the Chief of Staff and Secretary of the Air Force and a recipient of the U.S. Air Force Distinguished Public Service Medal. He serves on the editorial board of New Space Journal.
Chairman Babin. Yes, sir. Thank you, Mr. Pulham. I appreciate that.
And I would now like to recognize Mr. Stallmer for five minutes for his testimony presentation.

TESTIMONY OF MR. ERIC STALLMER, PRESIDENT, COMMERCIAL SPACEFLIGHT FEDERATION (CSF)

Mr. Stallmer. Thank you, Chairman Babin, and Members of the Subcommittee, and thank you for holding this hearing today.
The Commercial Spaceflight Federation is the leading national trade association for the commercial spaceflight industry. Our members are responsible for the creation of thousands of high-tech jobs driven by billions of dollars of investment. Through the promotion of innovation, CSF is guiding the expansion of Earth’s economic sphere, bolstering U.S. leadership in aerospace, and inspiring America’s next generation of engineers and explorers.

As the commercial space industry experiences rapid growth in demand, the U.S. launch industry is responding. Presently, the U.S. launch services market is dealing with demand in three ways. First, companies are investing a substantial—substantial capital in the development of a new class of small launch vehicle systems, including Virgin Galactic, Firefly, Vulcan, and Rocket Lab; second, through bundled satellite deals on dedicated medium to intermediate lift rockets with SpaceX, and soon, Blue Origin and Sierra Nevada’s Dream Chaser; and finally, through secondary payloads. Companies with small satellites piggyback on larger satellite launches. PlanetLabs, with its large constellation of small remote sensing satellites, has flown to orbit as a secondary customer on a number of flights already.

While small satellite customers benefit from being a secondary payload through fractional pricing, we acknowledge that the status as a secondary payload does result in tradeoffs for the small satellite customer. The best solution for access to space for small satellite companies would be when they’re dedicated U.S. small launch providers coupled with options for bundled launch services on larger rockets and more opportunities to ride to space as secondary payloads.

With the growth in demand for domestic space launch, the need in the near term for the state-of-the-art launch facilities is really necessary. There are numerous spaceports that are well-positioned to support existing and new launch vehicles that are coming online. The more U.S. launch vehicles available will provide more opportunities to access space from our many spaceports.

And even as the ink is still wet on last year’s Space Act, Congress is now facing efforts to reverse decades of sound policy with respect to the commercial use of ICBM assets. The vast majority—but I will note not all of CSF’s 70 member companies—oppose the efforts to reverse this policy. There are some in the DOD and the defense industry that are advocating for releasing old ICBM rocket motors for use in the commercial marketplace. Those advocating for this changes seek to buy the rocket motors at substantial discount and then compete against U.S. companies that have developed their own launch capabilities using private capital investment.
This proposal is counter to the longstanding U.S. law and policy. Wholesale conversion of ICBMs into space transportation vehicles risks placing the government in the position of competing with the private sector. It could have long-term consequences, and we've seen this in the past. Such behavior risks undermining investor confidence as well.

By consistently reaffirming 30 years of U.S. commercial launch policy, improving regulatory stability, and promoting pro-growth policies, the United States Government has fostered a healthy development of the U.S. commercial launch industry, and we're seeing this policy bear fruit today. CSF encourages this committee to pose any changes to the existing policy with respect to the commercial use of ICBM assets, the reasons that I've outlined in my written testimony.

CSF also opposes efforts to facilitate a government-subsidized foreign launch company—in this case India—to compete with U.S. companies. Such policy runs counter to many national priorities and undermines the work and investment that has been made by the government and industry to ensure the health of the U.S. commercial space launch industrial base.

At the same time, we have to be cautious not to squeeze out the U.S. satellite manufacturers and the operators that have immediate launch needs which cannot be served by the aforementioned U.S. commercial launch vehicles that will be coming online later this year.

If it can be shown that there is no viable U.S. launch opportunities in the given time frame to a required orbit, launches on Indian vehicles should continue to be considered on a case-by-case waiver review for U.S. payloads, as has been the practice for the last several years. This practice should continue while still relevant but with the knowledge that this is definitely a temporary solution.

In conclusion, on behalf of my 70 member companies, I appreciate the opportunity to testify in front of you today. American industry is responding to market demands and innovating on new technologies and outpacing any other country in the world. We seek to preserve this national leadership in space, and we look forward to working with this Congress to achieve these goals.

I look forward to your questions.

[The prepared statement of Mr. Stallmer follows:]
Chairman Babin, Ranking Member Edwards, and Members of the Subcommittee, thank you for holding this timely hearing on the commercial space launch industry and for providing me the opportunity to testify as President of the Commercial Spaceflight Federation.

The Commercial Spaceflight Federation (CSF) is the leading national trade association for the commercial spaceflight industry. Founded in 2006, CSF and its more than 70 members are 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 jobs driven by billions of dollars in investment. Through the promotion of technology innovation, CSF is guiding the expansion of Earth’s economic sphere, bolstering U.S. leadership in aerospace, and inspiring America’s next generation of engineers and explorers.

My testimony will focus on three key areas. First, I will provide an overview of key economic trends and investments in the commercial spaceflight industry, including existing and new markets associated with satellite telecommunication and demand for launch services in this sector; and the burgeoning industry around small satellite technology for telecommunication, remote sensing, scientific research, resource extraction, and space exploration, as well as demand for launch services and launch capacity in this segment. Second, I will focus on new technologies—all financed largely by private investment—that are reducing the cost of access to space, including reusable launch vehicle systems and small launchers. Third, I will outline key policy challenges facing the commercial spaceflight industry, such as reversing sound policy with regard to the use of excess ICBMs for commercial launches that would stunt the growth of emerging commercial sectors, and offer consensus industry recommendations to the Committee.

The Commercial Space Industry Today

The commercial space industry today is a robust and growing technology sector focused on innovation and providing capacity to new markets based on existing and emerging satellite and human spaceflight systems. In our view, the commercial space launch industry can be broken into three core markets:

1. Existing geostationary (GSO) satellite telecommunications market. The market for traditional telecommunications satellite carriage is mature, stable, and predictable.

2. Existing and emerging non-geostationary (NGSO) satellite market, including telecommunications, remote sensing, scientific research, cargo and crew carriage to LEO, and others. Here, the market for traditional NGSO launch is predictable, but new satellite constellations and new dedicated launch systems are emerging as the market expands.
3. **Commercial Human Spaceflight.** This includes space tourism, including suborbital spaceflights aboard Virgin Galactic’s SpaceShipTwo, Blue Origin’s New Shepard, XCOR’s Lynx, and near-space on World View Enterprise’s Voyagers; commercial space habitats, such as those developed by Bigelow Aerospace; and others.

These new and existing markets are driving substantial private capital investment into the U.S. space sector. In 2015, the commercial space industry saw historic levels of private capital investment and market growth. According to a recent report by the Tauri Group, “More than 50 venture capital firms invested in space deals in 2015, the most in any year during the 15-year study period (2000-2015).” These investments totaled $1.8 billion in venture capital, and nearly $2.7 billion in total investment and debt financing, according to this report. This investment is significant and reflects continued confidence in the market, which, according to the Tauri Group, has committed more than $13.3 billion in investment (including debt financing) since 2000.

Moreover, it seems like every day there is news of another significant technological breakthrough in the commercial space industry. Just to highlight a few:

1. In November 2015, Blue Origin demonstrated a successful launch and landing of its New Shepard rocket, and has since launched and landed the same rocket two more times, in January and April.

2. In December 2015, SpaceX successfully launched 11 Orbcomm OG2 satellites (built by Sierra Nevada Corporation) into Low Earth Orbit (LEO), and subsequently landing the first stage of the Falcon 9 rocket on its Landing Zone 1 at Cape Canaveral Air Force Station. Just two weeks ago, SpaceX successfully landing its first stage booster on its autonomous spaceport droneship after successfully deploying its Dragon spacecraft to orbit, and plans to re-fly this stage in the coming months.

3. On Saturday of last week, astronauts aboard the International Space Station (ISS) successfully attached the Bigelow Aerospace Expandable Module (BEAM) to the ISS using the Sierra Nevada Corporation’s Berthing Mechanism, following its launch inside of the trunk of SpaceX’s Dragon spacecraft.

4. Virgin Galactic unveiled its SpaceShipTwo suborbital vehicle, VSS Unity on February 19, 2016 and plans to launch its orbital small launch vehicle, Launcher One in 2017.

5. Virgin Galactic, Masten Space Systems and Blue Origin are supporting DARPA’s XS-1 program.

6. Planetary Resources deployed its first spacecraft, and will be deploying two more this year, AGI won its first space command contract with the U.S. government, and Spaceport America unveiled the “Spaceport America Experience.”

7. Moon Express, World View Enterprises, Vulcan Aerospace, XCOR Aerospace, and Sierra Nevada Corporation have all announced plans to begin flight operations in the next couple of years.

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This is an exciting time for the U.S. space industry, with technological advances being demonstrated nearly every day, significant investment by the private sector, unique public-private partnerships with the U.S. Government, and the onset of new space-based technologies, including commercial remote sensing and broadband internet service. Existing U.S. law and policy, including the National Space Transportation Policy, the Commercial Space Launch Act, which facilitates and encourages a robust domestic space launch and space systems industry, are clearly bearing fruit. As I discuss below, now is exactly the wrong time to reverse these policies, which have been decades in the making.

The Commercial GSO Market

The market for traditional commercial geostationary satellites has remained relatively robust and stable for the last several decades. The satellite industry experiences persistent annual growth and represents more than $195B in revenues per year, driven primarily by proven demand for telecommunications provided by satellites in geostationary orbit. Here, the accessible geostationary transfer orbit (GTO) launch market—meaning the market available open to competition from U.S. launch services providers—represents $2.0 billion to $2.5 billion in revenues per year, and roughly 20-25 satellite launches.

According to a 2015 report from the Federal Aviation Administration (FAA), which annually assesses and forecasts the global space launch market, “The GSO market remains stable with a projected demand of 25 satellites per year for the period 2015 – 2017, up from last year’s average of 22.3 for the period 2014 – 2016.”

The commercial GTO launch market is a good news story for the United States and U.S. competitiveness worldwide. In 1980, for example, the U.S. dominated this market with 100 percent market share. By 2010, however, America’s share of the market had collapsed to 0 percent, reflecting the impact of U.S. policies through which the Government competed directly against commercial firms (e.g. commercial payloads on Space Shuttle) and price non-competitiveness from existing U.S. providers relative to foreign competition. As a result, foreign launch service providers such as Arianespace out of Europe and International Launch Services (ILS) out of Russia came to dominate the market entirely.

However, a reversal of the foreign dominance of space launch in this market is underway, primarily due to evolutionary and revolutionary innovations taking place by U.S. space launch services sector. For example, SpaceX, which began offering its Falcon 9 commercial launch service in 2012, has unilaterally recaptured 60 percent of the global commercial satellite market in 2016. SpaceX’s entry into the market with reliable, affordable space launch services has prompted a major restructuring of Europe’s space launch sector, and Russia is also making...
drastic changes to reduce pricing in order to become more competitive. ULA, and other U.S. launch providers, have also followed suit by partnering with Blue Origin and XCOR to integrate innovative engine technology into their future launch vehicles. The promise of reusability has the potential to fundamentally alter the economics of space launch, if realized.

The NGSO Market

The NGSO market today is comprised largely of cargo resupply flights to the International Space Station (ISS), and, by 2018, the addition of crew flights using U.S. launch vehicle systems and spacecraft to service the ISS through NASA’s Commercial Crew Program. These missions utilize existing medium- to intermediate-class rockets, specifically the SpaceX Falcon 9, Orbital ATK’s Antares, and the United Launch Alliance (ULA) Atlas V.

In addition to ISS commercial transportation services, the existing NGSO market today is comprised of constellations of satellite systems to provide, for example, machine-to-machine (M2M) data messaging service, i.e. Orbcomm; telecommunications through the deployment of the IridiumNext constellation, GlobalStar, and O3b, among others; commercial remote sensing satellites, including PlanetLabs, Terra Bella (formerly Skybox Imaging), DigitalGlobe, Planetary Resources CERES constellation, and a number of others; and new mega-LEO constellations to support broadband internet such as OneWeb.

According to the FAA, “The demand for commercial NGSO launches is expected to be at a comparably high level as major NGSO telecommunication constellations are replenished and NASA ISS commercial crew and cargo resupply missions become more regular.”

In addition to dedicated flights on medium- to intermediate- lift launch vehicles, a new and rapidly-growing market of small satellite deployment has emerged via brokering and bundling of secondary launches, which in turn has ignited a commercial demand for smaller commercial launch vehicles to provide a dedicated launch service. Dedicated small launch capability being developed by multiple U.S. companies are scheduled to come online in the next 2 years, with many companies already manifesting flights. These companies, once fully operational, will launch 12-24 times a year.

The U.S. launch vehicle industry is seeing hundreds of millions of dollars of private sector investments, particularly in the last several years. This investment is driving innovations and technologies to develop launch vehicle systems, start new companies, and create high-paying jobs across the United States.

These developments should be celebrated and encouraged through sound U.S. policy. Until very recently, the space business has been somewhat limited to government agencies and large corporations—and innovation in technology has been static while launch costs have been high—the inverse of Moore’s Law. The onset of new firms driving down the cost of space launch and

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companies developing innovative, small, low-cost satellite systems is, however, resulting in a new world of exploration and experimentation for private industry, universities, research institutions, start-ups, and nonprofits.

**Private Industry is Meeting Launch Market Demand**

The predicted increase in the number of small satellites (1kg-500kg) over the coming years is directly related to the technology and manufacturing trends that are allowing for low-cost and rapid production of hardware and will be promulgated by the accelerated commercial development for access to space. As the commercial space industry experiences this rapid growth in potential demand, the U.S. launch industry is responding. Presently, the U.S. launch services market is dealing with demand primarily in three ways:

1. As noted, companies are investing substantial capital in the development of a new class of small launch vehicle systems for these payloads, including Virgin Galactic with Launcher One, Firefly with its Alpha vehicle, and Rocket Labs with its Electron launcher, among others.

2. Through bundled satellite deals, on dedicated medium- to intermediate-lift rockets, including the SpaceX Falcon 9, and Blue Origin’s future orbital launch vehicle.

3. Through secondary payloads, with help from Nanoracks and Spaceflight Services, companies with very small satellites join launches provided for other satellite customers—here, Planet Labs, with its large constellation of low-cost, small remote sensing satellites has flown to orbit as a secondary customer on a number of flights, including missions to the ISS.

Additionally, there have been several proposals for the deployment of large NGSO constellations of hundreds or thousands of small satellites to LEO to support low-cost, low-latency broadband Internet worldwide. Even here with these mega LEO constellations, the current commercial market is providing sufficient capacity. For example, one of these companies, OneWeb, has selected a mix of Ariane’s Europeanize Soyuz and Virgin Galactic’s Launcher One to deploy and replenish its constellation.

Outside of small launcher capacity and dedicated bundled flights, many small satellites today fly as secondary or auxiliary payloads on launch vehicles designed for much larger satellites. Although the market is responding with the development of new small-class rockets, there are limited options for dedicated launch vehicles today that allow small satellites to be the primary, or lead, payload. While small satellite customers benefit from being a secondary payload through fractional pricing relative to the price of a dedicated launch service, CSF acknowledges that status as a secondary or auxiliary payload does sometimes result in trade-offs for the small satellite customer. For example, satellites that fly as secondary or auxiliary payloads must align their launch schedules with the primary customer, and usually have to go to the orbit of the primary payload.

The best solution for access to space for small satellite companies in the U.S. will come when there are dedicated launch providers specifically targeting small satellites as their primary payload, coupled with options for bundled launch services on larger rockets and opportunities to ride to space as a secondary payload. As noted throughout my statement, small launch vehicle capability is less than a year away, financed by private capital. The launch services market is
robustly responding to demand—Government intervention at this time is not necessary and would likely be harmful.

**U.S. Launch Capacity**

With this growth in demand for domestic space launch, the need in the near term for state-of-the-art launch facilities is necessary. Various spaceports from Virginia to Florida to Alaska are well positioned to support existing as well as new launch vehicles that are coming on line. From horizontal, vertical, and other gateways into space (World View Experience incorporating balloon technology), as well as testing and research, many different types of facilities and in turn, multiple spaceports, are necessary.

Beyond the Federal Ranges at Cape Canaveral Air Force Station (CCAFS) and Vandenberg Air Force Base (VAFB), as well as the existing Mid-Atlantic Regional Spaceport (MARS), there are currently spaceports in all stages of development. In California, the Mojave Air and Spaceport has for years served as a critical test bed and proving ground for radical new technologies that have developed into new space capabilities for the United States. Spaceport America, in New Mexico, will soon serve as the launch pad for suborbital space tourism. In Georgia, the Camden County Spaceport seeks to join the ranks of the licensed spaceports in the near future. Space Florida is working with companies like Blue Origin to build modern manufacturing and launch facilities. To help support its incredible launch demand, SpaceX is currently developing the world’s first fully commercial orbital launch site at Brownsville, Texas. These spaceports will contribute to the Nation’s capacity to get to suborbit or orbit, and they will all benefit from a healthy market of launch vehicles—but, they will be inhibited if U.S. policy were ultimately to favor one or two companies over the investments being made in numerous private companies.

**Policy Matters Facing Congress and the Industry**

CSF, as the leading organization for the commercial space industry, worked hard with Congress on the Commercial Space Launch Competitiveness Act (CSLCA), which was signed into law in November of last year. This bipartisan legislation took important steps to refresh U.S. policy and law with respect to the commercial space launch industry. CSF appreciates the important and well-considered work done by this Committee and the entire Congress on this legislation, as it will facilitate the continued growth in commercial spaceflight.

**Commercial Use of Excess ICBM Assets**

Even as the ink is still wet on the CSLCA, the Congress is now facing efforts to reverse decades of sound policy with respect to the commercial use of excess intercontinental ballistic missile (ICBM) assets. The vast majority, but not all, of CSF’s 70 member companies strongly oppose any effort to reverse the policy.

There are now some in the defense industry that are advocating for releasing old Minuteman and Peacekeeper rocket motors from decommissioned U.S. Government intercontinental ballistic missiles (ICBMs) for use in the commercial marketplace. Those advocating for this change seek to buy the rocket motors at a substantial discount (or simply have it supplied as Government Furnished Equipment (GFE)) and then compete against other U.S. companies that have developed their own launch capabilities, using private capital investment. This proposal is counter to long-
standing U.S. law and policy, including the Commercial Space Act of 1998 and the National Space Transportation Policy, which seek to promote commercial space transportation capabilities.

In the early 1990s, following U.S.-Russian Strategic Arms Reduction Treaty (START) agreements, the issue of whether or not subsidized U.S. government launch assets should be allowed to compete against U.S. commercial launch service providers reemerged in the form of excess ballistic missile assets. Having learned the hard lessons from the failed government-subsidized Space Shuttle launch model, and not wanting to repeat them, the U.S. Government correctly reaffirmed the successful U.S. commercial space launch policies established under the Reagan Administration in the 1994 National Space Transportation Policy. The policy set out to "encourage private sector investment in new space transportation systems" by: (1) directing U.S. government agencies to purchase commercially available U.S. space transportation products and services to meet their needs; and (2) directing excess ICBMs to either be retained for government use (only after certain, stringent conditions are met) or destroyed.

Indeed, Congress was especially mindful of the potential negative impact that the conversion and use of excess ballistic missiles would have on the growth of the U.S. commercial space industry in crafting what eventually became Section 205 of the Commercial Space Act of 1998. For example, the Committee on Science commented: "It is the Committee’s understanding that the [National Space Transportation Policy] sought to strike a balance between efficient use of government assets and the potential to undermine the health of the U.S. commercial space transportation industry.

