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LOOKING FORWARD: AVIATION 2050

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BEFORE THE

SUBCOMMITTEE ON
AVIATION

OF THE

COMMITTEE ON
TRANSPORTATION AND
INFRASTRUCTURE
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MARCH 8, 2019

SUMMARY OF SUBJECT MATTER

TO: Members, Subcommittee on Aviation
FROM: Staff, Subcommittee on Aviation
RE: Subcommittee Hearing on "Looking Forward: Aviation 2050"

PURPOSE

The Subcommittee on Aviation will meet on Tuesday, March 12, 2019, at 10 a.m. in HVC–210 of the Capitol Visitor Center to hold a hearing titled, "Looking Forward: Aviation 2050." The hearing will explore the future of U.S. aviation and the National Airspace System (NAS), including how the NAS is evolving as a result of new aviation and aerospace technologies, as well as how new and future entrants (including unmanned aircraft, passenger air taxis, and supersonic aircraft) will change our airspace. The Subcommittee will hear testimony from the National Aeronautics and Space Administration (NASA), PrecisionHawk, Boom, Uber Elevate, and the Air Line Pilots Association.

FUTURE OF U.S. AVIATION AND AEROSPACE

Civil aviation plays a central role in the United States, supporting more than $1.5 trillion of economic activity and more than 11 million jobs, according to industry groups. This role will only grow with the introduction of new airspace users, such as unmanned aircraft and passenger air taxis, and the development of new aerospace technologies that change the way we operate in the airspace. The Federal Aviation Administration (FAA)—the Federal agency responsible for ensuring the safe and efficient operation of the NAS—along with NASA and industry are continuously exploring ways to make current airspace operations safer and more efficient, as well as to prepare our airspace for the arrival and integration of new users and technology.

The FAA's William J. Hughes Technical Center—a world renowned air transportation system laboratory—conducts extensive research and development to find solutions to air transportation safety challenges. The Technical Center also supports the FAA's Next Generation Air Transportation (NextGen) portfolio—an effort to modernize air traffic control systems to increase the safety and efficiency of the NAS.[1] NASA's Armstrong Flight Research Center has numerous flight test and research projects underway that seek to improve fuel efficiency and reduce emissions, reduce or mitigate aircraft noise, and support systems to safely integrate unmanned aircraft.[2] These Government programs, along with industry efforts, and public-private collaboration will ensure the United States remains the world leader in civil aerospace.

UNMANNED AIRCRAFT SYSTEMS

Unmanned aircraft systems (UAS)—ranging in size from those that can fit in your hand to 40-foot military drones weighing 16,000 pounds—are proliferating in the NAS. In fact, in its most recent aerospace forecast, the FAA estimates that the hobbyist (recreational) UAS fleet will more than double over the next 4 years—to

[1] *See* William J. Hughes Technical Center, https://www.faa.gov/about/office_org/headquarters_offices/ang/offices/tc/; FAA, *NextGen by the Numbers*, https://www.faa.gov/nextgen/by_the_numbers/.

[2] NASA, *Overview* (Feb. 16, 2015), https://www.nasa.gov/centers/armstrong/about/overview.html.

more than three million units by 2022. For the commercial UAS fleet, the FAA projects an increase from 110,000 units in 2017 to 450,000 units by 2022.[3] The Association for Unmanned Vehicle Systems International (AUVSI) estimates that by 2025, the UAS industry will have created more than 100,000 new jobs in the United States and have a total economic impact of more than $80 billion.[4]

UAS can be small, lightweight, inexpensive, easy to operate, and equipped with various technologies, such as cameras and infrared or thermal sensors, offering a virtually unlimited number of potential applications. UAS can perform work that manned aircraft cannot, such as close inspections of bridges, pipelines, railroad tracks, runways, and other critical infrastructure. UAS can also, among other things, image and survey wide swaths of land to monitor wildlife and combat animal poaching, inventory and classify forests, and deliver products such as medicine or medical supplies to rural and physically isolated areas. Over the past 2 years, UAS were vital in recovery efforts following hurricane events affecting several U.S. States and territories and in responding to wildfires that blazed across multiple Western States.[5]

