SUBCOMMITTEE ON SPACE AND AERONAUTICS
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

HEARING CHARTER

"The Commercial Space Landscape: Innovation, Market, and Policy"

Thursday, July 25, 2019
2:00 p.m.
2318 Rayburn House Office Building

PURPOSE

The purpose of the hearing is to provide an overview of the commercial space industry, including innovative capabilities, the market, policy issues, and associated matters.

WITNESSES

- **Dr. Bhavya Lal,** Research Staff Member, IDA Science and Technology Policy Institute
- **Ms. Carissa Christensen,** Chief Executive Officer, Bryce Space and Technology
- **Mr. Eric Stallmer,** President, Commercial Spaceflight Federation
- **Mr. Michael French**, Vice President, Space Systems, Aerospace Industries Association
- **Ms. Laura Montgomery,** Proprietor, Ground Based Space Matters and Professor, Catholic University's Columbus School of Law

OVERARCHING QUESTIONS

- *What types of innovate capabilities are influencing, or may influence, the growth of commercial space?*
- *What is the overall size of the commercial space market, and how is the industry structured?*
- *How can the government consider engaging in commercial capabilities in space?*
- *What are the key issues facing the commercial space industry?*

BACKGROUND

Space Economy

The Space Foundation, a nonprofit space organization, releases a now quarterly report on global space activity, including trends in the space economy, infrastructure, products, services, and the workforce. The global space economy is the sum of world government spending on space and commercial companies' revenues, excluding government contracts. Commercial revenues include the sale of products and services enabled by space assets and the products and services that enable private entities to access and use space. The Space Foundation's 2019 Quarter 2

report estimates that global space economic activity grew 8.1 percent from 2017 to 2018 to a total of $415 billion, of which $329 billion (79 percent) is commercial revenue.[1]

The Space Foundation's report on the global space economy, *The Space Report 2018*, analyzed the year 2017 and is the most recent Space Foundation assessment of the commercial space sector.[2] The report found that in 2017, total global commercial space activity was $307 billion. The largest areas of activity were:

- Direct-to-home television: $98 billion (32 percent of commercial activity)
- Position, navigation, and timing: $82 billion (27 percent)[3]
- Satellite communications: $23 billion (8 percent)
- Commercial satellite manufacturing: $7 billion (2 percent)
- Satellite radio: $5 billion (2 percent)
- Earth observation: $3 billion (1 percent)
- Commercial launch industry: $2 billion (1 percent)

The public and private demand for satellite services from commercial and government customers supports sizeable, growing markets in satellite manufacturing and launch services. The Satellite Industry Association's *2019 State of the Satellite Industry* report finds commercial revenues from the manufacture of commercial and government satellites totaled nearly $20 billion in 2018 alone, up 26 percent from the year prior.[4] The same report finds even larger growth in launch industry revenues from commercial and commercially-procured government launches, up 34 percent to $6.2 billion in 2018. In 2018, two of the three largest manufacturers of commercial satellites were American companies, according to the Space Foundation's 2019 Quarter 1 report.[5]

Many recent industry analyses assert that the space economy will grow significantly over the next two decades to reach at least $1 trillion by approximately 2040.[6] [7] [8] [9] However, some space

---

[1] Space Foundation, *The Space Report 2019 Q2*, July 15, 2019.
[2] Space Foundation, *The Space Report 2018*, July 19, 2018.
[3] Position, navigation, and timing revenues stem almost entirely from the commercial use of government satellites, such as the U.S. Air Force's Global Positioning System (GPS).
[4] Satellite Industry Association, *2019 State of the Satellite Industry Report*, May 2019, prepared by Bryce Space and Technology. Available at: https://www.sia.org/wp-content/uploads/2019/05/2019-SSIR-2-Page-20190507.pdf
[5] Space Foundation, *The Space Report 2019 Q1*, April 11, 2019.
[6] Swiss bank UBS predicts the global space economy will reach $926 billion annually by 2040. See: UBS Editorial Team, "Still over the moon, 50 years later," UBS, July 18, 2019. Available at: https://www.ubs.com/global/en/wealth-management/marketnews/home/article.1441593.html.
[7] Goldman Sachs predicts the global space economy will hit $1 trillion in the 2040s and Bank of America Merrill Lynch estimates the space economy will reach as high as $2.7 trillion in the 2040s. As reported in: Foust, Jeff, "A trillion-dollar space industry will require new markets," *SpaceNews*, July 5, 2018. Available at: https://spacenews.com/a-trillion-dollar-space-industry-will-require-new-markets/
[8] Morgan Stanley expects space revenues, a subset of the space economy, to be slightly more than $1 trillion by 2040. See: Morgan Stanley, "Space: Investing in the Final Frontier," July 2, 2019. Available at: https://www.morganstanley.com/ideas/investing-in-space
[9] The U.S. Chamber of Commerce predicts a space economy of $1.5 trillion by 2040. See: Higginbotham, Brian, "The Space Economy: An Industry Takes Off," U.S. Chamber of Commerce, July 11, 2018. Available at: https://www.uschamber.com/series/above-the-fold/the-space-economy-industry-takes.