Wholesale conversions of ICBMs [Intercontinental Ballistic Missiles] into space transportation vehicles risks placing the government in the position of competing with the private sector and could have long-term consequences."

By consistently reaffirming 30 years of U.S. commercial launch policy, improving regulatory stability, and promoting pro-growth policies, the United States Government has, thus far, fostered a healthy development of U.S. commercial launch service providers—and we are seeing this policy bear fruit today. Currently U.S. providers operate eight different commercially available orbital launch vehicles, with several more under development. Over the past two years, the U.S. commercial launch industry has made significant progress in terms of competitiveness and innovation. U.S. commercially available launch providers have both recaptured a predominant share of the global commercial launch market, and, established the U.S. as the leading provider of access to space for commercial small-satellite ventures. With a number of new U.S. launch vehicles entering commercial operations in the next year or two, including multiple dedicated small-satellite launch vehicles, this progress is forecasted to continue.

For decades, the Government has correctly recognized that it should not be competing against the U.S. commercial launch sector by utilizing excess ICBMs for its own use (unless certain, stringent conditions are met) because this would have adverse impacts on the U.S. launch industrial base, to the detriment of national security and civil space objectives. This concern would be materially exacerbated by allowing these excess ICBMs to be sold on the open commercial market, because the Government would be directly competing against U.S. industry beyond the Government launch services sector.

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CSF encourages this Committee to strongly oppose any change to the existing policy with respect to the commercial use of excess ICBM assets for the following reasons:

1. Flooding the market with cheap government motors would tilt the playing field away from the commercial industry and toward the company that received the cheap motors. This kind of market intervention is exactly what the current policy is designed to avoid: picking winners and losers in the marketplace. It also sends a strong signal to investors: don’t put your money in launch vehicle companies – the government may decide to cut you off at the knees anytime. The result: a weaker U.S. rocket propulsion industrial base, less innovation from start-up companies, fewer new technologies, and a less robust U.S. national security launch capability.

2. This policy reversal is not necessary. Not only are U.S. firms bringing launch vehicles to market, but Russia is removing both of its Dnepr & Rokot converted ICBM rockets from the market.10

3. The impact of this policy reversal has not been studied. Although media reports recently indicated that the Air Force is interested in changing the policy, it is abundantly clear that the Air Force or the Department of Defense has taken no steps to assess or understand the impact of this policy change on the commercial space launch market.11

4. This change would materially damage investment by sending a signal to potential developers of future commercial space transportation services that the Government will compete with them at any time, and that the Government will pick winners and losers.

5. This change would undermine longstanding non-proliferation efforts by the U.S. Government to limit the use of these missiles to Government use (in rare circumstances, requiring a waiver/certification), or be destroyed.

6. This change would undermine U.S. Government international leadership opposing the use by other nations of these excess assets on the commercial market, potentially resulting in a flood of these national assets into the market by other nations.

7. There will be no material cost savings to the Government, while this reversal in policy could irreparably harm the U.S. commercial launch industry. Even if a portion of these motors were allowed to be used for commercial launch services, the Air Force would still be required to pay storage and monitoring costs, even if the policy is changed.12


11 Klotz, Irene. Reuters. 14 April 2016. “The last thing we want to do is harm the entrepreneurial space market that we’ve built in this country. But I don’t think it’s necessarily a given that selling (ICBMs) will harm it, nor do I think that it won’t harm it. We don’t have any information one way or another,” Loverro said.” Source: http://www.reuters.com/article/us-space-missiles-commercial-idUSKCN0X182YG

India Launch Services

Prohibiting access to foreign launch services, like India’s, who do not allow their payloads to fly on U.S. vehicles, has opened another set of opportunities for U.S. commercial companies to develop their own systems to serve the global satellite launch market.

Here, CSF opposes any change to the current U.S. policy with respect to launch on Indian launch vehicle systems.

For commercial as well as government launches, Indian launch vehicles are operated by the Indian Space Research Organization (ISRO), a government entity that also funds the development and manufacture of these launch vehicles. Here, CSF has seen that pricing for commercial launch services on Indian rockets historically has not reflected the true costs associated with their initial development and on-going launch operations, putting U.S. commercial launchers at a disadvantage in competitions for these class of payloads. In effect, India is dumping these vehicles on the commercial market to the detriment of U.S. firms. We would encourage the U.S. Congress to support American firms offering legitimate pricing for launch services in this market.

To be sure, the U.S. National Space Policy, the National Security Space Strategy, and the National Space Transportation Policy all note the importance of a robust domestic commercial industry. Specifically, the National Space Transportation Policy notes that “strengthen[ing] U.S. competitiveness in the international commercial launch market is important to ensuring that U.S. space transportation capabilities will be reliable, robust, safe, and affordable in the future” and directs U.S. government entities to consider the health of the U.S. space industrial base in making decisions regarding space transportation.

As my statement has documented, American industry has invested hundreds of millions of dollars to meet government and commercial requirements for space launch services and is recapturing global commercial launch market share. Industry is bringing new launch capability to market to meet new market demand. A new generation of small, flexible, and low cost launch vehicles are being developed with private sector resources and these companies have already added thousands of high-tech American jobs. These new start-ups are particularly vulnerable to the predatory pricing practices of government-owned and -operated launch systems.

Consequently, CSF opposes efforts to facilitate a government-subsidized foreign launch company—in this case, ISRO—to compete with U.S. companies. Such a policy runs counter to many national priorities and undermines the work and investment that has been made by government and industry to ensure the health of the U.S. space launch industrial base. At the same time, we have to be cautious not to squeeze out the U.S. satellite manufacturers and operators that have immediate launch needs which cannot yet be served by the aforementioned U.S. launch vehicles that are still in development. If it can be shown that there are no viable U.S.

launch opportunities in a given timeframe to a required orbit, launch on PSLV or GSLV should continue to be considered on a case-by-case waiver review for U.S. payloads, as has been the practice for the last several years. This practice should continue while still relevant, but with the knowledge that it is a temporary solution until the U.S. launch industry further matures and becomes available for U.S. payloads.

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Conclusion

Mr. Chairman, on behalf of the more than 70 Members of the Commercial Spaceflight Federation, I appreciate the opportunity to testify before this Committee on this timely and important topic. Given the significant technological breakthroughs and private investment happening across our business, I strongly encourage this Committee to be highly circumspect about ill-conceived changes to policy that could effectively unwind the progress our industry is making.

American industry is responding to market demand and innovating on new technologies, outpacing any other nation in the world. We seek to preserve this national leadership in space, extend Earth’s economic sphere, and to create safe and reliable access to space. We look forward to working with the Congress to achieve these goals.
ERIC STALLMER, PRESIDENT OF THE COMMERCIAL SPACEFLIGHT FEDERATION

Eric Stallmer is the President of the Commercial Spaceflight Federation. CSF is the largest trade organization dedicated to promoting the development of commercial spaceflight, pursuing ever-higher levels of safety and sharing best practices and expertise throughout the industry. Under Stallmer’s leadership, CSF has worked tirelessly to develop industry standards, craft the modern Commercial Space Launch Act and encourage further growth in the commercial spaceflight industry.

Stallmer constantly promotes the industry and CSF member companies through his outreach to high-ranking officials and high-profile media outlets. His professional comments have been featured in The Washington Post, Wall Street Journal, NBC Today Show, ABC News, CBS News Radio, Fox News, The BBC, CNBC, SpaceNews, Orlando Sentinel, Florida Today, Der Speigel, Men’s Journal, and more. Stallmer also promotes the mission of CSF through participation at multiple industry conferences throughout the year.

Earlier this year, Stallmer testified before the Senate Subcommittee on Science, Space, and Competitiveness in a hearing titled, “U.S. Human Exploration Goals and Commercial Space Competitiveness.” There he encouraged Congress to codify a number of productive policies that will facilitate growth and innovation in the industry, and maintain the American space sector’s competitive leadership.

Before his position at CSF, Stallmer served as the Vice President of Government Relations at Analytical Graphics Inc. (AGI). Stallmer joined AGI in 2002. While there, Stallmer represented AGI’s commercial off-the-shelf products and technology to defense, intelligence, Congress and civil government sectors within the aerospace industry.

Stallmer came to AGI from The Space Transportation Association (STA), a non-profit, industry trade organization providing government representation to companies with a vested interest in the U.S space launch industry. Prior to that, Stallmer worked on Capitol Hill in the office of then Congressman Tom Coburn.

For the past two decades, Stallmer has served as an Officer in the United States Army and Army Reserves. He was awarded the Bronze Star Medal for meritorious service while engaged in combat operations during Operation Iraqi Freedom. He is currently assigned to the Pentagon in the office of the Deputy Chief of Staff Army for Logistics, G-4.

Stallmer earned a Master of Arts Degree in Public Administration from George Mason University, Fairfax, VA, and a Bachelor of Arts Degree in Political Science and History from Mount Saint Mary College in Newburgh, N.Y. He and his wife Amy live in Arlington, Virginia with their three children, Charlie, Billy and Catherine.
Chairman Babin. Thank you, Mr. Stallmer.
The Chair now recognizes himself for five minutes for questions.
This is directed to both of you. The United States has retained a number of excess intercontinental ballistic missiles and component parts. Current law permits these ICBMs to be converted for government use in space launch vehicles but only if certain conditions are met. Current law does not permit these ICBMs or their component parts to be converted to commercial launch vehicles.

Recently, in SpaceNews we saw dueling op-eds written by George Whitesides of Virgin Galactic and Scott Lehr of Orbital ATK regarding how changing the current rules to allow access ICBM motors to be used for commercial launches would impact America's space industry. Lehr says that U.S. companies are losing small satellite launches to international competitors—specifically, Russia—because of these restrictions. Whitesides argues that allowing excess government ICBMs to be used for commercial launches would undermine the nascent U.S. small satellite launch services industry, which is heavily invested in the development of new launch vehicles.

What would be the advantages and disadvantages of amending the law to permit wider use of excess ICBMs for commercial space launch? Mr. Pulham or Mr. Stallmer, who wants to go first?

Mr. Pulham. Thank you, Mr. Chairman. As you note, this is a fairly recent and highly contentious issue. And at the aforementioned Space Symposium last week, I had a considerable amount of lobbying from both sides of the issue for many of our member companies. And there's a disparity of opinion.

The Space Foundation has always prided itself on being a consensus-based organization. We put together our pioneering report that Congressman Bridenstine has incorporated in his American Space Renaissance Act, and we took a year to do that so that we could address all the concerns and make sure that what we came forward with was something that the entire space community would rally behind and benefit from, and similarly, the white paper recently on ensuring the U.S. leadership in space bringing 14 organizations and taking about seven months to write what's essentially a three page paper.

Our view right now is there is not consensus on this issue, and so we really are not going to take a stand one way or another. I think that the ideas need to play themselves out in the marketplace. I'm not a believer in the no-win scenario or the zero-sum game. I think that there is probably a path forward for consensus, but that will take some time.

Chairman Babin. Mr. Stallmer?

Mr. Stallmer. I will take the path of the choices—the advantages or disadvantages. I'll lean to the disadvantages first. Flooding the market with cheap government motors would certainly tilt the playing field from the commercial industry. There's many companies out there that have invested significant amount of private sector investment in developing a marketplace, developing vehicles to address this very market that we're talking about.

The long-standing government policy which has been around for 30 years, several different Administrations—is sound policy. We saw the effects that it had of the government in the marketplace
during the shuttle era when the government was launching commercial payloads. In 1980, the United States had 100 percent of the commercial launch market. By, I believe, 2010 we had zero percent of the commercial launch market.

So it’s a dangerous precedent to go down. And there’s a lot of different reasons, not just the cost. It stunts innovation. We have companies out there in Texas, and California, all over the world, probably in every State that is represented here on the dais, that are developing innovative technologies. And I think a step back in this direction would be a tremendous one, it would send a message in innovation and it would send a tremendous message to the investment community on whether, you know, government policy should be adhered to or followed as we move forward.

A lot has been said on the type of these vehicles and the cost savings to the Air Force. As we look at it, it’s very difficult to find that cost savings that the Air Force is looking for.

And, Congressman Veasey, I apologize on the delay on the testimony. As we mentioned, we were both out—Elliott in a much greater fashion—at the Space Symposium where we worked extensively with meetings with many of the different companies that are involved in this issue and also where the Air Force stands on this issue. And that’s also a very difficult position to find at times.

You can talk to some of the most senior members of the Air Force that have no opinion or no knowledge of this issue on Tuesday, and on Thursday the Air Force is coming out and saying, you know, maybe we should evaluate this and there could be a sweet spot but we don’t want to upset the apple cart with the commercial sector.

As far as the tax savings goes, a lot of it comes down—what is said—it’s the surveillance and monitoring and the maintenance of this fleet of ICBMs. There’s over 900 of these potential muscles that the Air Force is safeguarding, monitoring, and surveilling. If you just perhaps say that we’re going to give 50 of these motors to the commercial marketplace, you still have 850 of these motors that you have to surveil and monitor and watch and everything. If you rent storage space, and just because you take, you know, some items out of the storage space, you still have to pay for that storage space. And also, this is a sunk cost that the taxpayers have paid for for their intended purposes.

So there’s a lot of concern with this and how it could disrupt the marketplace. It can disrupt the private sector investment. I certainly see it and the debate back and forth has been tremendously cordial with the companies that are involved and thoughtful.

And for my companies, we represent most all of the spaceports in the United States. We have over 10 spaceports that we represent. And I see the concern that they have because to stay in business, you need to be launching vehicles. And I am all for that and I want to see them grow. I want to see other U.S. launch companies grow. But I think if you shut off this—the capital investment by, you know, tilting the playing field, it will certainly impact on other launch companies and limit the amount of launch companies that could be launching at these spaceports.

So I apologize for the long answer on that.

Chairman BABIN. Okay, sir. Thank you.
Okay. Now, I'd like to call on the gentleman from Texas, Mr. Veasey.

Mr. Veasey. Thank you, Mr. Chairman.

And I wanted to ask both members of the panel. There seems to be a lot of emerging activity in both the smallsat and small launcher arenas. A few years ago, dedicated small launchers were greeted with lukewarm reception and the demand never really materialized. What has changed this time around to make the small launchers more attractive?

Mr. Stallmer. Money. I would say money. There's tremendous investment capital. Elliott had mentioned earlier in the late '90s with these pie-in-the-sky ideas, these large, huge commercial constellations. I think the technology was almost there but the funding wasn't there as much, and the capital markets froze up. The capital markets aren't freezing up right now, and there's a tremendous amount of investors. There's crossover investors. They're investing not only in these large satellite constellations but also in the launch vehicles that will provide—you know, provide access to these constellations.

So I think that's probably the biggest difference right now from what we saw in the past, and it's the tremendous need for big data—data, data, I'm sorry. But there's a tremendous need there for internet access, as well as, you know, remote sensing needs, the satellite communication needs. So as our appetite for this grows larger, I think you're going to see the need for these larger constellations.

Mr. Pulham. I would agree with Mr. Stallmer's comments. I think, you know, a couple other things are at play. The large constellations that have been proposed in the '90s were really about building telecom backhaul and video backhaul, and today, we're in a world of much more directed consumer use of the satellites and their data. If you look at the largest category of commercial satellite activity, it is direct-home broadcasting followed by GPS, which is direct to consumer. Everybody that's got one of these a little iPhones or whatever you're carrying, you've got a satellite ground station that you're carrying in your pocket.

I think the other really interesting difference to me is somewhat about the money is the degree to which there is great synergy now between the technical and innovation focus of Silicon Valley and the people who are innovating in space and contributing to these startups in space. If you look at, you know, what's going on with SpaceX, well, you know, they know a thing or two about Silicon Valley; they have connections there. And there's this whole locus of people who are equally interested and equally financially invested in these markets that begin to integrate themselves.

And so I think you have a more directly relevant set of investors that is much better financially equipped than the last time around and with a business model that is much more sustainable.

Mr. Veasey. And the next question I wanted to ask both of you again is on the Indian launch vehicles. What are the critical factors that are leading U.S. commercial satellite operators to seek waivers to the U.S. policy on launching satellites on Indian launch vehicles?

Mr. Stallmer. The challenge right now is that the satellite manufacturers are making satellites at a quicker rate right now than
we have the launch capability. So a satellite is not making money as—while it’s sitting on the ground. Currently, the PSLV launch vehicle, the Indian launch vehicle, PSLV, has a sweet spot and it has the capability of launching some of these satellites right now in a timely manner.

We don’t want to see U.S. launches going overseas by any means, whether it’s to India, Russia, or whomever else, but right now from the satellite, you know, producers and manufacturers, they need to get their assets up in the sky as quick as possible.

I think this policy with the waivers and the review is a sound policy. I think it needs to be in place. I think we should be—you know, should stringently look at every launch that is taking place on every vehicle—or every payload that we’re putting up on an Indian vehicle. But I think it really needs to be evaluated, and I think—as the Congressman said earlier, time will tell on this. We hope to phase this out as the new generation of launch vehicles come online.

And in addition to that, a lot of these payloads that are being launched on these Indian vehicles are only one-off prototypes because as they’re being launched, they’re not being launched in a dedicated orbit. They’re being launched with the orbit that it’s putting on. So it’s mainly the prototypes of these vehicle—these payloads.

Mr. Veasey. Mr. Chairman, I yield back. Thank you.

Chairman Babin. Yes, sir. Thank you, Mr. Veasey.

Mr. Posey. Thank you very much, Mr. Chairman.

We got a lot of discussion but still a relatively small amount of information about the engines themselves. I’d like each one of you to just SWAG what you think each one of these engines would be worth on the market.

Mr. Stallmer. It’s hard to say, but I would say if you were trying to launch that payload or that class of payload, whether it’s 1,200 pounds or—1,200 kilograms or 1,500 kilograms, what would it cost on a commercial variant of that vehicle? And I’m guessing that that variant would probably be in the $30 million neighborhood. I think—the motors would be about in the $30 million vehicle.

Mr. Posey. Okay.

Mr. Stallmer. The motors would cost about $30 million, I believe.

Mr. Posey. Each?

Mr. Stallmer. So—each.

Mr. Posey. Okay.

Mr. Stallmer. But I think certainly if you go forward, a detailed cost analysis would have to be in place to see what the actual cost is, what the government cost, what they should be charging, things of that nature.

Mr. Posey. Yes.

Mr. Pulham. Votes, okay. Congressman, thank you for the question. I would associate myself with Eric’s remarks in terms of the detailed cost analysis being required. We don’t like to speculate, and if we were asked the question and had time to answer, I would task my research experts in talking with the Air Force about what
they're willing to sell for, talking with companies about what they're willing to pay to try and come back with some kind of a figure. I just have no idea at this time.

Mr. Posey. Well, I—you know, it is so hard on the Hill to get a yes or no answer out of anybody, much less a good guess at a value. And I really do appreciate you SWAG-ing that for me, and it just gets us in the ballpark.

Would either one of you care to comment on the percentage of cost of the launch vehicle, the engine is? So if you have one of these engines, do you have 50 percent of your program ready to go, 33, 25? What do you think?

Mr. Pulham. Again, Congressman, it’s an interesting question because each of these vehicles has different attributes. If you look at what Virgin Galactic is doing with LauncherOne, their entire first stage is an aircraft, and so their model is fundamentally different. So I just—you know, it would be different for virtually every launch vehicle, I think.