UAS INTEGRATION

The *FAA Modernization and Reform Act of 2012* (Pub. L. 112–95) required the FAA, in consultation with other Federal agencies and industry, to develop a comprehensive plan to accelerate the safe integration of civil UAS into the NAS[6] and subsequently issue regulations applicable to the operation of small commercial UAS.[7] In June 2016, the FAA issued its final rule on small commercial UAS operations—"Operation and Certification of Small Unmanned Aircraft Systems" (14 C.F.R. part 107)—which significantly expanded and standardized the ability to conduct commercial UAS activities.[8] For commercial UAS operations, part 107 imposed requirements on UAS pilots[9] and aircraft,[10] as well as operational limitations. Most notably, the UAS must remain within the visual line of sight (VLOS) of the remote pilot in command and must not to fly over people not involved in the operation.[11] Operations outside of the defined limitations require an FAA-waiver signifying the FAA finds the proposed operation can be performed safely. Notably, under part 107, no waivers can be issued for commercial UAS operations carrying property for compensation or hire beyond-VLOS.[12] This, in effect, bars the ability of U.S. companies to conduct package delivery via UAS.

The *FAA Extension, Safety, and Security Act of 2016* (Pub. L. 114–190) includes a subtitle on UAS safety. Notable provisions include requiring the expeditious authorization of UAS in support of firefighting operations and fines for those who interfere with such operations, and permitting expanded UAS operations involving critical infrastructure, such as pipelines and facilities that generate electric energy or produce oil or gas. The *FAA Reauthorization Act of 2018* (Pub. L. 115–254) authorizes the FAA to fully regulate hobby and recreational UAS in order to ensure the safety and security of U.S. airspace; advances the safe and efficient integration of UAS into U.S. airspace through the development and testing of new UAS technologies; and directs the FAA to move forward with authorization of certain advanced operations (e.g., package delivery).

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[3] *FAA Aerospace Forecast Report Fiscal Years 2018 to 2038: Unmanned Aircraft Systems*, available at https://www.faa.gov/data__research/aviation/aerospace__forecasts/media/FY2018-38__FAA__Aerospace__Forecast.pdf.

[4] AUVSI, *The Economic Impact of Unmanned Aircraft Systems Integration in the United States* (Mar. 2013), available at http://www.auvsi.org/our-impact/economic-report.

[5] *See, e.g.*, Andy Pasztor, *Drones Play Increasing Role in Harvey Recovery Efforts*, THE WALL ST. J. (Sept. 4, 2017, 6:51 PM), https://www.wsj.com/articles/drones-play-increasing-role-in-harvey-disaster-recovery-efforts-1504474194; Elizabeth McLaughlin, *National Guard Using Reaper Drone to Fight Wildfires*, ABC NEWS (Aug. 15, 2018, 5:17 PM), https://abcnews.go.com/US/national-guard-reaper-drone-fight-wildfires/story?id=57199785.

[6] Pub. L. 112–95, § 332(a).

[7] *Id.* § 332(b).

[8] FAA, *Operation and Certification of Small Unmanned Aircraft Systems*, https://www.faa.gov/uas/media/RIN__2120-AJ60__Clean__Signed.pdf. See also 14 C.F.R. § 107 (2016).

[9] A pilot must be at least 16 years old, obtain a remote pilot airman certificate (or be under the direct supervision of a certificate holder), demonstrate aeronautical knowledge in order to obtain such a certificate, and pass vetting by the Transportation Security Administration.

[10] An aircraft must weigh less than 55 pounds, and any aircraft that weighs more than 0.55 pounds must be registered with the FAA online. The aircraft must undergo a pre-flight check to ensure it is in a safe operating condition.

[11] FAA, *Summary of Small Unmanned Aircraft Rule (Part 107)*, https://www.faa.gov/uas/media/Part__107__Summary.pdf. The UAS must also fly under 400 feet and at or below 100 miles per hour, during the day, yield right of way to manned aircraft, and not from a moving vehicle. Id.

[12] FAA, *Beyond the Basics*, https://www.faa.gov/uas/beyond__the__basics/.

OTHER UAS INTEGRATION EFFORTS

UAS Integration Pilot Program. In October 2017, under the directive of a Presidential Memorandum, the Department of Transportation (DOT) announced a 3-year "UAS Integration Pilot Program." Under the program, DOT selected and entered into agreements with ten State, local, or tribal governments, in partnership with private entities, to test and validate advanced UAS operations and technologies.[13] The program, designed to accelerate the testing of UAS operations that are currently restricted (such as beyond-VLOS operations and flights over people) allows lower levels of government to participate in the development of Federal UAS guidelines and regulations.[14]

UTM. The FAA, NASA, other Federal agencies, and industry are working closely on the development of UAS Traffic Management (UTM).[15] Similar to how air traffic systems manage manned aircraft operations today, UTM will include systems necessary to manage UAS traffic in low-altitude airspace, allowing the FAA to communicate real-time airspace status and constraints to operators,[16] and provide services to prohibit UAS from operating in certain airspace or colliding with other aircraft.[17] UTM will enable complex UAS operations, such as beyond-VLOS operations, and is critical to the full integration of UAS into the NAS.