industry professionals have cautioned that even the lowest market analyses may be overly optimistic.[7] [10]

A venture capital firm, Space Angels, releases quarterly reports on global space investments. In the first two quarters of 2019, $2.9 billion was invested in space companies.[11] Since 2009, $22.3 billion has been invested in 476 unique companies, 54 percent of that investment has been in U.S. companies.

Workforce

The global space economy relies on a skilled workforce, including engineers and technicians. The Space Foundation's 2019 Quarter 1 report notes that the U.S. space workforce had more than 179,000 workers in 2018, which includes 135,000 in the private sector, 27,000 military personnel or national security civil servants, and 17,000 NASA civil servants.[5] The number of workers in the communications satellite manufacturing and services, guided missiles, and space vehicles sectors of the U.S. space workforce, after 8 consecutive years of decline, increased both in 2017 and the first half of 2018 over the previous year. However, workforce levels in those core sectors, were still 16 percent lower than they were in 2008. The same report found that space vehicles manufacturing (including guided missiles) and satellite telecommunications sectors saw job growths of 6.2 percent and 7.2 percent, respectively, while the broadcast and wireless communications equipment sector saw a 2.1 percent job loss.[5]

According to the 2018 *Aviation Week* Workforce Study, in 2017, women comprised 24 percent of the total U.S. aerospace and defense workforce, while minorities made up 26.7 percent of the aerospace and defense workforce.[12] The proportion of women and minorities in executive positions was significantly lower.

The 2019 Quarter 1 Space Foundation report found that Europe's space workforce has grown by an average of 4 percent annually since 2007.[5] In Japan, the space workforce declined 3.2 percent in 2018, but it has seen a strong decade of growth overall. India's workforce increased 4.6 percent in 2018, but was essentially flat compared to in 2011.

Commercial Innovations and New Capabilities

Several factors have helped enable innovative capabilities and potential new commercial space services and operations. The use of commercial off-the-shelf products, advanced information technologies, lower launch costs, and modern manufacturing process have facilitated the evolution of commercial space activities, including new capabilities and new entrants into the commercial space market.

---

[10] O'Sullivan, Sinéad, "Understanding the Space Economy," interview with the *Harvard Business Review*, May 28, 2019. Available at: https://hbr.org/ideacast/2019/05/understanding-the-space-economy.html

[11] Space Angels, "Space Investment Quarterly: Q2 2019," July 11, 2019. https://www.spaceangels.com/post/q2-2019-space-investment-quarterly

[12] Aviation Week Network, "2018 Aviation Week Workforce Study Report," September 18, 2018. Available at: https://aviationweek.com/2018-aviation-week-workforce-study-report.

Historically, launch costs have been seen as one of the major barriers to entry for new space companies. In recent years, innovations in rocket design and manufacturing have lowered per-launch costs as well as increased launch cadences.[13] Lowered launch costs and a more diverse array of launch options has made it easier for new companies to enter the market.

Improvements in the manufacturing industry from automation, artificial intelligence, and increasing efficiencies are creating new business opportunities. Some satellites today are forty times lighter than traditional satellites while still providing the same services, which dramatically lowers production and launch costs.[13] Lessons from the high-volume manufacturing industry and the attendant data is being used to enable the mass production of spacecraft and launchers, lowering total production costs.[14] Improvements in the throughput of satellite communication allow companies to provide high-speed data that is 20 times faster than traditional satellites, fast enough to compete with ground-based fiber optic networks.[13]

In addition, decreases in cost and technological improvements in areas such as processing power, data storage, camera technology, solar array efficiency, and micro-propulsion have been adapted into a variety of space related areas, including telecommunications, Earth observations, and even science and exploration missions.[13]