Mr. Stallmer. I think in the category of launch vehicles we’re talking about, though, I think it is significant. It is the motor. I mean, you certainly need the guidance systems and the payload fairings and everything else, but certainly you build a rocket around the engine, the motors.

But I’m not an engineer. I’m a poli-sci guy, so I would stick to the experts on that. But if you’re asking me for a WAG, I would say it’s a significant portion of the rocket on this type of——

Mr. Posey. Well, you know, I’m figuring that they would probably like to have the whole rocket. You know, what would the payload be on one of the ICBMs that we’re talking about accessing?

Mr. Pulham. The size of the payloads?

Mr. Pulham. Yes. The weight of the payload.

Mr. Stallmer. I believe that the payload range is anywhere from 500 kilograms to about 1,500 kilograms. And I think that’s a rough estimate because it falls in the medium-sized payload area. It’s—you know, whereas a Falcon 9 is a little bit larger. Falcon 9 Heavy is extremely larger. What Virgin Galactic and Firefly looking at are smaller payload and the less than, you know, 500 kilogram payload, maybe about 300 kilogram payloads.

Mr. Posey. Yes. So the question is if I could just buy one of the ICBMs, you know, take out the current payload, now I own it, what would the market demand be for the 500 to 1,500 range payload?

Mr. Stallmer. Well, that’s the challenge. It could—the market demand is high for that depending on how you use that payload or that rocket. So, for instance, just recently—I don’t have the exact date—but a few months ago, SpaceX launched the ORBCOMM constellation of satellites, and they basically bundled, I believe, 11 satellites and then they dispensed the satellites out.

So if you aggregate the payloads, it ranges. If you’re just looking for—you know, to use this launch vehicle for one payload, a 1,000 kilogram payload, then there you go. There may be a market for that. I’m not sure of what that mid-class market is, but I know mostly what we’re talking about now—and when you’re talking about a much larger market, you’re talking about the geostationary market, which is a lot—or it’s a very stable—we know almost exactly what that will be and who will be launching it.
With these smaller satellites that are going up, these smaller constellations—and I have a graph I could share with you and the breakdown of the weight and the—
Mr. Posey. That’s one of the talking points. I like that.
Mr. Stallmer. Yes.
Mr. Posey. And I was thinking like OneWeb.
Mr. Stallmer. So what OneWeb is looking to do right now—and they have already aligned—of their 700 launches, they are going to go with an Ariane space launch vehicle, as well as augment some of these smaller aggregation with Virgin Galactic. So the Virgin Galactic will maybe launch, you know, several—a handful of satellites at a time where the Ariane variant can launch a much larger amount because it’s a larger payload. And I think Elliott has a chart on that.
Mr. Pulham. Yes, Congressman. In my testimony there’s a chart from our research folks that shows from 2006 to 2015 the breakdown of various masses that were launched. And in the area that we’re talking about, the medium 501 to 1,500 kilograms in 2014, just eyeballing it, it looks like it was probably about 13 or 14 percent of what was launched, and in 2015, probably only about nine or 10 percent.
Mr. Posey. Okay. Thank you very much.
Chairman Babin. Thank you.
I’d like to recognize the gentleman from California, Mr. Rohrabacher.
Mr. Rohrabacher. Well, thank you very much, Mr. Chairman. Actually, is it okay—
Chairman Babin. No—
Mr. Rohrabacher. All right.
Chairman Babin.—he’s passing his time—
Mr. Rohrabacher. All right. Oh, my gosh.
Chairman Babin. —so you’re going next.
Mr. Rohrabacher. Well, he usually refutes me after I—no, thank you very much, Mr. Chairman. This—you know, we have perplexing issues here in Washington, D.C., and this is one of the perplexing issues because we know that one of our great assets is this new and thriving and futuristic space transportation systems that we have now being developed in the private sector.
And at the same time have made a lot of investments when they were needed during the Cold War, et cetera, in rocket missile technologies that are—there waiting and then what to do with them in a way that would not undermine these people who—not changing the rules in the middle of the game for this people who now have invested in this new industry.
So let me suggest that it is not an unsolvable formula that we’re looking for. We know, and it’s a pretty well—it is pretty well understood that the government does have a right to do launches on these ICBMs for government purposes, for a government mission, is that correct? I mean, we’re not saying—the private sector isn’t saying no, they’ve got to go with the private companies even though the government has the capability of doing it itself, is that correct? That’s pretty well—
Mr. Pulham. That’s correct.
Mr. ROHRABACHER. Okay. Well, then the problem then—let me just suggest that the government—maybe we're under—or not looking close enough to see that there are things that the government needs to do in space that will help alleviate this problem. For example, if you have a certain number of space vehicles that are there like ICBMs and waiting, well, we didn't build them because we wanted them to drop nuclear weapons on the Soviet Union. That's not why we built those. We built those just in case there was a war, but we didn't want that to happen.

Well, there are lots of things we need to do in space that would also mean that we have to have this capability. How about cleaning space debris? How about making sure that we have a new commitment to making sure—and that would be a federal commitment, and that these rockets will be used for things like that? Or how about global protection against meteorites or asteroids that might come and destroy the planet if we don't have the capability of dealing with that? Those are—you know, we have things we can do—that the Federal Government has to do and has to be part of.

If we don't clean up the space debris, we're not going to be able to do this business in space. It will undermine the private sector anyway. So we need to do that, and it needs to be done by the Federal Government. It needs to be a federal program. And so maybe we can dedicate these ICBMs to missions like that and—rather than trying to undermine our people in the private sector who have invested huge amounts of money in order to build this capability without thinking their federal—the Federal Government was going to change rules of the game and undermine their efforts to operate in the market.

So, anyway, that's just a thought. The bottom line is we need innovative technologies, but I think what we need, Mr. Chairman, is not just innovative technologies, but we need innovative policies and perhaps expanding the role and getting the job done that we need to get done in space, and focusing on that may help us overcome this perplexing issue that we're discussing today.

And you've got about a half-a-minute to say yes or no.

Mr. PULHAM. Space debris is a huge issue, and I never thought I would see a time when the commercial industry would be anxious to try and find ways to regulate itself because of the environment up there. We are starting to talk about space traffic management, which has been an off-subject thing in recent years. You know, absolutely space debris is a huge issue, and anything we can do to tackle it is something we need to do.

Mr. ROHRABACHER. Even with the old ICBMs might play a role?

Mr. PULHAM. If they can play a role, let them play a role.

Mr. STALLMER. I would say no on the ICBMs because China had a satellite that they justified that there was a dead satellite and they wanted to take it out of that orbit, and they used an ICBM as an ASAT weapon. And as we were tracking—the U.S. tracks over 20,000 pieces of debris because of this China ASAT that took place by shooting a piece of debris. It caused about 5,000 pieces of debris.

So that would not be the best way, I would say, to use this, but I think the focus the Air Force's technology on space traffic man-
agement and if there's a way to use these vehicles in that regard, I'd be for it.

Mr. ROHRABACHER. Yes. I think the suggestion wasn't that the ICBM——

Mr. STALLMER. Right. Right.

Mr. ROHRABACHER. That's your debris.

Mr. STALLMER. Right. Right.

Mr. ROHRABACHER. Yes, you weren't proposing to blow these things out of the——

Mr. STALLMER. Not one for one. Not one for one.

Mr. ROHRABACHER. Yes, but we might have some big machine that we put up there——

Mr. STALLMER. That's right.

Mr. ROHRABACHER. —that could actually——

Mr. STALLMER. If we could do that, I would be all for that, sir.

Mr. ROHRABACHER. Okay. Thanks very much, Mr. Chair.

Chairman BABIN. You're welcome. Thank you, good line of questioning.

Let's see. Now, the gentleman from Colorado, Mr. Perlmutter.

Mr. PERLMUTTER. Thanks, Mr. Chair.

And Mr. Rohrabacher and I often disagree, but a lot of times we agree, and he and I are on the same page when it comes to creating some kind of formula that both encourages private development of launch systems to carry, you know, smaller satellites to really maximize the private endeavors here but also maximize the investments that taxpayers have made, whether they're from Colorado or California or any place else in the Nation with all of these ICBMs.

So I think there will be a formula that will do both of those things. And, you know—and I agree we want to use the ICBM not to blow something up, up there but to maybe be the vehicle that——

Mr. PULHAM. Certainly.

Mr. PERLMUTTER. —you know, has the snowplow cleaning up the junk up there.

So, you know, one of the things I want to see encouraged, and I think we're seeing this development, is with the small satellites, the CubeSats, the microsats, whatever you call them, to be able to have some kind of a launch system that really is dedicated to them. And so that, you know, whether it's some private—small private enterprise that's building the satellite or whether it's, you know, a university developing the technology to go on a small satellite, I mean, I came in late and my guess is you gentlemen already answered this, but are those launch systems being developed? Is there something else we as a Congress can do to spur their development? And I'll turn it over to whoever wants to go first.

Mr. PULHAM. Thank you, Congressman, and I appreciate you being here and would invite you to see some satellite payloads being deployed from Fort Carson the summer. We are involved with the United Launch Alliance on a program called Future Heavy where we're going to be launching the world's largest amateur rocket from Fort Carson and deploying about a dozen student experiments that are all in the CubeSat sort of range. So I hope you can join us for that.
I think that, as my colleague has suggested, that development is going very, very well, and so what we need to focus our efforts on is how to be—to not perturb, I guess, the environment by acting without really, really thinking things through. I think that the—a lot of the launch companies have great, innovative ideas. The architectures that they're introducing are very interesting, and they're working with lots of different spaceports, which is going to give people a tremendous variety of options. So I think we're headed on a really good path. We've got a lot of private investment pouring in, and so I would say just let's not throw the baby out with the bathwater.

Mr. STALLMER. I would concur with Elliott on that. The process right now is working. We have at least four or five small satellite launch vehicles in development right now that should be coming online within the next year or so. I think any change in this policy again could be very disruptive to that process. A lot of this—you know, what you don't want is these companies coming to you for, you know, a handout or, you know, additional funding. They're doing it by themselves by private sector investment right now. And if we stunt that private sector investment growth, we're going to have a large—you know, a much greater problem. So I think we're doing the right thing in that regard. And even if the policy had—would change, you change it tomorrow, it would take at least a year to 24 months to transition these motors into vehicles, I believe, maybe a year, but maybe more. So I think that's a challenge that we have.

But I'm all for—you know, as a taxpayer, as someone who's served in the military for 25 years, I see the investment that these had and I think if there's a way that we can think creatively on how to use these missiles for not their intended purposes, I think it's ideal. And I'd like to come to—come forward with a solution—try to find a solution to that.

Mr. PERLMUTTER. Okay. So, I mean, I'm happy if you're telling me just let it develop on its own, that there really isn't any major need for us to do something, that's fine with me. I do want to see us not pass up the opportunity to put the ICBMs to work in some positive fashion. I guess I'm not afraid of India as being, you know, a launch country for some of our small satellites. So I'm happy just to be hands-off. But I also have a responsibility as a Member of Congress to make sure that the assets of the United States are used properly and not just thrown away.

Mr. STALLMER. I certainly see your concern there from the taxpayer perspective, and it's greatly appreciated. But sometimes the hands-off approach also is appreciated in industry. If you see—and sometimes, you need a little hand from the government and a pat on the back, but I think if you see the progress that the commercial sector has made just in the last week alone or last two weeks what Blue Origin has done out in West Texas on improving their reusability, what SpaceX did with the commercial cargo launch, they launched not only a cargo to the International Space Station, they put in their trunk an inflatable module made by a commercial company Bigelow Aerospace that attached to the International Space Station that was built—the delivery system was built by Sierra Nevada from Colorado, and all the different commercial play-
ers that were involved in that and launched from Space Florida. So there's a lot of tremendous growth going on in the commercial marketplace.

Mr. PERLMUTTER. I have one last question if I could, Mr. Chair. So when I walked in, I wasn't quite sure if I heard this correctly, but did you say that these companies should get their assets up into space as soon as possible? Is that what you said, assets, I hope?

Mr. STALLMER. I think, yes, the companies—and I think collectively as a nation we should get our other assets——

Mr. PERLMUTTER. Get our assets up into space? All right. Thank you. I yield back.

Chairman BABIN. Yes, sir. Thank you. And I'd like to call——

Mr. STALLMER. My mother might be watching, so I'll be careful. Chairman BABIN. I'd like to call on the gentlewoman from Virginia, Mrs. Comstock.

Mrs. COMSTOCK. Thank you, Mr. Chairman.

It's hard to have a discussion about commercial space and not mention Virginia's Mid-Atlantic Regional Spaceport at NASA Wallops, which is one of only four launch sites in the entire United States that is capable of launching to orbit. It has served as a vital asset in support of our nation's space industry. So there has been discussion on the commercial use of decommissioned ICBM motors, and I wanted to ask how potential use of these motors could benefit our nation's spaceports, including MARS?

Mr. STALLMER. Well, we represent MARS and the great people at the Mid-Atlantic Regional Spaceport. Dale Nash is doing a fantastic job down there, and I think it's a vital asset to the U.S. spaceports, and we are tremendously supportive of what he does. And I also should say, Congresswoman, tremendously supportive of what you do for McLean Little League and your support.

Mrs. COMSTOCK. Thank you.

Mr. STALLMER. You know, I have three children that are quite heavily——

Mrs. COMSTOCK. That was a great——

Mr. STALLMER. —involved.

Mrs. COMSTOCK. We just had our kickoff on Little League, and Jayson Werth threw out the first pitch, so that was fun, too, right?

Mr. STALLMER. I heard he was only going to be there because he knew you were going to be there so——

Mrs. COMSTOCK. Oh, yes.

Mr. STALLMER. But, no, the spaceports are vital to the economic growth of our industry. It's a total ecosystem of what we're dealing with. Without these state-of-the-art reliable spaceports, we're not going to have the vehicles that we can put up into space and all the tremendous benefits that we're going to get to space. So to say we support Mars, it would be an understatement because I think, as I say, a vital asset.

I guess our thinking would be—and they have a great partnership with Orbital ATK, another fantastic company, whose right in the middle of this issue, and we want to see Orbital be launching as many vehicles as they can from MARS and from the other spaceports.
We see the value, though, without these ICBMs, that there’s potential of launching even more vehicles from those spaceports and that spaceport in particular. However, I think if the government intercedes and cuts into the competitiveness of the commercial marketplace, as we’ve seen in the past, it can have a really damaging impact on the industry as a whole. So instead of launching one or two vehicles from the spaceport per year, you can go either way. It could be we launch several or launching a few, and I think that’s what we really need to examine. But tremendously supportive of the Virginia spaceport.

Mrs. COMSTOCK. All right. Thank you.

And thank you, Mr. Chairman.

Chairman BABIN. You’re welcome. Thank you.

I think at this time we’d like to go back through for a second round of questions if that’s amenable with everyone.

I recognize myself for the first one.

Under the 1998 Commercial Space Act the Federal Government can use excess ICBMs for its own use as long as certain conditions are met. We’ve heard that numerous times today. This provision was utilized by NASA for the LADEE mission. We’ve recently heard that the procurement for this mission was particularly onerous and resulted in a protracted protest to the GAO. As a result, we’ve heard NASA is hesitant to use excess ICBM motors on future missions despite being able to do so. What can the Congress do to make it easier for agencies to utilize existing authorities to use these access ICBMs for governmental purposes? Both of you.

Mr. PULHAM. Mr. Chairman, I think you cut right into the Armed Services Committee here. The issue, I think, is the difficulty of the contracting environment as regards federal defense and space procurements these days. There’s very rarely anymore a procurement that doesn’t end up in court or appealed or challenged or protested or whatever can be done. And so, you know, I think that the issue is not one that’s particular to launch vehicles of any kind. I think it’s systemic within federal contracting and needs to be the subject of contracting reform discussions.

Chairman BABIN. Mr. Stallmer?

Mr. STALLMER. And I think a lot of this discussion, you know, when we go through the research and the waiver process to launch in these vehicles, a lot of this policy is the discussion on the potential of what if a launch failure happened at one of these ICBMs? I think that is a discussion and what this could mean to the nuclear triad. I think that was where a lot of the area of pause came from and the implication and the integrity of our ICBM arsenal.

So I think there’s a lot of broader policy implications involved with this. Certainly, the discussion with Congress on how we can streamline these processes would be helpful in that regard because, again, the national policy does state that these assets can be used for defense and other government missions and just—they—you know, they need to go through that process. So I think it needs to be a thoughtful discussion involved on that.

Chairman BABIN. Okay. Thank you.

And then, again, General Hyten, Commander of Air Force Space Command, stated in the “Financial Times” yesterday that a growing number of commercial launch ventures made him worry wheth-
er there was enough business to sustain them all, noting a similar bubble in the late 1990s that burst when commercial satellite constellations went bankrupt. Is the recent prosperity of the small satellite market a result of technological advances such as Moore’s law and spin-in from the technology sector, or is it a reflection of a short-term bubble in launch services brought about by government subsidies?

Mr. PULHAM. Thank you, Mr. Chairman.

I certainly don’t think it’s because of government subsidies. I think that you’re seeing different success in different sectors of the space industry, and that drives itself into the various types of satellites that are being launched.

In the case of the very small satellites, it’s really been the development of microelectronics and the compression of processors and, you know, the availability of nanotechnology that is allowing these small satellites to be produced almost as a commodity. They’re coming off an assembly line and students are putting them together, and it’s not the kind of intense clean-room operation that major satellites are contending with.

At the same time, the companies that have orbital slots where they’re able to put very high-value satellites in geostationary orbit, they’re not shrinking those satellites. They’re putting more and more capability into them and more and more capability to stay in orbit longer. And because the longer a commercial satellite is functioning, the more revenue they’re able to see from it.

And so you’re seeing investment from the commercial operators in things like research that will help them with satellite servicing. And I think it was Intelsat that just inked an agreement with somebody to do a——

Mr. STALLMER. With Orbital ATK.

Mr. PULHAM. With Orbital ATK to do a demonstration of satellite servicing.

So you have different types of investment being made in different sectors of the industry. You do have—you know, the launch business is interesting. It really only comprises about 2 to 2–1/2 percent of the total space marketplace globally, but that 2–1/2 percent works out to, you know, about $3 billion or so, so that’s not—$6 billion, so that’s not chump change if you want to be in that business.

So there is a market for each of these things, and I think, you know, we need to trust the companies that have business plans and business models to go after each of the segments and to do so knowing that some are going to succeed and some are going to fail. But I think we’re at a point in the maturity of technology and the maturity of the industry and the depth of financial strength behind these that we’re going to see more successes than failures as we go forward.

Mr. STALLMER. I would say in all due respect to General Hyten that I would gauge the forecast of the commercial marketplace more from the commercial marketplace rather than from the Air Force, as well as through a lot of the organizations that are doing these forecasts in tremendous detail, you know, for instance, the Tauri Group on their annual forecast of what venture startup looks like and on what the Space Angels Network is seeing, as well as
the FAA’s forecasts, annual forecasts of what they see for these markets.

The way Silicon Valley has invested in these companies I think—as I said, there’s a lot of crossover investors that have also invested not only in the satellite systems, but also in the vehicles that are producing these.

So I certainly applaud General Hyten’s passion on this issue, but I think unless they have reports that I haven’t seen, these forecast reports on the commercial marketplace, I would kind of look forward to more of what the commercial forecasts are looking at.

Chairman BABIN. Okay. Thank you.

Yes, sir?