Government-Industry Collaboration. Government and industry have collaborated extensively on UAS issues. Key partnerships, which have resulted in data and research to help integrate UAS, include:

- The *Drone Advisory Committee*, formed in 2016 to support the safe and efficient introduction of UAS into the NAS;[18]
- *UAS Test Sites*, established under the 2012 law,[19] to develop research findings and operational experiences that will help ensure the safe integration of UAS through regulations and operational procedures;[20]
- The FAA's *UAS Center of Excellence*—the Alliance for System Safety of UAS through Research Excellence (ASSURE)—comprises more than 20 leading aviation research universities that work to provide the FAA with the research needed to safely and efficiently integrate UAS into the NAS;[21] and
- The *Low Altitude Authorization and Notification Capability (LAANC)* (pronounced like "Lance"), launched in October 2017, is a system that can enable efficient (almost instantaneous) authorizations for otherwise-permissible UAS operations in controlled airspace (e.g., near an airport). LAANC supplements a manual process that takes 80 days on average to complete. LAANC is available today at nearly 300 FAA air traffic control facilities across the United States, covering approximately 500 airports.[22]

CHALLENGES TO UAS INTEGRATION

Safety. The FAA receives more than 100 UAS sighting reports each month.[23] While the Government Accountability Office (GAO) has concluded that the extent to which these reports represent actual incidents of unsafe UAS use is unclear,[24] the volume of the reported sightings reflects the risk of collision between UAS and manned aircraft near airports, critical infrastructure, and over populated areas. For example, in late 2017, a UAS collided with and damaged a U.S. Army UH–60 Black

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[13] DOT, Press Release—*U.S. Transportation Secretary Elaine L. Chao Announces Unmanned Aircraft Systems Integration Pilot Program Selectees* (May 9, 2018), https://www.faa.gov/news/press__releases/news__story.cfm?newsId=22755.

[14] FAA, *UAS Integration Pilot Program*, https://www.faa.gov/uas/programs__partnerships/uas__integration__pilot__program/splash/.

[15] FAA, *Unmanned Aircraft System Traffic Management*, https://www.faa.gov/uas/research__development/traffic__management/.

[16] *Id.*

[17] NASA, *UAS Traffic Management*, https://utm.arc.nasa.gov/index.shtml.

[18] See FAA, *Drone Advisory Committee*, https://www.faa.gov/uas/programs__partnerships/drone__advisory__committee/.

[19] Pub. L. 112–95, § 332(c). Current UAS test sites are located in Alaska, Nevada, New Mexico, New York, North Dakota, Texas, and Virginia.

[20] FAA, Fact Sheet—*FAA UAS Test Site Program* (Dec. 30, 2013), https://www.faa.gov/news/fact__sheets/news__story.cfm?newsId=15575.

[21] *See* ASSURE, *About Us*, http://www.assureuas.org/about.php.

[22] FAA, *UAS Data Exchange (LAANC)*, https://www.faa.gov/uas/programs__partnerships/data__exchange/.

[23] FAA, *UAS Sightings Report*, https://www.faa.gov/uas/resources/public__records/uas__sightings__report/.

[24] GAO, *Small Unmanned Aircraft Systems, FAA Should Improve Its Management of Safety Risks*, GAO–18–110 (May 2018).

Hawk helicopter near Staten Island, New York.[25] Another UAS struck a commercial plane with 8 passengers onboard as it approached the Jean Lesage International Airport in Québec City, Canada.[26] More recently, a UAS spotted near London's Gatwick Airport led to the cancellation or diversion of approximately 1,000 flights, affecting nearly 150,000 passengers.[27] UAS technology such as geofencing, collision avoidance, automatic landing, and return-to-home technology can help UAS prevent accidents with other aircraft, infrastructure, and people; however, the standardization, security, and availability of this technology are limited and not currently mandated.[28]

Security. Identification of UAS operators is a key concern of the FAA and law enforcement community. The *FAA Extension, Safety, and Security Act of 2016* required the FAA to convene industry stakeholders to facilitate the development of consensus standards for remotely identifying operators and owners of UAS, which would assist the FAA in the issuance of subsequent regulations or guidance, including those that allow expanded commercial UAS operations over people and beyond-VLOS. On December 20, 2018, the FAA issued a request for information to inform ongoing remote identification rulemaking. To date, the FAA has not issued a proposed rule on remote identification standards for UAS operations.