The factors noted above have, in part, helped facilitate a host of potential new commercial space activities and services. Some commercial space companies are planning to provide services including tracking space debris for space situational awareness or on-orbit satellite servicing. Space-based suborbital and orbital tourism are also anticipated to become available.[15] Other companies are hoping to manufacture products in space that benefit from the microgravity or zero-gravity environment, such as fiber-optic cables, LEDs, crystals, metal alloys, or even human organs.[16] In addition, some industry providers that had largely served government markets have been expanding their services for non-government customers, such as the use of Earth observation imagery data for customers and users ranging from agricultural entities to fast food businesses.[17]

Current Commercial Space Policies

Signed in 1967, the Outer Space Treaty provides the framework for international space law and policy, holding nations responsible for all activities in space conducted by either their governmental or their non-governmental actors. In particular, Article VI of the Outer Space Treaty states that "*the activities of non-governmental entities in out space, including the Moon*

[13] Lal, Bhavya, "Reshaping Space Policies to Meet Global Trends," *Issues in Science and Technology*, Summer 2016. Available at: https://issues.org/reshaping-space-policies-to-meet-global-trends/
[14] Institute for Defense Analyses Science and Technology Policy Institute, "Global Trends in Space Volume 1: Background and Overall Findings," June 2015. Available at: https://www.ida.org/-/media/feature/publications/g/gl/global-trends-in-space-volume-1-background-and-overall-findings/p5242v1.pdf
[15] REVFINE "Space Tourism: 5 Space Companies That Will Make You an Astronaut." Available at: https://www.revfine.com/space-tourism/
[16] Lewin, Sarah, "Making Stuff in Space: Off-Earth Manufacturing is Just Getting Started," *Space*, May 11, 2018. Available at: https://www.space.com/40552-space-based-manufacturing-just-getting-started.html
[17] GISGeography, "100 Earth Shattering Remote Sensing Applications and Uses," February 10, 2019. Available at: https://gisgeography.com/100-earth-remote-sensing-applications-uses/

and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty."[18] Congress has given statutory authorities to certain Federal agencies to meet the United States' international obligations under the Outer Space Treaty for non-governmental space activities. The Federal Aviation Administration (FAA) licenses launch, reentry, and launch and reentry sites; the Federal Communications Commission (FCC) licenses radio communications; and the National Oceanic and Atmospheric Administration (NOAA) licenses commercial remote sensing systems.

In May 2018, the administration issued Space Policy Directive-2 (SPD-2),[19] a presidential memorandum that instructs various federal agencies to streamline regulations on the commercial use of space. Below, the current state of commercial space regulations and corresponding proposed new rulemaking efforts in according with SPD-2 are briefly described.[20]

Launch, Reentry, and Spaceports: FAA

The Office of Commercial Space Transportation (AST) within the FAA issues commercial space transportation licenses and experimental permits, under authority granted to the Department of Transportation.[21] Licenses are required to launch a launch vehicle, operate a launch or reentry site (spaceport), or reenter a reentry vehicle within U.S. borders, as well as for any U.S. citizen or U.S. entity (including companies only organized within a foreign country but of which a U.S. citizen or U.S. entity holds a controlling share) to out a launch or reentry abroad. As of May 2019, the FAA has licensed or permitted more than 370 launches and reentries, and twelve commercial spaceports currently hold active licenses.[22]

Consistent with SPD-2, the FAA released a Notice of Proposed Rulemaking (NPRM) on April 15, 2019 with the intent of streamlining launch and reentry licensing requirements.[23] The public comment period for the NPRM has been extended through August 19, 2019.

Satellite Communications: FCC

Under its authority to regulate all radio communication and transmission under the Communications Act of 1934[24] and the United States' obligations under the International

[18] "Treaty on the Principles Governing the Activities of State in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies," ratified 1967. Available at: http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html
[19] Space Policy Directive-2, "Streamlining Regulations on Commercial Use of Space," May 24, 2018. Available at: https://www.whitehouse.gov/presidential-actions/space-policy-directive-2-streamlining-regulations-commercial-use-space/
[20] More detail on the current state of regulations and rulemaking efforts can be found in Congressional Research Services Report R45416, *Commercial Space: Federal Regulation, Oversight, and Utilization*, by Daniel Morgan, November 29, 2018. Available at: https://crsreports.congress.gov/product/pdf/R/R45416/2
[21] Title 51, U.S. Code, Section 50904(a) Available at: https://www.law.cornell.edu/uscode/text/51/50904
[22] FAA, "Fact Sheet – Commercial Space Transportation Activities." May 29, 2019. Available at: https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=19074
[23] FAA-2019-0229. Streamlined Launch and Reentry Licensing Requirements. Available at: https://www.regulations.gov/docket?D=FAA-2019-0229
[24] Title 41, U.S. Code, Section 152(a). Available at: https://www.law.cornell.edu/uscode/text/47/152