Mr. PULHAM. And if I can add, we talked a lot about Silicon Valley investments and angel investors here. I think one of the hallmarks of where we are today is that the investment is not just coming from high-risk-tolerant people, that a lot of the times when you see an investment made in a space company, you’ll see a Silicon Valley company sort of as a lead or a face, but it’ll be somebody very institutional like Fidelity Investments or one of the big banks back in New York that is putting a huge equity put into that because they see profits and they see progress being made in other parts of the sector. They see what is being accomplished, and their confidence to invest as institutional investors is quite strong.

So that again takes it out of the realm of where we were back when we had things like Teledesic when you were, you know, just depending on somebody’s personal, individual wealth, but you’re able to appeal to large financial institutions.

Chairman BABIN. Thank you. Thank you very much.

Now, I’d like to recognize the gentleman from Colorado one more time, Mr. Perlmutter.

Mr. PERLMUTTER. Thanks, Mr. Chair.

And, you know, obviously, this is a frontier, but with all frontiers, there’s lots of opportunity and there is risk. And to the degree there are failures, you know, I spent my life before I was elected to Congress as a Chapter 11 lawyer, you know, so that’s just the nature of private enterprise. And the fact is that more companies, more individuals are willing to see this frontier for the opportunities that it presents. And if we have some mistakes or some things don’t go, then that’s the way it is.

Now, I have a couple questions. Mr. Pulham, deploying small satellites from the space station using a commercial dispenser is perhaps the most accessible onramp for new entrants to space. What is the importance of this asset for educational institutions and space research?

Mr. PULHAM. Thank you, Congressman. It’s very important, and we’re pleased to work with the folks at CASIS in Florida on a number of programs appealing to students. But it is one of the largest users of these small satellites is for universities and student research because they don’t have access to the big national labs and platforms. And so the ability to go someplace like CASIS, manifest your payload, and have it ejected from a dispenser, which I’m—it sounds like we’re all eating PEZ here, but it works and it’s a very good approach.
And what we’re seeing is that other companies that have other solutions are also beginning to think about sort of the philanthropic part of this, yes, we’re going to put up a vehicle and we’ve got room for five small satellites. Why don’t we dedicate one of those to a university project?

So the International Space Station continues to be a profound investment that pays off for this country every single day, and the ability to deploy small satellites is just one of many, many things the ISS has given us.

Mr. PERLMUTTER. Okay. Anything to add?

Mr. STALLMER. I absolutely, completely concur. I mean, the value of the ISS is innumerable to speak of, and it is absolutely a great onramp for a lot of the type of payloads that are being launched from it.

As we move forward, I know a lot of these satellite payloads want to be—get in their dedicated orbit that would be optimal for their use, and—whereas ISS you go out where they ship you out. So—but it is just an outstanding resource and the work, you know, that CASIS is doing is fantastic and, you know, the companies like NanoRacks that help support this, it’s great.

Mr. PERLMUTTER. Similar to a question and discussion we had with my last round of questions, so this year, we found ourselves talking at length about how to transition from the Obama Administration to the next President. These conversations will likely carry over after this year. What advice do you gentlemen have to our committee and the incoming Administration, whoever it is, to support the growing commercial space industry?

Mr. PULHAM. So, Congressman, thank you. In my introductory remarks I asked to have included a white paper that our two organizations and 12 others worked on called “Ensuring U.S. Leadership in Space.” And that paper was written particularly to present an industry consensus on exactly this issue for people that are running for office, both those that have and those that have not space experience. I think this committee is very rich in that you have a lot of people here who have this experience and can share that with other members.

The—you know, the enemy that seems to gnaw at space programs in the United States is the enemy of transition from one Administration to another. And I know this plays out in a lot of different parts of the space community, but certainly where we see it the most visible is in NASA where it seems like every new Administration wants to put their thumbprint on the program, and we stop and throw away billions of dollars worth of effort and start all over again.

Starts and stops and redos are killing us, and we have to get to a position of consistency. And many of these recommendations that we’ve made in the past are now in Congressman Bridenstine’s bill that he announced last week.

And so things that give NASA and others in the space business the opportunity to do multiyear procurements, no-year procurements, stability and leadership, it’s a highly technical enterprise, and it shouldn’t be subject to political—high political turnover, and just the long-term vision of what are we intending with our space industry? We have good space policies—
Mr. PERLMUTTER. I'm going to stop you for one second——
Mr. PULHAM. Please.
Mr. PERLMUTTER. —just to put in a plug for something I'm push-
ing, which is the orbital mechanical engineers say 2033 is the best
time to get our astronauts on Mars because that's when we're clos-
est, it saves a lot of travel time, and so my goal is to make sure
we have something from a Congressional standpoint suggesting to
the Administrations as they come and go, let's get our astronauts
to Mars at least by 2033 if not before then.
And so you're absolutely right, a lot of starts, a lot of stops. We
need continuity of mission. We need not to start engaging in things
if the private sector is actually working its way through all of this.
So 2033, just remember that date, and then, Mr. Stallmer, if you
had something you wanted to add, go for it.
Mr. STALLMER. I think Elliott did a great job covering it.
I would say for the private sector and, you know, the civil and
military space, their goals should be to do—in regards to civil and
military space—do what the commercial sector cannot do. The com-
mercial—and I'm going to tell you all the great things that are
going on in the commercial marketplace. But there is still funda-
mental science and technology that only the government has that
competency and capability of doing.
So, you know, I know firsthand your staff and all the staff here
has always been engaged with our member—myself and our mem-
ber companies on knowing what our capabilities are and what our
aspirations are and what our limitations are. And I think we'll al-
ways be honest with you. And I think as we move forward, you
know, from whatever new Administration it is going to be, is that
NASA has core competencies that they're very good at, as does the
DOD. And you've got to keep in mind that the commercial market-
place would be there to help throughout the way.
Mr. PERLMUTTER. Thank you. Thanks, Mr. Chair.
Chairman Babin. Yes, sir. Thank you.
And now, I'd like to recognize the gentleman from Florida, Mr.
Posey.
Mr. POSEY. Thank you, Mr. Chairman.
I'm still trying to quantify the potential values and potential uses
of our potentially expendable ICBMs. Is there anyone in the industry
who uses the same motor now?
Mr. STALLMER. I do not believe so. I believe that Orbital ATK is
the subject matter expert on solid rocket motors. I could be cor-
rected on that. But by and large, the majority of folks in the launch
industry use liquid motors, so Orbital is the one—Orbital ATK are
that. And again, I'll check for clarification, but I believe—if they
aren't, there's not that many others.
Mr. POSEY. Okay.
Mr. STALLMER. I believe they are the only one.
Mr. POSEY. And I was interested really in domestic because I
don't want them to go overseas——
Mr. STALLMER. Right. Right. Yes, of course.
Mr. POSEY. —by any stretch of the imagination.
A little while ago, you talked about the United States having 100
percent of the commercial launch market back in the '80s, and then
I missed the last part of that sentence. We managed to parlay it into what?

Mr. STALLMER. So the United States changed their policy. The United States and—you know, the commercial launches, and then we changed the policy to go onto the shuttle. And then after the shuttle happened, during that time frame, lot of—Ariane space emerged to take up a lot of those commercial launches because of the limitations that the U.S. launch companies had. So the U.S. Government was still launching—or we still were launching government payloads, but as far as commercial geostationary satellites, were at zero.

And that has recently changed, I think, with the emergence of SpaceX. I think in 2010 we started beginning to capture a larger amount of the market share, and right now, I believe—correct me if I'm wrong, but I believe that we have 60 percent of the geostationary commercial marketplace.

Mr. POSEY. Okay. Yes. My recollection is a little bit differently. I think we lost the commercial market because we overregulated it while other companies subsidized and actually helped their industries. We choked the golden goose. And I think we managed to do that. I don't think there was ever a necessity for an Ariane if they had left our commercial launch vehicles alone and let them do their job without trying to fund federal agencies with what should have been value-added—or actually were non-value-added cost to our commercial launch market.

Thank you, Mr. Chairman. I yield back.

Chairman BABIN. Okay. Well, I think this pretty much wraps up the questioning for today. And I'd like to thank the witnesses very much for being here. And I know there were some other folks that wanted to come back, but I think they had other meetings.

So I guess the record will remain open for the two weeks for additional written comments and written questions from members who did not get to get back and ask their questions.

So thank you again, witnesses. We appreciate it. This hearing is now adjourned.

[Whereupon, at 11:22 a.m., the Committee was adjourned.]
Appendix I

Answers to Post-Hearing Questions
Responses by Mr. Elliot Pulham

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

The Commercial Space Launch Industry: Small Satellite Opportunities and Challenges

Mr. Elliot Pulham, Chief Executive Officer, Space Foundation

Questions submitted by Rep. Brian Babin, Chairman, Subcommittee on Space

1. The Federal Aviation Administration Office of Commercial Space Transportation (FAA AST) and its Commercial Space Transportation Advisory Committee (COMSTAC) publish annual 10-year forecasts of demand for commercial launch services. The April 2015 forecasts project that commercial launches to geosynchronous orbit will increase from 16 per year in 2015 to 18 per year in 2017, while launches to other orbits will peak at 19 per year in 2016 and 2017 before dropping off to 10 or 11 per year in 2020 and beyond.

a. How consistent are these projections with your own expectations about the commercial space launch industry? What industry trends have you observed that might result in higher or lower launch rates?

The COMSTAC numbers for geosynchronous orbit appear reasonable given recent launch rates. Since the numbers remain very small overall, and there are no projects that required the launch of large numbers of satellites to GEO, we do not anticipate a surge in launches. For other orbits, our understanding is that COMSTAC forecasts are conservative and only include the launches that are currently planned/expected to occur in a particular year. To quote the forecast methodology in COMSTAC’s 2014 Commercial Space Transportation Forecasts: “The production cycle for today’s satellites is typically two to three years, but it can be longer for heavier or more complex satellites. Orders within a two- to three-year horizon are thus generally reliable. Satellite orders more than three years out can be difficult to identify, as many of these programs are in the early stages of planning or procurement. Beyond five years, new markets and new uses of satellite technology may emerge that are currently unanticipated.”

As such, the projections should be viewed as a baseline rather than an expectation of actual decline in launch rates. Assuming that the companies planning large constellations of satellites in low orbits remain solvent, we expect launch rates to increase over the current rate.

New launch providers do not seem to be “stealing” launches from incumbent providers. Instead, satellite operators seem to be embracing and snatching up the new opportunities offered by launch providers, even as they increase annual launch rates. Arianespace launched only 6 rockets in 2010. They nearly doubled that launch rate in
2015. Looking within the domestic market, ULA accounted for 8 of 15 U.S. orbital launches in 2010. ULA was 12 of 20 for 2015, even as SpaceX has been ratcheting up its launch campaign. When other nations, such as India, have increased their launch rates, the trend of the past 10 years seems to indicate additional launches instead of some sort of “zero-sum game” balancing among nations. In other words, the launch pie has been slowly getting bigger. It is unclear whether the market is getting bigger quickly enough to absorb the additional launch capacity, or whether the competition is driving prices down past the point of profitability for launch operators. But the appetite for PNT, imagery, and communications services seems to be growing, which will continue to drive launch services.

b. The April 2015 forecasts project growth in the number of micro- and small-class payloads, but project that these will be launched in clusters, so that there will be little net effect on the demand for launches. How consistent is this with your own observations of the industry?

There are two primary reasons for a micro- or small-sat operator to require dedicated launches: schedule and orbit. If the satellite operator’s business case does not require launches to occur at a specific time, then they can wait till there are other satellites to be launched in a cluster. Similarly, if the satellite’s orbit is flexible (Planet Labs has reputedly been more focused on getting satellites into space than getting them all in specific orbits), then any ride-along opportunity is potentially viable. However, if the satellite operator’s business plan requires definite launch windows or destination orbits, then that could drive demand for more launches to serve those needs.

c. Considering the FAA AST and COMSTAC forecasts, as well as your own observations and experience, how likely is it that the demand for commercial space launch services over the next decade will be sufficient to support a healthy U.S. space launch industry? What do you consider to be the greatest risks for the industry over the next decade?

The U.S. launch industry continues to be one of the most diverse of its kind in the world. During the past five years the United States used at least 10 different types of orbital launch vehicles for launch operations. This diversity may increase in the next few years depending on whether plans from small-satellite and suborbital launch providers come to fruition. The FAA AST and COMSTAC forecasts seem to anticipate those possibilities, although not necessarily an increase in demand that may occur if launch prices come down. The public demand for data provided from the satellites has increased. It seems unlikely the data demand will decrease soon.
2. The FAA AST and COMSTAC forecasts project that commercial crew and cargo resupply missions to the International Space Station (ISS) will account for a majority of the commercial launches to non-geosynchronous orbits over the next decade, rising to 70% or 80% of the market in 2020 and beyond.
   a. How consistent are these projections with your own expectations?

   The rising percentages are largely due to COMSTAC’s forecasts in NGSO launches dropping off to 10 or 11 per year in 2020. As noted above, that launch rate is intended to be a baseline rather than an expected total.

   b. Although these crew and cargo missions to the ISS are considered commercial, the customer is a federal agency, NASA. How might increasing reliance on a single government customer affect the commercial space launch industry?

   Most U.S. launches throughout history have been conducted by companies for the U.S. government, so this appears to be business as usual (albeit under different contractual and operational terms) rather than a case of increasing reliance on the government.

   c. U.S. use of the ISS is currently authorized through at least 2024 (P.L. 114-90, Sec. 114(b)). When ISS operations end, how will the consequent reduction in demand affect the commercial space launch industry?

   It depends substantially on whether there are commercial opportunities to absorb the launch capacity that would have been used for the ISS. This could include commercial space stations, space tourism, higher satellite launch rates, or other commercial activities. We won’t know until closer to 2024 whether there will be a reduction in total demand for launches.

3. Earlier this year, SpaceX launched a cargo resupply mission to the ISS and, for the first time, landed the first stage of the launch vehicle on a floating platform in the Atlantic Ocean. The company plans to refurbish and reuse the first stage in a future launch and expects this practice to reduce launch costs.
   a. If the company’s plans for reusability are successful, how might that affect the rest of the commercial launch industry?

   This is not an area we have studied, and it is sufficiently complex that we would prefer not to hazard a guess.
b. How sensitive is the commercial launch market to launch costs? How much potential is there for growth in launch demand, if launch costs can be reduced?

Launch prices tend to shift gradually, so there is not a good precedent for seeing what would happen if reusability causes a sudden drop in prices. Common sense might indicate more demand when there’s less expense. One example of how the market has reacted to a new entrant: Rocket Lab, which hasn’t even conducted its first launch yet, is booked solid for all 12 of its launches of cubesats from Q4 2016 through Q1 2018. Each launch will deploy 32 small satellites in orbit. The costs for one 3u satellite (of which there are 24 on each launch) are as high as $250,000 launching on Rocket Lab’s Electron. So the demand is there, and maybe even pent up.

What are the key steps in refurbishing a rocket for reuse?

We recommend discussing this with the rocket manufacturers since it is likely to be different for every vehicle.

c. What changes, if any, are needed in current federal licensing and oversight to address the potential reuse of refurbished rockets?

We recommend discussing this with the rocket manufacturers since it is likely to be different for every vehicle. As always, public safety takes priority, which is something the FAA’s Office of Commercial Space Transportation is very good about.

d. What concerns might potential customers have about launching their payloads on a refurbished launch vehicle? How could a launch company address those concerns? Is there any federal role in facilitating this interaction?

There may be a perception of more risk to their payloads. Lower costs and a demonstration of reusable components’ reliability are the most likely strategies for addressing concerns. Even unproven launch vehicles find customers willing to take the risk of a launch failure, which is not that different from flying aboard a proven launch vehicle with pre-flown hardware. It is probably best for the federal government to let the various parties involved work the details out among themselves.

4. Under the 1998 Commercial Space Act, the federal government can use excess ICBMs for its own use as long as certain conditions are met. This provision was utilized by NASA for the LADEE mission. We’ve recently heard that the procurement for this mission was particularly onerous, and resulted in a protracted protest to the GAO. As a result, NASA is hesitant to use excess ICBM motors on future missions despite being able to. What can the
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Congress do to make it easier for agencies to utilize existing authorities for using excess ICBMs? I had heard something similar but I was not privy to the precise details. I would suggest you discuss this episode with the NASA officials involved and ask them what relief they would need from Congress for future procurements. I will say as an observer of government aerospace procurement, that in the past decade almost every procurement involves a contentious process and almost automatic protest by losing bidders. In my opinion it is because aerospace spending has been flat and each procurement becomes almost a “do or die” event for some of these companies.

If government intrusion on the small launcher market is a concern, then why is the USAF’s Operationally Responsive Space (ORS) program getting the go-ahead, and building their own SLV system? Wouldn’t that potentially depress the market more than reusing ICBM motors, using taxpayer money to do so? Even so, reusing ICBM motors would take time for integration and testing, with no likely immediate impact on current launch demand. The introduction of using these motors for commercial uses might even increase demand.

Globally, our own laws have not stopped particular country competitors from using their ICBM inventories to launch commercial SLVs, giving them a pricing advantage to customers worldwide (DNEPR=SS-18; Rokot’s first two stages).

5. There are many companies intent on developing small satellite launch vehicles, but these are not readily available. A paper submitted to the Smallsat 2015 conference suggested that there are at least 20 such launch vehicles under development. While there are many in the works, it seems that there are many small satellites ready to launch today. How long do you think it is reasonable for small satellite manufacturers and operators to wait for these launch vehicles? What catalyst should Congress use to determine if and when a policy change is needed to meet the demand for domestic launch? If these small SATs are for government missions, Congress should use its oversight responsibility to impress upon whichever government agencies overseeing these small SAT programs to find the most expeditious manner to get them on orbit and executing their mission. If the small SATS waiting for rides are privately developed and to be privately operated, I am wary of the government interceding where I think the free market will provide solutions.

If we treat this as a commercial market, then it would be unreasonable to expect any manufacturer to wait for another to get their act together. They only do so because they have no choice (yet). The investors and owners of these burgeoning companies are basically dead in the water while waiting for the opportunity to launch, and expecting them to do so would be different from how other sectors work. There’s a definite risk to their future if we
ask them to wait. Would we ask Ford to wait for a particular tire manufacturer to fulfill an order if that manufacturer were months or years behind? And what would this do to those who wish to enter the market, but then see politically-motivated limitations imposed on those already trying to build a business? Recommend eliminating the concept of “reasonable waiting period.”

6. Foreign launch service providers are seeking to expand their share of the world market.
   a. How will foreign competition affect the U.S. commercial launch services industry over the next decade? With more launch options available, it will certainly force U.S. launchers to be price and performance competitive. As I said in my testimony, the problem will be with foreign launch providers who are not exactly transparent about their funding sources and their labor rates.
   b. How are U.S. companies responding to the possibility of increased foreign competition in this industry? U.S. launch companies are seeing almost constant improvements in vehicle design, manufacturing, processing, component sourcing and ensuring they have the proper sized workforce. None of these companies are resting on their laurels. How should the federal government be responding? Promote policies that provide long term stability. This includes support for major space programs already underway and need consistent support. Also ensure ITAR rules stay updated and modern as well as full support for Ex-Im bank. Investors and customers alike will want to see that they can be certain business dealings with U.S. companies are reliable, routine and transparent.
   c. In the 1990s, the United States had bilateral commercial space launch agreements with Russia, China, and Ukraine. More recently, the United States attempted unsuccessfully to negotiate a commercial space launch agreement with India. How does the presence or absence of commercial space launch agreements affect the U.S. commercial space launch industry? Like the question states, these agreements were twenty years ago when there was expected to be a surge demand for launch that did not materialize. Also geopolitics are very different from twenty years ago. I would say these agreements are often part of a larger diplomatic engagement between the U.S. and said counterpart nation. Since the domestic space industrial base and workforce are essentially dual-use for both civilian and national security reasons, any policies...
7. The 2013 National Space Transportation Policy states that “the United States will maintain its general policy of not supporting the development or acquisition of space transportation systems” in countries that are not members of the Missile Technology Control Regime (MTCR). India is not a member of the MTCR. A Technology Safeguards Agreement signed with India in 2009 permits the granting of export control licenses for civil and non-commercial satellites for launch on Indian launch vehicles, but it maintains a “presumption of denial” for export control licenses for commercial satellites.

a. In 2015, the U.S. company Spire Global received a waiver from the “presumption of denial” in order to launch several small satellites on an Indian launch vehicle. At least two other U.S. companies have contracted for future Indian launches. What factors in the launch market are driving this apparent trend?