URBAN AIR MOBILITY (UAM)

Americans lost, on average, 97 hours a year due to traffic congestion in the United States, costing them nearly $87 billion in 2018, according to a recent industry report.[29] This not only impacts drivers, but also has harmful effects on businesses.[30] With recent advances in technology, flying cars, passenger air vehicles or taxis, and personal hovercraft may take to the skies as early as 2020. More than 70 concepts are reportedly in development and testing.[31] These concepts have the potential to reduce traffic congestion on U.S. roads and commute times, especially in cities and urban areas, and lessen the current burden on surface infrastructure.

Take Off and Landing. These aircraft must be small and lightweight, compared to conventional aircraft, so many concepts will rely on batteries and electric engines. While some concepts are designed to drive on the road before transitioning to flight mode with airplane-like wings,[32] others will operate as vertical takeoff and landing (VTOL) aircraft, with multiple rotors like a helicopter.[33] VTOL aircraft can lift off from existing city infrastructure (such as modified parking garage rooftops) instead of airports or long runways.[34]

Anticipated Operations. Unlike conventional aircraft, these aircraft are intended to fly at low altitudes and across short to medium distances, often in heavily congested areas.[35] Some UAM concepts include plans to fly more than 100 miles per

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[25] David Shepardson, *U.S. Probing Collision Between Civilian Drone, Army Helicopter*, REUTERS (Oct. 5, 2017, 12:30 PM), https://www.reuters.com/article/us-usa-military-drone/u-s-probing-collision-between-civilian-drone-army-helicopter-idUSKBN1CA1Z0.

[26] Travis Andrews, *A Commercial Airplane Collided With a Drone in Canada, a First in North America*, WASH. POST (Oct. 16, 2017), https://www.washingtonpost.com/news/morning-mix/wp/2017/10/16/a-commercial-airplane-collided-with-a-drone-in-canada-a-first-in-north-america/?utm__term=.1337b42f8e49.

[27] Jamie Grierson, *Gatwick Returns to Normality but Drone Threat Remains*, THE GUARDIAN (Jan. 4, 2019, 12:32 PM), https://www.theguardian.com/world/2019/jan/04/gatwick-returns-to-normality-but-drone-threat-remains.

[28] Tim Moynihan, *Things Will Get Messy if We Don't Start Wrangling Drones Now*, WIRED MAG. (Jan. 30, 2016, 7:00 AM), https://www.wired.com/2016/01/things-will-get-messy-if-we-dont-start-wrangling-drones-now.

[29] INRIX, *Congestion Costs Each American 97 Hours, $1,348 A Year* (Feb. 11, 2019), http://inrix.com/press-releases/scorecard-2018-us/.

[30] *See id.*

[31] Samantha Masunaga, *A New Generation of Flying Cars is Taking to the Air. But Without the Cars*, L.A. TIMES (Feb. 22, 2019, 5:00 AM), https://www.latimes.com/business/la-fi-flying-cars-20190222-story.html.

[32] *See, e.g.*, Terrafugia, *The Transition*, https://terrafugia.com/transition/.

[33] *See, e.g.*, Aurora Flight Sciences: A Boeing Company, *PAV—Passenger Air Vehicle*, https://www.aurora.aero/pav-evtol-passenger-air-vehicle/.

[34] *See* Gideon Lichfield, *When Will We Have Flying Cars? Maybe Sooner Than You Think*, MIT TECH. REV. (Feb. 13, 2019), https://www.technologyreview.com/s/612891/when-will-we-have-flying-cars-maybe-sooner-than-you-think/.

[35] CRS, *Flying Cars and Drones Pose Policy Challenges for Managing and Regulating Low-Altitude Airspace* (July 23, 2018), available at https://fas.org/sgp/crs/misc/IN10934.pdf.

hour and close to 1 hour on a single battery charge. Current models can be single-seated, or carry as many as five passengers.[36]

Ownership. While some of these concepts contemplate personal ownership and use, other companies' models rely on ride-sharing (i.e., air taxis) to reduce operational costs and ensure accessibility. These companies anticipate these concepts will be an affordable and a viable option for the traveling public, especially in urban areas.[37] Some companies claim their air taxi concepts will be less expensive than personal car ownership.[38]