Telecommunications Union (ITU) Radio Regulations,[25] the FCC issues licenses for private space-based communications. Satellites communicate with other satellites and with ground systems over radio frequencies, and thus must obtain FCC licenses for access to a given spectral frequency or band. Most private satellites are licensed through the Satellite Division of the FCC's International Bureau.

In May 2018, the FCC released an NPRM[26] proposing to revise licensing procedures for small satellites; the NPRM sought public comment in part on what the FCC's definition of "small satellites" should be, as different entities define them in a variety of ways. On July 11, 2019, the FCC released a new draft of the policy to be considered at its August 2019 Open Meeting.[27]

Remote Sensing from Space: NOAA

The Land Remote Sensing Policy Act of 1992 authorizes the Secretary of Commerce[28] to issue licenses for operation of commercial remote sensing systems on space-based platforms. As defined in the Code of Federal Regulations, a "remote sensing space system" is one capable of "*actively or passively sensing the Earth's surface, including bodies of water, from space by making use of the electromagnetic waves emitted, reflected, or diffracted by the sensed objects.*"[29] The Department of Commerce oversees the issuance of commercial remote sensing licenses through the Commercial Remote Sensing Regulatory Affairs Office (CRSRA) within NOAA. Similar to the other licenses for commercial space activities, NOAA licenses are required for any U.S. citizen, U.S. entity, or foreign entity with substantial U.S. connection.

In June 2018, NOAA issued an Advance Notice of Proposed Rulemaking[30] with a draft revision of the current regulations governing commercial remote sensing licensing. NOAA issued an updated Proposed Rule[31] in May 2019, for which the public comment period recently ended. The stated intention of the NPRM is to reflect changes in the industry and improve the regulatory approach, in accordance with SPD-2.

---

[25] The ITU Radio Regulations were first adopted in 1995, and last revised at the 2015 World Radiocommunication Conference (WRC-15). The next WRC will take place in October 2019. More information: https://www.itu.int/pub/R-REG-RR/en

[26] FCC, "Streamlining Licensing Procedures for Small Satellites," 83 *Federal Register* 24064, May 24, 2018. Available at: https://www.federalregister.gov/documents/2018/05/24/2018-10943/streamlining-licensing-procedures-for-small-satellites

[27] FCC, "Streamlining Licensing Procedures for Small Satellites," Public Draft, July 11, 2019. Available at: https://www.fcc.gov/document/streamlining-licensing-procedures-small-satellites-0

[28] Title 51, U.S. Code, Section 60121. Available at: https://www.law.cornell.edu/uscode/text/51/60121

[29] Title 15, U.S. Code of Federal Regulations, Part 960.3. Available at: https://www.ecfr.gov/cgi-bin/text-idx?SID=95e2df51e3d82db5c6c2d7c7fd4df4f6&mc=true&node=se15.3.960_13&rgn=div8

[30] Department of Commerce, NOAA, "Licensing Private Remote Sensing Systems," 83 *Federal Register* 30592, June 28, 2018. Available at: https://www.federalregister.gov/documents/2018/06/29/2018-14038/licensing-private-remote-sensing-space-systems

[31] Department of Commerce, NOAA, "Licensing of Private Remote Sensing Systems," 84 *Federal Register* 21282, May 14, 2019. Available at: https://www.federalregister.gov/documents/2019/05/14/2019-09320/licensing-of-private-remote-sensing-space-systems

Other Policies for Commercial Space

Licenses to export some commercial space technologies are issued by the Department of State, if they are subject to the International Traffic in Arms Regulations (ITAR).[32] Other export control licenses are issued by the Department of Commerce for technologies which are subject to the Commerce Control List.[33]

The Department of State's Office of Space and Advanced Technology leads U.S. government consultations with other countries and international organizations on space policy and law.

[32] https://www.pmddtc.state.gov/ddtc_public?id=ddtc_kb_article_page&sys_id=%2024d528fddbfc930044f9ff621f961987

[33] https://www.bis.doc.gov/index.php/regulations/commerce-control-list-ccl