Business—the difference between success and waiting. There is an unprecedented demand for launching small satellites, and it is logical for companies to conduct their business, instead of spending money while waiting to conduct business. From a satellite operator’s perspective, any amount of time a finished satellite spends on Earth instead of in orbit is equivalent to lost revenue. Most, if not all, major launch providers have a backlog of several years. If an overseas launch provider, whether in India or anywhere else, is able to provide a launch sooner and at a competitive price, it is the fiduciary duty of the satellite operator’s management to make use of that option if at all possible.

b. How would the U.S. space industry be impacted if India joined the MTCR and U.S. policy restrictions on India launch services were removed? I GUESS IT WOULD DEPEND HOW AGGRESSIVELY INDIA PROMOTED THEIR LAUNCH SERVICES TO AMERICAN SATELLITE OWNERS OPERATORS WHO NEED LAUNCHES AND ARE NOT HAVING THAT NEED MET DOMESTICALLY. IF IT WERE A FEW YEARS, I DO NOT SEE A BIG IMPACT. IF ON THE OTHER HAND INDIA OFFERS ROBUST LAUNCH SERVICES AT “FIRE SALE” PRICES, IT COULD BE PROBLEMATIC.

Minimally? India’s current launch rate is very low, and they’ve already been soliciting customers globally. Part of this may be due to the time requirements of their processes to build and integrate missions. Part of it may be the limitation in launch facilities. They don’t have many launch facilities, and building more would take time. They also need to prove the reliability of the Geosynchronous Satellite Launch Vehicle (one of the two types of Indian SLVs), which suffered from two launch failures in 2010 and has launched to orbit at a very low rate, nearly once per year, or none, since 2010. The often-used Polar Satellite Launch Vehicle (PSLV) has launched 26 times in the last ten years, averaging what? About 2.6 launches per year? This is not to discount the achievements of India in space, but current trends show
they have a long way to go to become truly competitive with an increasingly diverse U.S. launch market, and in the meantime, our businesses can benefit from their services.

8. In addition to small satellites, many people are talking about the possibilities afforded by hosted payloads, especially for DoD purposes. Can explain how small satellites and hosted payloads compare and contrast in terms of capabilities? FOR THE MOST PART HOSTED PAYLOADS HAVE BEEN EMPLOYED ON LARGE, POWERFUL, MANEUVERABLE SATELLITES THAT WILL RESIDE IN THE GEO BELT FOR MANY YEARS. SMALL SATS ARE NOT VERY POWERFUL, RESIDE IN LEO AND DO NOT STAY IN ORBIT VERY LONG. A REAL CONCERN ABOUT SMALL SATS IS THE LACK OF ON ORBIT MANEUVERING CAPABILITIES AND SOME DO NOT EVEN HAVE TRANSPONDERS THAT CAN SIGNAL THEIR PRECISE POSITION. THIS CAN BE A RECIPE FOR COLLISIONS ON ORBIT AND RESULT IN DANGEROUS DEBRIS FIELDS. Do small satellite manufactures and launch providers see hosted payloads as competition to their sector of the industry? I HAVE NOT HEARD THAT ASSERTION BEING MADE.

9. Several companies are currently developing launch vehicles specifically designed for small payloads, as an alternative to the “rideshare” approach of launching small satellites as secondary payloads alongside a larger satellite.
   a. What are the advantages and disadvantages of launching a small satellite on a dedicated small launch vehicle, rather than as a secondary payload on a larger launch vehicle? IF A SMALL SAT HAS TO RIDE SHARE, IT IS HELD HOSTAGE TO THE NEEDS AND DICTATES OF THE MAIN PAYLOAD IN TERMS OF WHEN IT EVENTUALLY GETS TO ORBIT. IF A SMALL SAT CAN HAVE A LAUNCH TAILORED TO ITS NEEDS, THEN IT IS NOT HOSTAGE TO ANYTHING BUT ITS OWN ABILITY TO BE READY FOR LAUNCH. ALSO SOME SMALL SATS WILL HAVE PECULIAR ORBITS TO RESIDE IN WHERE THE LARGER, MORE TRADITIONAL SATELLITES NEVER GO TO, THUS RIDE SHARE IS NOT AN OPTION.
   b. Looking a decade or more into the future, what fraction of the launch demand for small satellites do you expect will be met by dedicated small launch vehicles? I WOULD SAY ABOUT 50%-50%. NOT ALL THESE SMALL SAT COMPANIES AND SMALL LAUNCHER COMPANIES WILL BE AROUND TEN YEARS FROM NOW. What factors will determine the balance between dedicated small satellite launch vehicles and the “rideshare” approach? HOW WELL THESE NEW COMPANIES PERFORM. WHAT WILL BE THEIR FAILURE RATE? WILL THEY BE TRULY ABLE TO UNDERCUT THE RIDE SHARE OPTIONS? ARE THEIR ENOUGH SMALL SATS THE REALLY NEED RIDES TO UNUSUAL ORBITS?
c. What federal laws, regulations, or policies (if any) affect industry decision-making about how to launch small satellites? THE FAA’S AST OFFICE IS DOING A PRETTY GOOD JOB FROM WHAT I’VE SEEN IN TRYING TO REGULATE YET HELP “MID-WIFE” THIS EMERGENT PART OF OUR INDUSTRY. I HAVE NOT HEARD ANY SPECIFIC COMPLAINTS ABOUT ANY SPECIFIC GOVERNMENT POLICY. Would you recommend changes in any of these? JUST ENSURE THAT FAA-AST IS FULLY FUNDED.

10. As demand goes up for small satellites and more and more are launched, low Earth orbit will become a much more crowded place. Current Inter-Agency Space Debris Coordination Committee guidelines say that these satellites must be placed at a low enough orbit that atmospheric drag will cause them to re-enter 25 years after the end of its mission. Industry has said it will follow these guidelines. What is being done on the industry side to ensure that its small satellites do indeed follow these orbital guidelines? INDUSTRY IS DOING A GOOD JOB ON TRYING TO BE RESPONSIBLE ACTORS IN SPACE. THE SPACE DATA ASSOCIATION IS A GOOD EXAMPLE OF THAT. AT THE MOST RECENT SPACE SYMPOSIUM, THE SPACE FOUNDATION HELD A SEMINAR ON SPACE TRAFFIC MANAGEMENT. ALL OF US AS STAKEHOLDERS KNOW WE CANNOT IGNORE THIS ISSUE. I WOULD SAY THAT THERE IS SOME NAIVETE ON THE PART OF SOME SMALL SAT COMPANIES BY NOT PUTTING AT THE VERY LEAST SOME SORT OF LOCATION BEACON ON THEIR SATELLITES SO ALL OTHER ACTORS KNOW WHERE THE SMALL SAT IS AND IF IT POSES A THREAT.

11. One drawback of cube satellites is that many lack any kind of propulsion mechanism. As a result, they are not maneuverable and can pose a collision risk. There are some technologies under development now such as solar sails and solar electric propulsion that can grant some amount of mobility to small satellites. How do you see industry standards for collision avoidance and end-of-life disposal capabilities evolving? AGAIN, I ECHO MUCH OF WHAT I STATE ABOVE. THE MORE ESTABLISHED SATELLITE MANUFACTURERS AND OPERATORS SHOULD ALMOST LOOK TO MENTOR THESE NEW COMPANIES AND INSTILL UPON THEM THE NEED FOR THESE SMALL SATS THE ABILITY TO TRACKED, IDENTIFIED AND HAVE RESPONSIBLE DISPOSAL PROTOCOLS. I WOULD SUGGEST PERHAPS FAA-AST DENY LAUNCH LICENSES IF THE PAYLOADS DO NOT MEET SOME MINIMUM STANDARD OF THESE.

12. Some companies like Spire, Digital Globe and OneWeb plan to launch huge constellations of small satellites into orbit. Assuming that the growth in the small satellite market continues, do you foresee a time when popular orbits will become too crowded by constellations of hundreds or thousands of satellites? Is there talk within the industry about stricter industry standards so that debris does not make popular orbits unusable?
Could orbits be overcrowded one day? Maybe. But current orbital "crowding" has a different source than commercial satellites. The majority of satellites launched and orbiting the Earth are operated by some branch of government. Based on the FAA’s *Annual Compendium of Commercial Space Transportation: 2016* (page 36), in 2015 alone 53 of 196 satellites (27%) launched or deployed were for commercial use. At least 126 of those 196, according to our own research, fell into the nanosat/cubesat realm. While there is some concern about orbits becoming crowded, some U.S. companies, such as Planet Labs, are making sure their satellites do not litter the orbital landscape. In 2015, based on Space-Track data, 17 of 38 Planet Labs satellites deployed from the ISS have already decayed from orbit. In 2014, 100% of the company’s satellites deployed from the ISS decayed. The responsibility taken by the company to ensure its satellites do not become part of a congestion and debris problem is commendable and hopefully other commercial and government organizations follow suit, possibly even agreeing on standardized solutions.

13. The Satellite Industry Association’s 2015 State of the Satellite Industry report mentions a “growing concern regarding collisions with CubeSats,” and notes that NASA has had to move satellites in order to avoid running into these small satellites. How would you characterize the risk associated with CubeSat’s in orbit today? ALL I WILL SAY IS THAT IT IS WELL KNOWN THAT MANY IN OUR INDUSTRY REFER TO THESE SMALL SATS AS “DEBRIS SATS.” I THINK THAT SPEAKS VOLUMES AND THE NEED FOR US TO ADDRESS THIS INCREASING RISK.

14. Arizona State University recently published an article on its SunCube FemtoSat, a small satellite that is 3 centimeters long on each side. Many others have talked about incredibly small satellite and ‘chipsats’ that are weighed in grams. When you look at the trend in satellite size, do you see these extremely small satellites becoming more popular? I DO NOT SEE THEM PROVIDING ENOUGH CAPABILITY TO HAVE A REAL BUSINESS CASE BEHIND THEM AND THUS WILL NOT SEE LARGE Fleets OF THEM. THEY ARE ALMOST RATHER LIKE ONE-OFF EXPERIMENTS TO SEE WHAT CAN BE DONE IN TERMS OF DECREASING COMPONENT SIZE. If so, what is industry doing to ensure that we can track these very small satellites? THEY MAY NOT BE TRACKABLE. I WOULD LOOK INTO MANDATING THAT THESE WOULD BE SENT TO LESS POPULATED ORBITS WHERE THE CHANCES OF COLLISION IS LESS. Do you envision a commercial need for space situational awareness information and services beyond what the Air Force currently provides to the public free-of-charge? YES. I THINK WE SEE THE Need FOR SPACE TRAFFIC MANAGEMENT AND GET THE USAF OUT OF BEING THE FAA FOR SPACE. SOME SORT OF COMMERCIAL/US GOVERNMENT CIVILIAN JOINT EFFORT IS THE GOAL. THE HARD PART IS HOW DO WE ACTUALLY GET THERE.
15. Small satellite technology can serve both commercial and scientific interests. When you look at where investments are being made in small satellites, is it mostly with an eye to the commercial benefits or do more end users plan to use them for scientific purposes like research and technology development? Slightly more than half, 65, of the 126 small satellites launched in 2015 were for some kind of experiment or technology demonstration. Fully 46 of the 126 were for commercial imagery (Planet Labs). If other companies implement plans and manage to launch small satellites for space-based communications networks, other imagery constellations, automated identification systems, forest fire detection networks, and more, then the balance of small satellites would likely tilt greatly towards commercial products.

16. Last summer, NASA announced that it would be sending two CubeSats to Mars. The twin communications-relay satellites are to be built by NASA’s Jet Propulsion Laboratory and will launch as secondary payloads to the InSight lander. This mission will be the first time that CubeSats have flown into deep space. The vast majority of CubeSats are placed into low Earth orbit. Does industry have any plans to move beyond this orbit, out into deep space? NOT UNTIL THERE IS BUSINESS CASE WHERE THESE SMALL SATS GOING TO DEEP SPACE PROVIDES A MEASUREABLE RETURN ON INVESTMENT. PERHAPS AS SCOUTING PROBES FOR MINING OF ASTEROID COULD BE A REASON.

17. NASA has several programs dedicated to the development of small satellites including its CubeSat Launch Initiative and Venture Class Launch Program. Can you please describe what the commercial industry’s experience has been working with NASA and other government agencies in developing small satellites and launch? NASA IS NOT ALWAYS THE EASIEST PARTNER TO HAVE, THAT SAID, THEY SHOULD BE COMMENDED FOR STARTING THESE PROGRAMS. TO DATE I HAVE NOT LEARNED OF ANY TROUBLES ON THESE PROGRAMS. What policy recommendations do you have that could better serve American interests and promote the continued development of small satellite and launch technology? ENGAGE AND INVEST WITH SCHOOLS. GIVE YOUNG AMERICANS THE OPPORTUNITY TO WORK ON THESE PROGRAMS AND GIVE THEM EXPERIENCE THAT HELPS THEM ENTER THE SPACE WORKFORCE BETTER PREPARED.

18. In May of last year, the chairman of the Surrey Satellite Technology Ltd., Martin Sweeting, warned that there might be too much “heady enthusiasm” when it comes to CubeSats. SpaceNews called his comments a warning about a CubeSat bubble. Are CubeSats a sustainable business model, or is this just a Silicon Valley fad? AS I MENTIONED IN MY TESTIMONY AT THE HEARING, I DO SEE SOME SIMILARITIES TO THE LITTLE LEO BUBBLE OF THE 1990’S AND EARLY 2000’S. THAT SAID, THERE HAVE BEEN IMPROVEMENTS IN TECHNOLOGY THAT COULD ENABLE SOME OF THESE PROVIDERS A SUCCESSEFUL BUSINESS CASE. I DO NOT THINK THERE WILL BE DOZENS AND DOZENS OF SMALL SAT COMPANIES, BUT RATHER AN EXPLICIT NICHE IN THE SPACE INDUSTRY WITH A HANDFUL OF PROVIDERS. What kind of timeline are investors in CubeSats looking at? BEING THAT MANY OF THESE ARE
FROM SILICON VALLEY, I WOULD SAY THEY ARE USED TO RELATIVELY SHORT RETURN MONTHS TO A FEW YEARS AT THE VERY MOST, NEED A STIFF ANSWER HERE PERHAPS?

19. NASA’s Launch Services Program is actively trying to develop the small satellite commercial launch industry as an alternative to rideshare opportunities. Small satellite launch vehicles, like the ones proposed by Firefly, Virgin Galactic, and Rocket Lab, seem to be well suited to launching venture class missions. When looking at the market, do small satellite launch service providers see NASA as their primary customer or anchor tenant? I THINK FROM THE STANDPOINT OF ATTRACTING INVESTORS, A COMPANY THAT HAS NASA AS AN “ANCHOR TENANT” IS VERY HELPFUL. THE NASA “BRAND”, IF YOU WILL, STILL CARRIES TREMENDOUS POSITIVE CREDIBILITY. I THINK NASA TECHNICAL EXPERTISE CAN BE HELPFUL AS WELL. Can you describe the demographic interested in small satellite launch services? I THINK THIS WILL BE OPERATORS WHO OFFER VERY SPECIALIZED AND NOT EXQUISITE ON ORBIT CAPABILITIES IN TERMS OF PRIMARILY REMOTE SENSING, AND COMMUNICATIONS.

Several people have called the development of CubeSats a revolution in satellite technology. According to the Satellite Industry Association’s “State of the Satellite Industry Report” 63 percent of all satellites launched in 2015 were CubeSats. This is an impressive number. And yet while most of the satellites launched were CubeSats, they only made up less than 1 percent of the total market value of all the spacecraft launched. Can you give us a sense of scale for how big this revolution really is? What kind of economic impact are investors foreseeing in small satellite manufacturing and launch?

CubeSat deployment numbers have been growing. The ISS alone demonstrates this with its satellite deployment rates, the majority of which involved cubesats. Five years ago, the ISS deployed one satellite. In 2012 and 2013, a total of 10 satellites were deployed. In 2014 and 2015, deployments nearly reached 50 cubesats each year. This year, 30 have already been deployed. Traditional orbital launch vehicles are also making use of cubesat deployers. In 2014, one Russian Dnepr deployed 33 satellites, many of which were cubesats, one of which deployed 4 more satellites. In 2015, an Atlas V deployed about 35 satellites, one Long March deployed 20, and a Soyuz deployed 20. Each year, other launchers also deployed cubesats, showing one of the cubesat’s strengths as a standardized satellite bus. This year, maybe as soon as July, a Falcon 9 will deploy more than 80 satellites from a Spaceflight Industries Sherpa deployer.

There is nothing really revolutionary about cubesats themselves. The technology cubesats are based on has existed for decades. The critical factor is the affordability, customization, and risk-minimization presented by cubesats. These reasons alone are inviting many more participants into the space industry, particularly those not necessarily interested in operating satellites, but interested in gaining data collected from them. Due to the inexpensive nature of cubesats, even large constellations may not have a substantial impact on the satellite
manufacturing and launch industry. The focus should be on the businesses that are supported by the capabilities that these cubesats offer, since that is where we are most likely to see revenue growth.

20. Space Works’ 2016 Nano and Microsatellite Market forecast predicts that as many as 3,000 nano and microsatellites will require a launch in the next six years. The report concludes that “the industry has a need for small launch vehicles.” There are a number of such vehicles under development by U.S. companies. Even if new U.S. vehicles enter the market, will U.S. domestic launch vehicles alone will be able to meet forecasted demand?

It is doubtful the U.S. domestic launch vehicles could meet the demand. Combined with the ISS deployments, 126 small satellites were deployed in 2015 using global launch industry resources. If that deployment tempo remained the same, it would take more than six years to deploy 3,000 small satellites.

The previous example of the Sherpa deployer gives us some idea of launch capability possible for small satellites. If an 80-cubesat deployer were launched 12 times a year, and successfully deployed payloads, that would result in 960 cubesats in orbit each year. Smallsat launchers like Rocket Lab seem to be advertising a launch rate of about twice a quarter, with each launch able to deploy about 32 cubesats. That would be 256 cubesats deployed in one year. If 3,000 satellites are to be launched in the next six years, the global launch industry would probably need to be involved to keep small satellite businesses alive.

21. In March of last year, the International Telecommunication Union held a conference in Geneva to discuss challenges facing the development of small satellites including frequency management and radio communication standardization. Out of that conference came a document called the “Prague Declaration” that confirms the “importance of implementing national legal and regulatory frameworks in conformity with international laws, regulations, guidelines and procedures.” What are the major radio communication policies impacting the small satellite industry?

This is not an area that we have studied. However, there is research underway to develop laser-based communications hardware for use in cubesats, which may alleviate some of the concerns about spectrum management. Even assuming the R&D goes well, it is likely to take at least several years before such systems are affordable and widespread.

22. The Federal Communications Commission licenses spectrum in the form of radio communication for satellites under three different categories: amateur, experimental and professional or operational. According to SpaceNews, the fee to license an experimental satellite is $430,000. The fee to license an amateur satellite is $60. It seems clear why most small satellite operators choose to purchase an amateur license. What kinds of frequency
issues are influencing the industry right now? Can you talk about this discrepancy in licensing prices? Does this inhibit the growth of the small satellite industry?

This is not an area that we have studied, but lower startup costs generally make it easier for new satellite companies to begin operations.

23. What are the differences of the U.S. government’s role in space launch promotion for use in commercial space launch twenty years ago and now? I AM NOT SO SURE THERE IS THAT MUCH DIFFERENCE. THE GOVERNMENT STILL HAS TO MAINTAIN AND OPERATE THE LAUNCH RANGES. THE GOVERNMENT STILL HAS AN INTEREST IN A ROBUST WORKFORCE AND INDUSTRIAL BASE. THERE IS ALSO A NEED FOR THE GOVERNMENT TO HAVE SOME MODICUM OF CHOICE AND VARIETY IN PROVIDERS AS WELL. THUS THE POLICIES IT ALREADY HAS OR DEVELOPS NEEDS TO HELP ENSURE THE AFOREMENTIONED. Are the drivers for space assets and products different and/or bigger now than they were twenty years ago? PAYLOADS ARE MUCH MORE CAPABLE, BUT THEY STILL PROVIDE CAPABILITIES THAT WE NEED HERE ON EARTH. PRIMARILY COMMUNICATIONS AND EARTH OBSERVATIONS.

24. Many of the companies we see entering the small satellite market are startups in Silicon Valley. This ‘new space’ industry has a very different look and feel from older aerospace companies and satellite manufacturers. How would you characterize the small satellite workforce? This is not an area that we have studied. Are these new space startups positively impacting the employment and training pipeline for STEM students and recent graduates? This is not an area that we have studied.

25. The number of small satellites and CubeSats launched in the past few years has skyrocketed. There is an entire industry developing just to serve the small satellite and CubeSat community – including manufacturing, launch, and value-added data products. Can you give us a sense of how the small satellite industry is impacting job creation?

Our space workforce reports are largely based on data from the U.S. Bureau of Labor Statistics, which does not provide sufficient detail to answer this question. An additional complication is that new companies that provide analysis of satellite imagery or customized tools for end-users may be recorded as software companies or something else instead of “space companies” in government-collected data sets. This speaks to the growing reach of space as it is integrated into other industries.
Questions submitted by Rep. Barbara Comstock

1. To any witness: As you all are aware, it is not unusual for the federal government, including both DOD and NASA, to make surplus government property and assets available to commercial users in order to save taxpayers money and support U.S. businesses. I think there is a broad consensus that making use of surplus assets when done in a transparent and competitive manner, is in the national interest.

In recent years, both the Air Force and NASA have made a tremendous amount of federal launch property available to commercial users at Cape Canaveral and Kennedy Space Center, often at extremely discounted rates, in the name of removing the maintenance costs from the government books as well as encouraging greater use of the launch complexes. This has included multiple launch pads, processing facilities and other property which was built or acquired at significant taxpayer expense.

When these federal assets were made available to launch companies, there was little debate about doing so – despite the fact that it directly competed with state spaceports, like MARS, Alaska, and others, who were developing similar capabilities with state and private investment and competing for the same customers that were given valuable federal property under very generous terms.
Given that the government policy for this ground infrastructure has been to make surplus assets available to commercial customers at below market rates, why is there opposition to allowing a restricted number of decommissioned motors available to commercial providers at fair market value? Can you clarify how some commercial launch providers readily accepted surplus ground infrastructure but are now opposing a similar policy when it comes to excess motors? This is not an area that we have studied.

2. As the committee reviews this issue, Members have a fiduciary responsibility to act in the best interest of taxpayers as well as to determine what is in the best interest of our national security.

From both of these perspectives, it appears that it is in the Air Force’s interest to reduce its stockpile of decommissioned motors in a responsible manner by reducing annual maintenance costs and avoiding the costly process of responsibly destroying these engines.

The taxpayers would also benefit from having more immediate, low-cost launch options from a variety of spaceports, which already have the launch pad and ground infrastructure in place to launch these vehicles to launch NASA and NOAA payloads on a commercial contract.

Would you agree that using these decommissioned motors in such a manner is ultimately in the best interest of both the taxpayer, the Defense Department and customers who need immediate affordable launch options? This is not an area that we have studied.
1. You caution to not be overly bullish about emerging small satellite demand. Last year, we had a lapse in the Export-Import Bank in this country. Do you see lack of available export financing as an obstacle this industry faces in reaching its potential? ANY CONTINUED HINDERING OF THE EX-IM BANK HURTS ALL OF U.S. AEROSPACE COMMERCE.
HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON SPACE

The Commercial Space Launch Industry: Small Satellite Opportunities and Challenges

Mr. Elliot Pulham, Chief Executive Officer, Space Foundation

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

1. In response to a question from Mr. Perlmutter on the importance of the International Space Station’s (ISS) capability to deploy small satellites for educational institutions and space research, you stated that such a capability was very important. In light of the possibility that ISS operations will cease in 2024 and the importance you place on this current capability, how would you suggest we start planning for the transition of this important user community to future launch options? FROM WHAT I HAVE SEEN IN THE PUBLIC DOMAIN, ISS COULD REMAIN IN ORBIT WELL INTO 2028. I WOULD SUGGEST SOME THOUGHT BE GIVEN TO EXTENDING ISS. AS FOR OTHER LAUNCH OPTIONS, THERE ARE COMPANIES THAT ARE SEEKING OUT PAYLOADS FROM EDUCATION INSTITUTIONS TO PROVIDE FREE OR EXTREMELY REDUCED COST RIDEALONGS.
2. In your response to that same question, you indicated that companies were starting to think of philanthropic solutions to the challenge of sending student payloads into space. You cited launch companies possibly devoting excess payload capacity space for smallsats and even dedicating an entire launch for university projects.
   a. How can companies be encouraged to make their excess payload capacity available to academic institutions? I DO NOT THINK THEY NEED MUCH ENCOURAGEMENT. MANY COMPANIES SEE THESE AS OPPORTUNITIES TO MARKET THEMSELVES TO THIS NEXT GENERATION WORKFORCE.
   b. How could companies and academic institutions develop a process which would allow excess payload capacity to be matched with small payloads seeking a low-cost ride to space? AGAIN, THESE COMPANIES WANT TO BE GOOD CORPORATE CITIZENS AND THEY ARE VERY EAGER TO ENGAGE WITH STUDENTS INTERESTED IN SPACE WHO COULD BECOME THEIR NEXT GENERATION EMPLOYEES AND INNOVATORS. THEY ARE ALREADY ENGAGING WITH A VARIETY OF INSTITUTIONS.

3. During the hearing, Mr. Perlmutter raised the question of whether or not excess ICBMs might be used for government missions such as for addressing orbital debris.
   a. What is your response to this proposal? IF THERE IS A GOVERNMENT DEVELOPED PAYLOAD THAT CAN HELP “CLEAN UP” ORBIT, PERHAPS FLYING THAT SYSTEM ON SUCH LAUNCHERS MAKES SENSE.
   b. Should excess ICBMs be considered for the philanthropic uses you mentioned in the hearing, such as for dedicated launches of university payloads? I THINK THAT IS AN IDEA THAT BEARS SOME CONSIDERATION. THE COSTS OF THE BOOSTERS WOULD STILL BE PRETTY STEEP EVEN FOR THE WEALTHIEST UNIVERSITIES, AS SUCH THE GOVERNMENT WOULD PROBABLY BE GIVING THEM AWAY.
Responses by Mr. Eric Stallmer

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

The Commercial Space Launch Industry: Small Satellite Opportunities and Challenges

Mr. Eric Stallmer, President, Commercial Spaceflight Federation

Questions submitted by Rep. Brian Babin, Chairman, Subcommittee on Space

1. The Federal Aviation Administration Office of Commercial Space Transportation (FAA AST) and its Commercial Space Transportation Advisory Committee (COMSTAC) publish annual 10-year forecasts of demand for commercial launch services. The April 2015 forecasts project that commercial launches to geosynchronous orbit will increase from 16 per year in 2015 to 18 per year in 2017, while launches to other orbits will peak at 19 per year in 2016 and 2017 before dropping off to 10 or 11 per year in 2020 and beyond.

a. How consistent are these projections with your own expectations about the commercial space launch industry? What industry trends have you observed that might result in higher or lower launch rates?

When measuring the consistency between CSF’s expectation for commercial space launch demand and the 10-year forecasts in the FAA/AST-COMSTAC’s April 2015 Report, it is important to take into account factors that contextualize the Report’s demand forecast:

1. The Report’s launch forecast projection is based on publicly announced launch demand at the time of the Report’s research and writing, which was in 2014. While this is no fault of the Report, its data is at least two years old and fails to take into account many of the new U.S. launch company contracts announced over the previous two years. These include, but are not limited to, the following:

a. Virgin Galactic’s deals for: 39 launches of OneWeb satellites; and 1 launch of NASA small satellites under its Venture Class Launch Services contract.

b. Rocket Lab’s deals for: 3 launches of Planet (formerly Planet Labs) satellites; 3 launches for Moon Express; up to 12 launches of Spire satellites, and 1 launch of NASA small satellites under its Venture Class Launch Services contract.

c. Firefly’s deal for: 1 launch of NASA small satellites under its Venture Class Launch Services contract.
d. SpaceX's deal for launching Spaceflight Industries' SHERPA (89 satellites).

2. The Report utilizes what it refers to as a "realization factor" in its forecast calculations – which the annual forecast has used since the "realization factor's" inception in 2002 - whose methodology may not be valid to forecast emerging markets. For instance, the "realization factor" methodology is derived by comparing forecast satellite launches with actual satellites launched in the five years prior to the Report. This methodology is more appropriate to apply to forecast for mature, stable, and predictable markets, like the existing geostationary (GSO) satellite telecommunications market. But for nascent markets that are expanding, like the emerging new satellites constellations in the non-geostationary (NGSO) satellite market, utilizing the previous five year launch average to forecast the next 10 years is most likely to under forecast the future. It's like taking a growing teenager's average height over the previous five years and applying it to calculate their height for the next 10 years – that methodology is likely to drastically underestimate their annual height over the next 10 years.

While the Report's forecast is consistent with our expectations with regard to mature markets, like GSO telecommunication satellites and commercial crew and cargo flight to the ISS, its forecast does not adequately calculate the growing and emerging markets, like new satellites constellations, for the reasons outlined above.

b. The April 2015 forecasts project growth in the number of micro- and small-class payloads, but project that these will be launched in clusters, so that there will be little net effect on the demand for launches. How consistent is this with your own observations of the industry?

The April 2015 Report fails to adequately project the demand for dedicated launch demand of micro- and small-class satellite for the reasons outlined in the previous answer.

c. Considering the FAA AST and COMSTAC forecasts, as well as your own observations and experience, how likely is it that the demand for commercial space launch services over the next decade will be sufficient to support a healthy U.S. space launch industry? How would you define a "healthy" U.S. space launch industry? What do you consider to be the greatest risks for the industry over the next decade?

A healthy U.S. space launch industry is one with multiple launch suppliers and multiple
satellite operators, governed by policies that promote regulatory stability, fair and open competition, efficiency, and innovation. By consistently reaffirming 30 years of U.S. commercial launch policy (preventing U.S. government launch assets from competing against the private sector), improving regulatory stability, and promoting pro-growth policies, the United States Government has, thus far, fostered a healthy development of U.S. commercial launch service providers and users—and we are seeing this policy bear fruit today. As noted in my answer to question 1(a), a review of recent launch service contracts illustrate that U.S. commercial launch service providers are very effectively meeting the needs of commercial and international users of commercial launch services.

Policies that prevent or undermine fair and open competition is one of the greatest risks for the industry. This kind of market intervention would send a negative signal to investors: don’t put your money in U.S. launch vehicle companies. The result: a weaker U.S. rocket propulsion industrial base, less innovation from start-up companies, fewer new technologies, and a less robust U.S. launch industry.

2. The FAA AST and COMSTAC forecasts project that commercial crew and cargo resupply missions to the International Space Station (ISS) will account for a majority of the commercial launches to non-geosynchronous orbits over the next decade, rising to 70 percent or 80 percent of the market in 2020 and beyond.
   a. How consistent are these projections with your own forecasts?

The April 2015 Report fails to adequately project the demand for dedicated launch demand of micro- and small-class satellite for the reasons outlined in the previous answer.

   b. Although these crew and cargo missions to the ISS are considered commercial, the customer is a federal agency, NASA. How might increasing reliance on a single government customer affect the commercial space launch industry?

I respectfully disagree with the premise that underpins the question for the reasons that I outlined in my answer to question 2(a).

   c. U.S. use of the ISS is currently authorized through at least 2024 (P.L. 114-90, Sec. 114(b)). When ISS operations end, how will the consequent reduction in demand affect the commercial space launch industry?

NASA’s Bill Gerstenmaier in July 2016 testified before Congress that NASA will continue to require commercial space transportation services to LEO even after ISS
operations end (this includes 2024 and 2028 deadlines). In addition, we anticipate additional commercial activity in LEO to expand over the next decade, which will require commercial space launch services post-ISS as well. Beyond this general demand it is too early to better predict post-ISS demand. It better understand post-ISS demand it may be useful for the committee to hold a hearing on the matter.

3. Earlier this year, SpaceX launched a cargo resupply mission to the ISS and, for the first time, landed the first stage of the launch vehicle on a floating platform in the Atlantic Ocean. The company plans to refurbish and reuse the first stage in a future launch and expects this practice to reduce launch costs.

   a. If the company’s plans for reusability are successful, how might that affect the rest of the commercial launch industry?

I defer to SpaceX on this matter.

   b. How sensitive is the commercial launch market to launch costs? How much potential is there for growth in launch demand, if launch costs can be reduced?

The Space Angels Network, which is the leading source of capital for early-stage space companies, states that the “exponential growth in entrepreneurial activity and investment in space is underpinned and enabled primarily by the emergence of low-cost access to space...a number of new launch companies are innovating at an incredible pace, driving efficiency through standardization, and accessibility through transparency, ultimately bringing the cost down and the space sector within the reach of startups and entrepreneurs for the first time.”

   c. What are the key steps in refurbishing a rocket for reuse?

Multiple companies within the commercial space industry are working on the challenges of reusability. Because of the different approaches, each company has developed different methods (and therefore different steps for refurbishment) for reusability. The specific steps depend on an array of factors including altitude and payload capability. Many of the vehicles are vastly different and cannot therefore adhere to one set of steps.

   d. What changes, if any, are needed in current federal licensing and oversight to address the potential reuse of refurbished rockets?

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CSF is working with its member companies on to figure out whether changes, if any, are needed, and looks forward to providing the Committee more constructive feedback on this matter in the future.

e. What concerns might potential customers have about launching their payloads on a refurbished launch vehicle? How could a launch company address those concerns? Is there any federal role in facilitating this interaction?

CSF defers to the individual companies working on reusability, and their potential customers, to answer this question.

4. Under the 1998 Commercial Space Act, the federal government can use excess ICBMs for its own use as long as certain conditions are met. This provision was utilized by NASA for the LADEE mission. This procurement resulted in a protracted protest to the GAO. As a result, NASA is hesitant to use excess ICBM motors on future missions despite the fact that it is permissible. What can the Congress do to make it easier for agencies to utilize existing authorities for using excess ICBMs?

I respectfully disagree with the premise that underpins the question, as there is no official statement or public record of NASA stating any hesitancy regarding government use of excess ICBM-derived launch vehicles. And if NASA follows all the requirements outlined in the 1998 Commercial Space Act for government procurement of excess ICBM-derived launch vehicles, then it should have no concerns, as its decision would be vindicated by any potential GAO review.

5. There are many companies intent on developing small satellite launch vehicles, but have yet to launch. A paper submitted to the Smallsat 2015 conference suggested that there are at least 20 such launch vehicles under development. While there are many in the works, it seems that there are many small satellites ready to launch today. How long do you think it is reasonable for small satellite manufacturers and operators to wait for these launch vehicles? What catalyst should Congress use to determine if and when a policy change is needed to meet the demand for domestic launch?

Domestic launch capability is already available for sub-500kg performance. This year Orbital ATK’s Minotaur-C (commercial variant of the Minotaur launch vehicle family) will
aggregate and launch 6 Skysat small satellites, which weigh 120 kg each, to Sun Synchronous Orbit (SSO). Similarly, SpaceX’s Falcon 9 will launch Spaceflight Industries SHERPA spacecraft and payload adapter, which will launch 87 small satellites that are up to 500kg to LEO. In addition, additional domestic launch options for sub-500kg satellites will be coming online soon, including services by Virgin Galactic, Firefly, Vulcan Aerospace, Masten Space Systems, and Rocket Lab.

American industry is responding to market demand and innovating on new technologies, outpacing any other nation in the world. Per my written testimony, small satellite operators believe that the maintenance of current policies is the best way to meet their demand for domestic launch.

6. Foreign launch service providers are seeking to expand their share of the world market.
   a. How will foreign competition affect the U.S. commercial launch services industry over the next decade?

Foreign launch service providers have lost significant share of the commercial market to U.S. launch service providers over the past 5 years; a positive trend that is anticipated to continue, especially in the small satellite market. The expansion of U.S. launch service providers expanding their share of the commercial market is detailed below:

a. The 500-2000 kg commercial and internationally competitive satellite market has been a relatively small portion of the overall commercial launch market over the past 20 years. This market has been dominated by the deployment of three satellite constellations (Globalstar, Iridium, and O3b) on multi-manifested missions by vehicles with greater capability than repurposed ICBMs and international small launch vehicles. Not including these constellations, launch demand in this market is projected to fall on average to less than two payloads per year. In the near future, the FAA Commercial Space Transportation Advisory Committee projects that U.S. based launch systems will dominate the 500-2000 kg commercial satellite market due to the deployment of the Iridium Next constellation.

b. The 1-500 kg commercial and internationally competitive satellite market has been a very small portion of the overall commercial launch market over the past 20 years. This market has been dominated by the deployment of one satellite constellation (ORBCOMM) on multi-manifested missions using U.S.-based launch systems. Not including the ORBCOMM constellation, launch demand in this market is projected to increase for dedicated small satellite launch vehicles. In the near future, U.S. based launch systems will dominate the 1-500 kg commercial satellite market due to the deployment of several new constellations (OneWeb, SHERPA, Terra Bella, Planet, Spire, BlackSky, Planetary Resources).
2. American industry is responding to market demand and innovating new
technologies, outpacing any other nation in the world. If the Committee wants to
American industry to maintain this lead and prevent foreign competitors from
catching up then it should continue to affirm 30 years of U.S. commercial launch
policy, improve regulatory stability, and promote pro-growth policies. This
includes:
   a. Strongly opposing any change to the existing policy with respect to the
      commercial use of excess ICBM assets; and
   b. Retaining the current case-by-case waiver process.

   b. How are U.S. companies responding to the possibility of increased foreign
      competition in this industry? How should the federal government be
      responding?

CSF opposes any change to the current U.S. policy with respect to launch on Indian
launch vehicle systems.

c. In the 1990s, the United States had bilateral Commercial Space Launch
   Agreements with Russia, China, and Ukraine. More recently, the United
   States attempted unsuccessfully to negotiate a Commercial Space Launch
   Agreement with India. How does the presence or absence of Commercial
   Space Launch Agreements affect the U.S. commercial space launch
   industry? How does it affect the U.S. commercial satellite industry?

CSF strongly supports implementation of effective mechanisms for restricting foreign
governments from imposing unfair and anti-competitive practices against the U.S.
commercial space industry.

7. The 2013 National Space Transportation Policy states that “the United States will
   maintain its general policy of not supporting the development or acquisition of
   space transportation systems” in countries that are not members of the Missile
   Technology Control Regime (MTCR). India is not a member of the MTCR. A
   Technology Safeguards Agreement signed with India in 2009 permits the
   granting of export control licenses for civil and non-commercial satellites for
   launch on Indian launch vehicles, but it maintains a “presumption of denial” for
   export control licenses for commercial satellites.

   a. In 2015, the U.S. company Spire Global received a waiver from the
      “presumption of denial” in order to launch several small satellites on an
      Indian launch vehicle. At least two other U.S. companies have contracted
for future Indian launches. What factors in the launch market are driving this apparent trend?

Outside of small launcher capacity and dedicated bundled flights, many small satellites today fly as secondary or auxiliary payloads on launch vehicles designed for much larger satellites. Although the market is responding with the development of new small-class rockets, there are limited options for dedicated launch vehicles today that allow small satellites to be the primary, or lead, payload. While small satellite customers benefit from being a secondary payload through fractional pricing relative to the price of a dedicated launch service, CSF acknowledges that status as a secondary or auxiliary payload does sometimes result in tradeoffs for the small satellites customer.

b. How would the U.S. space industry be impacted if India joined the MTCR and U.S. policy restrictions on India launch services were removed?

CSF strongly supports implementation of effective mechanisms for restricting foreign governments from imposing unfair and anti-competitive practices against the U.S. commercial space industry.

8. In addition to small satellites, many people are talking about the possibilities afforded by hosted payloads, especially for DoD purposes. Can you explain how small satellites and hosted payloads compare and contrast in terms of capabilities? Do small satellite manufactures and launch providers see hosted payloads as competition to their sector of the industry?

CSF strongly supports the U.S. Government’s use of commercial services via small satellites, hosted payloads, high altitude platforms, and other commercial platforms that can help meet and augment its service needs, improve its uninterrupted collection of data, lower costs, and increase resiliency.

9. Several companies are currently developing launch vehicles specifically designed for small payloads, as an alternative to the "rideshare" approach of launching small satellites as secondary payloads alongside a larger satellite.

a. What are the advantages and disadvantages of launching a small satellite on a dedicated small launch vehicle, rather than as a secondary payload on a larger launch vehicle?

The primary advantage afforded by launching a small satellite on a dedicated small launch vehicle is that the small satellite is a primary payload, not a secondary payload. Launched as a secondary payload, the small satellite is at the mercy of the primary...
payload in terms of launch schedule and orbital placement. It goes wherever the larger primary payload goes, regardless of whether or not that is the optimal orbital injection for the completion of the mission of the satellite. On a dedicated launch vehicle, the operators of those satellites can choose where their satellites will go.

The main disadvantage is a potential loss in economies of scale. For CubeSats where the exact orbit is less important, the most cost-effective launch method could still be as a secondary payload on a larger launch vehicle. This is already taken into account in the prices of the two respective launch services. Individual satellite companies should have the freedom to choose which launch service best fits with their business model.

b. Looking a decade or more into the future, what fraction of the launch demand for small satellites do you expect will be met by dedicated small launch vehicles? What factors will determine the balance between dedicated small satellite launch vehicles and the “rideshare” approach?

It is too early to tell. The nascent small satellite market is still working through what is the right balance, which may vary by individual company based on their unique business case needs. With that said, if the U.S. government were to flood the market with cheap government motors and tilt the playing field away from the commercial dedicated small satellite launch vehicle industry, there may not be an opportunity in the future for companies to make that choice.

c. What federal laws, regulations, or policies (if any) affect industry decision-making about how to launch small satellites? Would you recommend changes in any of these

CSF is working with its member companies on to figure out whether changes, if any, are needed, and looks forward to providing the Committee more constructive feedback on this matter in the future.

10. As demand goes up for small satellites and more and more are launched, low Earth orbit will become a much more crowded place. Current Inter-Agency Space Debris Coordination Committee guidelines say that these satellites must be placed at a low enough orbit that atmospheric drag will cause them to re-enter 25 years after the end of its mission. Industry has said it will follow these guidelines. What is being done on the industry side to ensure that its small satellites do indeed follow these orbital guidelines?

CSF is working with its member companies on this matter, and looks forward to remaining engaged with the Committee on this matter.
11. One drawback of cube satellites is that many lack any kind of propulsion mechanism. As a result, they are not maneuverable and can pose a collision risk. There are some technologies under development now such as solar sails and solar electric propulsion that can grant some amount of mobility to small satellites. How do you see industry standards for collision avoidance and end-of-life disposal capabilities evolving?

CSF is working with its member companies on this matter, and looks forward to remaining engaged with the Committee on this matter.

12. Some companies like Spire, Digital Globe and One Web plan to launch huge constellations of small satellites into orbit. Assuming that the growth in the small satellite market continues, do you foresee a time when popular orbits will become too crowded by constellations of hundreds or thousands of satellites? Is there talk within the industry about stricter industry standards so that debris does not make popular orbits unusable?

CSF is working with its member companies on this matter, and looks forward to remaining engaged with the Committee on this matter.

13. The Satellite Industry Association’s 2015 State of the Satellite Industry report mentions a “growing concern regarding collisions with CubeSats,” and notes that NASA has had to move satellites in order to avoid running into these small satellites. How would you characterize the risk associated with CubeSat’s in orbit today?

CSF is working with its member companies on this matter, and looks forward to remaining engaged with the Committee on this matter.

14. Arizona State University recently published an article on its SunCube FemtoSat, a small satellite that is 3 centimeters long on each side. Many others have talked about incredibly small satellite and ‘chipsats’ that are weighed in grams. When you look at the trend in satellite size, do you see these extremely small satellites becoming more popular? If so, what is industry doing to ensure that we can track these very small satellites? Do you envision a commercial need for space situational awareness information and services beyond what the Air Force currently provides to the public free-of-charge?
CSF is working with its member companies on this matter, and looks forward to remaining engaged with the Committee on this matter.

15. Small satellite technology can serve both commercial and scientific interests. When you look at where investments are being made in small satellites, is it mostly with an eye to the commercial benefits or do more end users plan to use them for scientific purposes like research and technology development?

CSF defers to the individual companies working on small satellite technology, and their potential customers, to answer this question.

16. Last summer, NASA announced that it would be sending two CubeSats to Mars. The twin communications-relay satellites are to be built by NASA's Jet Propulsion Laboratory and will launch as secondary payloads to the InSight lander. This mission will be the first time that CubeSats have flown into deep space. The vast majority of CubeSats are placed into low Earth orbit. Does industry have any plans to move beyond this orbit, out into deep space?

Many companies do hope to move beyond orbit to cislunar space and beyond. Companies such as Planetary Resources are preparing to use CubeSats or similar platforms for exploring asteroids for prospective mining operations.

17. NASA has several programs dedicated to the development of small satellites including its CubeSat Launch Initiative and Venture Class Launch Program. Can you please describe what the commercial industry's experience has been working with NASA and other government agencies in developing small satellites and launch? What policy recommendations do you have that could better serve American interests and promote the continued development of small satellite and launch technology?

Policies that promote the fullest possible commercial use of space requires NASA to leverage commercial products where available, and avoid competing with private sector goods and services, and avoid government-derived duplication with the private sector.

18. In May of last year, the chairman of the Surrey Satellite Technology Ltd., Martin Sweeting, warned that there might be too much “heady enthusiasm” when it comes to CubeSats. SpaceNews called his comments a warning about a CubeSat bubble. Are CubeSats a sustainable business model, or is this just a Silicon Valley fad? What kind of timeline are investors in CubeSats looking at?
I fully believe that CubeSats are a sustainable business model. They can offer immense capabilities, often at a fraction of the cost of what would be necessary to achieve the same mission with one large satellite. Just as Moore’s Law decreased the size of computers and made them more commonplace, the miniaturization of satellites is an exponential trend. CubeSats are here to stay.

19. NASA’s Launch Services Program is actively trying to develop the small satellite commercial launch industry as an alternative to rideshare opportunities. Small satellite launch vehicles, like the ones proposed by Firefly, Virgin Galactic, and Rocket Lab, seem to be well suited to launching venture class missions. When looking at the market, do small satellite launch service providers see NASA as their primary customer or anchor tenant? Can you describe the demographic interested in small satellite launch services?

Many of the launch vehicle providers see NASA as just one of many potential customers. There are a number potential dedicated smalls satellite launch customers including industry, governments, and academia that are looking to launch satellites into space and companies like Virgin Galactic, Vulcan, and Firefly will be able to offer launch services to these start ups at affordable prices.

20. Several people have called the development of CubeSats a revolution in satellite technology. According to the Satellite Industry Association’s "State of the Satellite Industry Report" 63 percent of all satellites launched in 2015 were CubeSats. This is an impressive number. And yet while most of the satellites launched were CubeSats, they only made up less than 1 percent of the total market value of all the spacecraft launched. Can you give us a sense of scale for how big this revolution really is? What kind of economic impact are investors foreseeing in small satellite manufacturing and launch?

I will defer to the investment community to answer this question.

21. Space Works’ 2016 Nano and Microsatellite Market forecast predicts that as many as 3,000 nano and microsatellites will require a launch in the next six years. The report concludes that "the industry has a need for small launch vehicles." There are a number of such vehicles under development by U.S. companies. Even if new U.S. vehicles enter the market, will U.S. domestic launch vehicles alone be able to meet forecasted demand?

Yes. American industry is responding to market demand and innovating on new technologies, outpacing any other nation in the world.
22. In March of last year, the International Telecommunication Union held a conference in Geneva to discuss challenges facing the development of small satellites including frequency management and radio communication standardization. Out of that conference came a document called the “Prague Declaration” that confirms the “importance of implementing national legal and regulatory frameworks in conformity with international laws, regulations, guidelines and procedures.” What are the major radio communication policies impacting the small satellite industry?

CSF is working with its member companies on this matter, and looks forward to remaining engaged with the Committee on this matter.

23. The Federal Communications Commission licenses spectrum in the form of radio communication for satellites under three different categories: amateur, experimental and professional or operational. According to SpaceNews, the fee to license an experimental satellite is $430,000. The fee to license an amateur satellite is $60. It seems clear why most small satellite operators choose to purchase an amateur license. What kinds of frequency issues are influencing the industry right now? Can you talk about this discrepancy in licensing prices? Does this inhibit the growth of the small satellite industry?

CSF is working with its member companies on this matter, and looks forward to remaining engaged with the Committee on this matter.

24. What are the differences of the U.S. government’s role in space launch twenty years ago and now? Are the drivers for space assets and products different and/or bigger now than they were twenty years ago?

By consistently reaffirming 30 years of U.S. commercial launch policy, improving regulatory stability, and promoting pro-growth policies, the United States Government’s role will continue to be an enabling partner with U.S. industry.

25. Many of the companies we see entering the small satellite market are startups in Silicon Valley. How would you characterize the small satellite workforce? Are these new space startups positively impacting the employment and training pipeline for STEM students and recent graduates?

These new and existing markets are driving substantial private capital investment into the U.S. space sector. In 2015, the commercial space industry saw historic levels of private capital investment and market growth. According to a recent report by the Tauri
Group, “More than 50 venture capital firms invested in space deals in 2015, the most in any year during the 15-year study period (2000-2015).” These investments totaled $1.8 billion in venture capital, and nearly $2.7 billion in total investment and debt financing, according to this report. This investment is significant and reflects continued confidence in the market, which, according to the Tauri Group, has committed more than $13.3 billion in investment (including debt financing) since 2000.

Over the past 5 years, a growing number of U.S. commercial space companies have expanded the commercial space economy beyond the traditional spaceflight hubs that were established back in the Apollo-era.

From Florida to Seattle, the expanding commercial space economy is creating modern manufacturing facilities, high-tech jobs, and professional and personal fulfillment to an ambitious generation of Millennials that are determined to make America’s 21st century better than the last.

- SpaceX, and commercial space companies, most meaningful place to work for Millennials. Median workforce age is 29.4
- Commercial satellite company OneWeb, a satellite telecommunication company that will expand broadband access globally, is building a 21st century satellite manufacturing and testing facility on the Florida Space Coast. The facility will bring 250 high-tech jobs to the area.5
- Jeff Bezos’s Blue Origin rocket company is also building a 21st century rocket manufacturing and integration facility on Florida’s Space Coast. The facility will bring 330 high tech jobs to the area.6
- Firefly Space Systems, building a dedicated small-satellite launch vehicle, is building a rocket manufacturing and test facility in Cedar Park, Texas. The facility will bring 200 high tech jobs to the area.7
- SpaceX building private spaceport in McGregor, Texas, which employs 300 people.8

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• World View Enterprises, a company that manufactures helium-filled balloons and capsules that can carry passengers and scientific payloads to the edge of space, is building a modern manufacturing and launch facility in Tucson, Arizona. The facility will create 448 new high tech jobs over the next five years.9

• Virgin Galactic has opened a new facility in Long Beach, California to design and manufacture the company’s small satellite launch vehicle, LauncherOne. The facility will create 200 new high tech jobs in the area.10

• Spaceflight Industries, securing rideshares for secondary payloads and building a 60 satellite remote sensing constellation, is doubling its Seattle-headquartered staff to keep up with its growing business.11

26. The number of small satellites and CubeSats launched in the past few years has skyrocketed. There is an entire industry developing just to serve the small satellite and CubeSat community—including manufacturing, launch, and value-added data products. Can you give us a sense of how the small satellite industry is impacting job creation?

Please see my answer to question number 25 for details on job creation and economic growth.

27. Would the use of excess ICBM motors for commercial launches compete with sub-500kg class vehicles currently in development?

Yes. Every orbital Minotaur launch, except for one, has launched a sub-500kg class satellite as its primary payload.

   a. How would payload aggregating affect an evaluation of whether excess ICBM motors would compete with sub-500kg class vehicles currently in development?

Every orbital Minotaur launch, except for one (Minotaur IV launch Sept. 26, 2010), has launched a sub-500kg class satellite as its primary payload. It would be competing regardless of aggregation.

   b. Would launch vehicles that used excess ICBM motors compete with larger launch vehicles for market-share of aggregated payloads?

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10 http://www.space.com/28866-virgin-galactic-launcherone-rocket-factory.html
11 http://www.bizjournals.com/seattle/blog/techflash/2015/03/spaceflight-industries-to-double-in-staff-revenue.html
106

c. If they would compete, with or without aggregation, is there a way to mitigate the impact to the commercial market?

Don’t allow them to compete.

d. Would a sunset on the availability of excess of ICBM motors mitigate any concerns?

No.

e. How would the commercial market be affected (if at all) by only allowing excess ICBM motors to be used for commercial markets until sub

Although we expect the market to grow, it is small enough at this point that even the addition of a relatively small number of ICBM motors would dilute the market and cause harm.

f. Would a cap on the number of motors available (either in total or to an individual recipient) mitigate concerns?

To a degree this would mitigate some of the concerns depending on the exact number, but it would still not address the inherently anti-competitive behavior that would be introduced into the market that would threaten the space launch industrial base. I believe that the cap that should remain is zero, zero ICBM motors available to anyone.

28. How should the government determine the fair market value of an excess ICBM motor?

In order to assess any potential methodologies for determining fair market value of excess ICBM rocket motors, it is important to review and analyze the current methodology by which the Air Force establishes value for its excess ICBM rockets.

In the Air Force’s most recent financial report, United States Air Force Agency Financial Report 2015, excess ICBM rocket motor assets (“uninstalled intercontinental ballistic missiles motors”) are recognized and reported as Operating Materials and Supplies (OM&S). The Air Force is required by Statement of Federal Financial Accounting

Standards No. 3 (SFFAS 3), Accounting for Inventory and Related Property, to use the historical cost to value its Operating Materials and Supplies inventory. The SFFAS 3 stipulates that historical cost shall include all appropriate purchase and production costs incurred to bring the item to their current condition and location. This is the most appropriate methodology option available for valuating excess ICBM rocket motor assets because there are additional costs required to maintain the assets in their current “flight worthy” condition in “environmentally controlled” locations. Or as officials of the Rocket System Launch Program (RSLP) put it more succinctly, “Our capability to store, age and monitor assets allows us to offer deactivated weapons grade motors and components as some of the most reliable launch vehicles currently available.”

With that said, it appears that the Air Force employs a different valuation methodology that deviates from the FASAB standard. Per Air Force Instruction 21-103, Equipment Inventory, Status and Utilization Reporting, certified current on 7 June 2014, states, “The RSLP SPO is responsible for establishing the value of uninstalled RSLP owned rocket motors. This value is normally derived from the original weapon system CFO reporting data elements (full cost and useful life) however, in the absence of this information (for the older weapon systems), the cost may be derived from other means. For example, retired ICBM weapon system booster costs established by the ICBM SPO.” Per this mandatory instruction, the Air Force only takes into account the original weapon system’s full cost and useful cost when determining a rocket motor’s value, which fails to adequately capture all of the asset’s historical costs, including “current condition and location” costs. When deciding to use an ICBM-derived launch vehicle for government missions, the Air Force should update its excess ICBM rocket motor valuation methodology to meet the FASAB historical costs standard, to include the aggregated costs of annual storage, aging surveillance, and refurbishment costs for each rocket motor from the time that it is deactivated and stored to the time it is refurbished and launched.

With regard to selling ICBM rocket motors for commercial space launches, the SFFAS 3 would require rocket motor assets to be governed by “Inventory” standards rather than “Operating Materials & Supplies” standards. The SFFAS 3 requires the reporting of inventory in one of four categories: (1) inventory held for sale, (2) inventory held in reserve for future use, (3) excess, obsolete, and unserviceable inventory, and (4) inventory held for repair. The standards require historical cost or latest acquisition cost

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13 Space and Missile Systems Center, Performance-Based Work Statement (PWS) For Orbital/Suborbital Program 3 (OSP-3), 10 May 2012
15 The RSLP SPO is responsible for establishing the value of uninstalled RSLP owned rocket motors. [page 99]
valuation of inventory held for sale and inventory held in reserve for future sale. Federal law and policy for thirty years have allowed the use of these assets by the government for launch and as targets, and these assets have been successfully used in that fashion.

Ultimately, any methodology for determining the fair market value of the ICBM motors made available for government and commercial launch purposes should adequately reflect the substantial taxpayer investment in these assets. Historical cost valuation methodology appears to be the most accurate option for capturing the total investment and maintenance cost of these assets. With that said, focusing on fair market value for individual rocket motors misses the larger point, implied by other questions in this RFI, which is these rocket motors are intended for sale to provide the vast majority of the hardware for a space launch vehicle. For example, question number 8 inquires about the appropriate quantity of rocket motors that should be sold per year, but always in sets of 3. Why always in sets of 3? Because as the title of this RFI indicates, the purpose of selling excess ICBM motors is not to rebuild heritage ICBMs or ballistic missile targeting vehicles, but rather to build and compete commercial space launch vehicles. By focusing only on a method to determine a fair market value for the rocket motors and ignoring the fair market value of the potential space launch vehicle, a scenario could be created where the rocket motors are sold at a fair market price but then are used by a buyer to build a space launch vehicle that cost significantly less than comparable launch vehicles composed of new commercial boosters, thereby giving the buyer an unfair advantage in the commercial space launch marketplace. For example, "In 1998, RSLP supported its first orbital mission by launching an R&D satellite using a Peacekeeper ICBM Stage 1 to replace the Castor 120 booster on a Taurus SLV. This strategy saved the satellite customer about $6M\text{[million]}." This scenario could materialize because boosters represent the highest cost component for the launch vehicle hardware. Typically, boosters represent 90% of the cost of launch vehicle hardware. Surplus ICBM boosters, integrated into launch vehicles using modern avionics, offer a way to shave 30%-50% off the cost of comparable launch vehicles composed of new commercial boosters.

Furthermore, if the U.S. Air Force were authorized to sell excess rocket motor assets through U.S. General Service Administration, the scenario outlined in the above

17 Ibid.
paragraph may require an antitrust review by the Department of Justice per Federal Management Regulations:

“When the sale of personal property has an estimated fair market value of $3 million or more or if the sale involves a patent, process, technique, or invention, you must notify the Attorney General of the Department of Justice (DOJ) and get DOJ’s opinion as to whether the sale would give the buyer an unfair advantage in the marketplace and violate any antitrust laws.”

Ultimately, any methodology should include preventive measures to avoid this scenario, such as launch vehicle pricing provisions used in commercial space launch agreements to ensure potential excess ICBM-derived launch vehicles are comparable to similarly capable U.S. commercial space launch vehicles (e.g., Minotaur IV&V comparable to Athena 2c).

29. What is your estimate of the fair market value of an excess ICBM motor? What is this estimate based on?

Please see my answer to question number 28.

30. What should the U.S. do to prevent U.S. payloads from going overseas to launch on foreign launch vehicles? Should it do anything?

American industry is responding to market demand and innovating on new technologies, outpacing any other nation in the world. We seek to preserve this national leadership in space by the Committee strongly opposing any change to the existing policy with respect to the commercial use of excess ICBM assets and retaining the current case-by-case waiver process.

31. What impact would a limitation on access to foreign launch services have on small satellite operators?

A healthy small satellite industry would continue to grow and thrive by maintaining the current limitations that we advocate for in our response to question number 30.

32. How long have the following launch vehicles been in development?

CSF defers to the individual companies working on the vehicles you reference.

33. When is the expected operational readiness for the following vehicles? Please indicate if the initial operational readiness date was delayed.

CSF defers to the individual companies working on the vehicles you reference.

34. When do you believe a domestic launch capability will be available for sub-500kg performance?

Domestic launch capability is already available for sub-500kg performance. This year Orbital ATK's Minotaur-C (commercial variant of the Minotaur launch vehicle family) will aggregate and launch 6 Skysat small satellites, which weigh 120 kg each, to Sun Synchronous Orbit (SSO). Similarly, SpaceX's Falcon 9 will launch Spaceflight Industries SHERPA spacecraft and payload adapter, which will launch 87 small satellites that are up to 500kg to LEO. In addition, additional domestic launch options for sub-500kg satellites will be coming online soon, including services by Virgin Galactic, Firefly, Vulcan Aerospace, Masten Space Systems, and Rocket Lab.

35. How long should the U.S. small satellite operator community wait for the development of a domestic launch capability for sub-500kg performance?

It doesn't have to wait. Please see my answer to question 34.
In recent years, both the Air Force and NASA have made a tremendous amount of federal launch property available to commercial users at Cape Canaveral and Kennedy Space Center, often at extremely discounted rates, in the name of removing the maintenance costs from the government books as well as encouraging greater use of the launch complexes. This has included multiple launch pads, processing facilities and other property which was built or acquired at significant taxpayer expense.

When these federal assets were made available to launch companies, there was little debate about doing so - despite the fact that it directly competed with state spaceports, like MARS, Alaska, and others, who were developing similar capabilities with state and private investment and competing for the same customers that were given valuable federal property under very generous terms.

Given that the government policy for this ground infrastructure has been to make surplus assets available to commercial customers at below market rates, why is there opposition to allowing a restricted number of decommissioned motors available to commercial providers at fair market value? Can you clarify how some commercial launch providers readily accepted surplus ground infrastructure but are now opposing a similar policy when it comes to excess motors?

Yes, you’re correct, the DoD and NASA have made surplus government property and assets/equipment available to a number of users, including allied Foreign governments, State and local governments, and U.S. commercial businesses, for a variety of reasons, which include, among others, leveraging taxpayer property, reducing Federal government agencies’ Operation and Maintenance (O&M) costs, and supporting new U.S. businesses and job creation. However, as you’re aware, there are significant differences between how the U.S. Government makes surplus government property and surplus government assets/equipment available for private sector use.

For instance, U.S. commercial launch companies and State spaceports primarily acquire excess launch property and infrastructure through lease agreements with U.S. Government (DoD and NASA), rather than purchase excess launch property and infrastructure through auctions via the Government Services Administration (GSA), per Federal Acquisition Regulations (FAR). Leasing U.S. government excess launch property and infrastructure is a significantly different acquisition process, with significantly different implications, than the sale of excess DoD and
NASA assets/equipment to be competed for commercial market-share against other U.S. private companies. In fact, Congress recognized this important difference over 20 years ago when it codified established policy into law that limited the sale of excess defense assets/equipment if it were to have "an adverse impact on the national technology and industrial base and, particularly, will not reduce the opportunities of entities in the national technology and industrial base to sell new or used equipment." 20 22 U.S. Code 2321j(b)(1)(E).

If these excess ICBM rocket motors were to be sold for competition in the commercial space launch market, they would both have "adverse impact on the national technology and industrial base and, particularly, . reduce the opportunities of entities in the national technology and industrial base to sell new" rockets in the commercial space launch market.

In addition, if Congress were to decide to overturn 20 years of longstanding policy, it would be very difficult to define fair market value of these excess ICBM rocket motors. Any methodology for determining the fair market value of the ICBM motors made available for government and commercial launch purposes should adequately reflect the substantial taxpayer investment in these assets. Historical cost valuation methodology appears to be the most accurate option for capturing the total investment and maintenance cost of these assets. With that said, focusing on fair market value for individual rocket motors misses the larger point, implied by your question’s reference to a “restricted number of decommissioned motors available to commercial providers”, which is the purpose of selling excess ICBM motors is not to rebuild heritage ICBMs or ballistic missile targeting vehicles, but rather to build and compete commercial space launch vehicles. By focusing only on a method to determine a fair market value for the rocket motors and ignoring the fair market value of the potential space launch vehicle, a scenario could be created where the rocket motors are sold at a fair market price but then are used by a buyer to build a space launch vehicle that cost significantly less than comparable launch vehicles composed of new commercial boosters, thereby giving the buyer an unfair advantage in the commercial space launch marketplace. For example, “In 1998, RSLP supported its first orbital mission by launching an R&D satellite using a Peacekeeper ICBM.


https://www.law.cornell.edu/uscode/text/22/2321j
Stage 1 to replace the Castor 120 booster on a Taurus SLV. This strategy saved
the satellite customer about $6M[illion].

This scenario could materialize
because boosters represent the highest cost component for the launch vehicle
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Furthermore, if the U.S. Air Force were authorized to sell excess rocket motor
assets through U.S. General Service Administration, the scenario outlined in the
above paragraph may require an antitrust review by the Department of Justice
per Federal Management Regulations:

"When the sale of personal property has an estimated fair market
value of $3 million or more or if the sale involves a patent, process,
technique, or invention, you must notify the Attorney General of the
Department of Justice (DOJ) and get DOJ's opinion as to whether
the sale would give the buyer an unfair advantage in the
marketplace and violate any antitrust laws.

Ultimately, any methodology should include preventive measures to avoid this
scenario, such as launch vehicle pricing provisions used in commercial space
launch agreements to ensure potential excess ICBM-derived launch vehicles are
comparable to similarly capable U.S. commercial space launch vehicles (e.g.,
Minotaur IV&V comparable to Athena 2c).

2. As the committee reviews this issue, Members have a fiduciary responsibility
to act in the best interest of taxpayers as well as to determine what is in the best
interest of our national security.

21 Major Sebek, Captain Knorreck, First Lieutenant Elson, Mr. Buckley, "Low-Cost,
Reliable Spacelift for Small Satellites Using a Peacekeeper ICBM Derived Space
Launch Vehicle and Multi Payload Adapters". [page 1]
http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1756&context=smallsat
22 Ibid.
From both of these perspectives, it appears that it is in the Air Force’s interest to reduce its stockpile of decommissioned motors in a responsible manner by reducing annual maintenance costs and avoiding the costly process of responsibly destroying these engines.

The taxpayers would also benefit from having more immediate, low-cost launch options from a variety of spaceports, which already have the launch pad and ground infrastructure in place to launch these vehicles to launch NASA and NOAA payloads on a commercial contract.

Would you agree that using these decommissioned motors in such a manner is ultimately in the best interest of both the taxpayer, the Defense Department and customers who need immediate affordable launch options?

No, I respectfully disagree with your assessment. First, from 1972 to 2006, the Air Force reduced its stockpile of decommissioned motors in a responsible manner by over 650 rocket and missile launches using these surplus motors.\textsuperscript{24} RSLP used these rocket motor assets over the last thirty years to support DoD research and testing, chiefly as target vehicles for interceptor and sensor testing.\textsuperscript{25} Even with this significant reduction in its stockpile, the Air Force’s oversight and maintenance costs for these motors has remained constant as this a fixed costs.

It is not in the interest of the taxpayer to use old assets to compete against new businesses creating high-tech jobs. Rather, these assets are best utilized by continuing to lower cost for activities like ballistic missile targeting. To that end, the Army’s and Missile Defense Agency’s use of excess ICBM motors has lowered the cost of developing new ballistic missile targeting vehicles. In April 2016, Lt. Gen. David Mann, USA, Commanding General of the U.S. Army Space and Missile Defense Command testified to the Senate Armed Services Committee about how the Army was taking advantage of excess ICBM motors to develop low-cost targeting vehicles:

\textsuperscript{24} Emmer, Freyenhagen, Hockenberry, Geiger, “ICBM Derived Small Life Vehicles: Past, Present, and Future”. [page 2]
http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1597&context=smallsat

\textsuperscript{25} Major Buckley, Captain Weis, Lieutenant Marina, Jr., Lieutenant Morris, Schoneman, “The Orbital/Suborbital Program (OSP) "Minotaur" Space Launch Vehicle: Using Surplus ICBM Motors To Achieve Low Cost Space Lift For Small Satellites”. [page 1]
http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2216&context=smallsat
"Low-Cost Target Development: The Army continues to pursue a technology effort to develop a suite of low-cost targets for the Patriot testing program. The intent is to design threat-representative targets at a substantially reduced cost for short-range ballistic missile testing. Over the past year, we completed detailed designs for three new short range ballistic missile targets leveraging existing excess solid rocket motors. The first risk reduction flight of these targets is planned for May 2016. The Army will realize significant savings conducting operational test events using these new targets beginning in Fiscal Year 2017. We will continue to leverage existing missile inventory and technology advancements to develop less expensive targets that are representative of real world threats."

As for the best interest of our national security, I also respectfully disagree that it is in our best interest to use these old assets for commercial space launches. Excess Intercontinental Ballistic Missiles (ICBM) assets are already available to government users today. Expanding the transfer of ballistic missile rocket motor assets to include commercial launch providers would result in little change, if any at all, to space access for national security users. Under the current policy and law that has been in place for the last three decades, the U.S. Government agencies can use launch vehicles derived from excess ICBM rocket motors as long as there is no cost-effective commercial alternative, which is determined on a case by case basis.

In addition, the United States' current national security dependence on Russian rocket engines is due, in part, to its decision to focus on solid-fuel boosters:

"The Soviet arsenal was built exclusively on liquid engines, whereas the military in the West eventually abandoned liquid engines for solid-fuel booster rockets, which were deemed easier to launch quickly. Over all, the Russian fleet of liquid fuel rockets was far more diverse than the West's... Most importantly, Moscow kept working at it, hard. Apart from the space shuttle main engine, the United States developed no new power plants for liquid rockets after the 1960's." 

26 http://www.armed-services.senate.gov/imo/media/doc/Mann_04-13-16.pdf [page 9]
This situation was further exacerbated by the U.S. Government's decision to compete the U.S. Government's space shuttle against potential U.S. commercial space launch services. As noted by the Congressional Research Service, it was not until after the U.S. Government decided to end its practice of competing government launch assets against U.S. private industry that a U.S. commercial launch services industry was able to emerge: "But removing the shuttle as a competitor is seen as the major factor in fostering the U.S. commercial space launch business."²⁸

These two decisions – a significant focus on solid-fueled rocket motors and government assets competing with U.S. private companies – that helped lead to a 1990s "wave of activity...characterized by the export of Russian ideas, engines and vehicles to Western states."²⁹

Now, after putting into place policies to obviate that from reoccurring, many commercial companies are developing, under the regulatory auspices of more than two decades of consistent Government policy, innovative new launch vehicles that can meet national security, civil space, and commercial needs. Any policy shift now allowing for commercial access to excess ICBM assets would have a negative impact on national security and would encourage the entry of artificially cheap launch vehicles, based on old, inefficient, and finite technologies. This in turn, would discourage further investment in small satellite launch, and pick winners and losers in the marketplace, with one or two companies receiving an unfair advantage and the rest being forced to compete unfairly.

3. It is my understanding that the US Government maintains an inventory of hundreds of decommissioned ICBM motors at a cost of millions of dollars annually to the taxpayer. There has been a lot of discussion lately on whether or not these motors should be used commercially and what that impact would look

like for the industrial base. If Congress does modify existing law to allow for commercial use of these assets, but set limits on the number of flight vehicles sold to no more than 5 per company annually and then conduct a review in 3 years to examine if changing the policy has negatively impacted the broader industrial base, do you believe that could help alleviate concerns on this issue?

Although we expect the market to grow, it is small enough at this point that even the addition of a relatively small number of ICBM motors would dilute the market and cause harm. More important, however, is the signal that the Government would be sending by reversing its longstanding policy and involving itself in this strategic market. Such an action would indicate to investors that the Government could increase its involvement at any time, and could expand its involvement to other commercial spaceflight activities. This creates uncertainty, which harms investment.

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

The Commercial Space Launch Industry: Small Satellite Opportunities and Challenges

Mr. Eric Stallmer, President, Commercial Spaceflight Federation

Questions submitted by Rep. Jim Bridenstine

1. Given that the ISS will not be around forever, do you see commercial habitats as the next generation of LEO platforms?

I do believe that commercial habitats will be the next generation of LEO platforms. Commercial companies are already heavily involved in the operations of the ISS. NanoRacks has now launched over 100 satellites from the ISS and Made in Space’s 3D printer allows astronauts to print new tools right on aboard the station. If commercial companies take the initiative LEO operations, then NASA could focus on its deep space missions.

In a recent success for the industry, Bigelow Aerospace successfully expanded their BEAM module on the ISS, demonstrating the readiness of the technology to lead the way when the ISS is decommissioned.
The Commercial Space Launch Industry: Small Satellite Opportunities and Challenges

Mr. Eric Stallmer, President, Commercial Spaceflight Federation

Questions submitted by Rep. Mo Brooks

1. Mr. Stallmer, you said that Arianespace will be supporting OneWeb’s launch of hundreds of smallsats with the Soyuz launch vehicle. The Russian Federal Space Agency is the prime contractor for Arianespace for Soyuz launches. How much money will Russia receive from supplying Arianespace and OneWeb?

CSF defers to Arianespace for an accurate answer. With that said, Virgin Galactic is launching 39 of OneWeb’s launches, which is 18 more launches than Arianespace is contracted for. In addition, OneWeb has a contract clause with Virgin Galactic which allows it to contract for up to an additional 100 launches with Virgin Galactic. Clearly U.S. launch providers are meeting the global commercial launch market’s needs.

1. Mr. Stallmer, the US government has had a close contractual relationship with the contractor of these missile assets. Additionally, next-generation launch companies are developing systems that cannot use these motors. Would that contractor have a competitive advantage in this case?

Yes, absolutely. This close contractual relationship includes:

- The Air Force spent millions of dollars helping the contractor of these missile assets develop a number of orbital launch vehicles using these exact rocket motors that are being discussed for commercial space launch use.
- Then, over the past 20 years the Air Force has spent hundreds of millions of dollars procuring orbital launches from the contractor of these missile assets, using the launch vehicles that incorporate these rocket motors as described above, through the Orbital/Suborbital Program-1 (OSP-1) contract, Orbital/Suborbital Program-2 (OSP-2) contract, Suborbital Rocket Program-1 (SRP-1) contract, Suborbital Rocket Program-2 (SRP-2) contract, and Suborbital Rocket Program-3 (SRP-3) contract.
- In addition, the Air Force has spent additional hundreds of millions of dollars contracting with the contractor of these missile assets to do
storage, aging and surveillance, and refurbishment activities to these motors.

2. Mr. Stallmer, would you be willing to work and find a compromise to ensure that US launch providers could use decommissioned ICBM motors while at the same time address the concerns of your organization? If so, what would need to be addressed in the compromise?

Absolutely. The Commercial Spaceflight Federation is, and has been, more than willing to work with others to find a compromise if the outcome likely would result in improving the health and competitiveness of the United States commercial space industry, and as a result, strengthen the nation’s assured access to space. However, we are opposed the notion that a highly successful, long-standing policy should be arbitrarily overturned for the sake of compromise, regardless of the collateral damage that would likely ensue.
Appendix II

ADDITIONAL MATERIAL FOR THE RECORD
Thank you Mr. Chairman for holding this morning’s hearing.

There is no denying that small satellites have started a quiet revolution. Their low cost and quick turnaround in development and construction make them attractive platforms.

Users from the Commercial Sector, the Federal Government, and Universities are showing us the way as they build more and more capable smallsats on a daily basis.

Last November, the Committee heard from Planet Labs on how it is developing, and operating its Dove smallsats as components of a constellation for performing whole Earth, every day imaging.

And although we have yet to hear from members of the Federal Government and academia, and I hope we do so soon, rest assured that both are doing amazing things.

Notably, NASA is seeking to determine ways by which small satellites, and Cubesats in particular, can play an increasingly larger role in exploration, technology demonstration, scientific research and educational investigations. Two months ago, NASA selected four contracts as part of its InVEST Cubesat program to test Earth science technology in Space.

And universities are assisting NASA. For example, the University of Colorado Boulder’s Miniature X-ray Solar Spectrometer was launched last December aboard the Orbital ATK cargo resupply mission to the ISS. CU-Boulder’s NASA-funded Cubesat will study solar flares and the powerful X-rays emitted by the sun and is currently awaiting deployment into space using the ejection capability of a commercial dispenser on the ISS.

And, the National Academies will soon be releasing the results of its study on “Achieving Science Goals with Cubesats.”

But as with many technological advancements, there are challenges to consider in the potential that smallsats offer.

Our U.S. commercial launch vehicles have been focusing on launching and deploying larger satellites, so understanding any gaps in the U.S. launch capacity for smallsats and how to
address them is something that I hope this morning’s discussion can contribute. Because finding affordable, reliable, and responsive access to space for smallsats will be critical to realizing their potential.

In addition, there are questions that I hope the Subcommittee will discuss at future hearings, such as the potential implications of a large number of smallsats on an already worrisome orbital debris problem and considerations were we to provide Universities with greater opportunities to be secondary payloads on launches conducted and paid for by the government.

But for today, I hope this panel can shed additional light on possible solutions to providing smallsat users and operators with more launch options, particularly those that are affordable.

Because if this Nation is to maintain its global leadership in technology, we must facilitate the means by which our young are inspired to do great things. Small satellites, along with rocketry and robotics, provide the learning catalysts we so dearly seek and need.

We must capitalize on the opportunities made possible by smallsats and find ways to launch them affordably.

Thank you, Mr. Chairman, and I yield back.