UAM Integration and Challenges

Safety and Security. Unlike small UAS, which generally weigh less than 55 pounds, UAM concepts will be heavier, typically with a pilot and one or more passengers on board. A mid-flight event, such as a failed battery or structural failure, could pose significant safety risks to the vehicle's occupants and to people and property on the ground, particularly if the vehicle is used in congested urban areas. UAM concepts, like small UAS, will fly in low-altitude airspace, and will need to be safely integrated with conventional airspace users, especially around airports. Not unlike unauthorized helicopter operations, unauthorized UAM operations, such as those over critical infrastructure or other restricted or sensitive areas, could pose even greater safety and security risks than small UAS.[39]

Air Traffic Management. Like small UAS, these aircraft would generally operate in low-altitude airspace (below 400–500 feet); however, some may fly as high as 2,000 feet above ground level. Such operations would pose challenges to traditional FAA air traffic control methods of managing air traffic and separation, particularly in urban settings and with large volumes of these vehicles and small UAS in the vicinity.[40] Technologies currently in development such as UTM—a system that can provide airspace design, dynamic geofencing, conflict avoidance, and separation and sequencing for small UAS—will assist the FAA in safely separating flying cars from other aircraft.[41]

Pilot Training and Certification. The FAA is charged with ensuring aviation safety, which includes establishing the requirements for a pilot's license and the standards for the design, production, and maintenance of aircraft. In many cases, the FAA's current regulatory framework does not contemplate UAM concepts and their anticipated business models.[42] The FAA will need to provide this framework to allow the safe integration of these new technologies and operations.

Noise and Emissions. Many UAM concepts would rely on electric propulsion technology to operate, thereby having no direct emissions and emitting little noise relative to conventional airplanes and large trucks. Low noise and emissions will be necessary to their acceptance and utility in heavily populated settings.[43]

*Weathe*r. A UAM aircraft, like other aircraft, would be much more sensitive than a traditional ground vehicle to inclement weather. To ensure safe operations, these concepts will require the physical and operational standards necessary to avoid unsafe weather and to fly safely in weather conditions like rain and strong wind that do not preclude safe flight.[44]

State and Local Participation. Federal aviation statutes and regulations preempt State and local laws respecting aviation,[45] which includes the regulation of aviation safety, the use of airways, and aircraft certification. The supremacy of Federal authority has led to a consistent regulatory structure for all airspace users, ensuring safety and efficiency across the NAS.[46] In the UAS context, States and cities have sought to enact laws and regulations that control or restrict UAS operations,[47] potentially in contradiction to Federal law. Defining and delineating Federal, State, and local responsibilities with respect to both UAS and urban air mobility will con-

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[36] See Jeremy Bogaisky, *Your Flying Car May Be Almost Here*, FORBES (May 31, 2018), https://www.forbes.com/sites/jeremybogaisky/2018/05/24/your-flying-car-is-almost-here/#4c7d6aeb5724.

[37] *See* MIT, *supra* note 34.

[38] *See* Uber Elevate, *Fast-Forwarding to a Future of On-Demand Urban Air Transportation*, 3 (Oct. 2016), available at https://www.uber.com/elevate.pdf.

[39] *See id*. *See also* CRS, *supra* note 35.

[40] *Id*.

[41] *Id*.

[42] *See id.*; MIT, *supra* note 34.

[43] Uber Elevate, *supra* note 38, at 6.

[44] *See id*. at 70–73.

[45] *See, e.g*., city of Burbank v. Lockheed Air Terminal, Inc., 411 U.S. 624, 638–39 (1973) (recognizing the need for a "uniform and exclusive system of Federal regulation if the congressional objectives underlying the Federal Aviation Act are to be fulfilled").

[46] *See* CRS, *supra* note 35.

[47] *See id.*

tinue to be a topic of discussion and need to be addressed as these operators are safely integrated into the NAS.

SUPERSONIC AIRCRAFT

Supersonic flight is faster than the speed of sound, which can be upwards of 750 miles per hour.[48] The Concorde aircraft performed the first trans-oceanic commercial supersonic passenger flight in 1976, flying at twice the speed of sound and at a cruising altitude of 65,000 feet. Concorde flights could cut the duration of a subsonic trans-Atlantic flight in half. More than 2.5 million passengers flew at supersonic speeds along a limited number of routes until the Concorde terminated service in 2003; no supersonic passenger aircraft have flown since that time.[49]

Several factors contributed to the Concorde's lack of widespread success. Concorde aircraft were expensive to operate, particularly due to high fuel consumption. These high operating costs meant a roundtrip on the Concorde could cost as much as $15,000 U.S. dollars today.[50] The aircraft itself also had limited cargo space, preventing airlines from generating additional revenue by transporting cargo or mail. In addition, unlike traditional subsonic flight, the Concorde's design and speed created a "shock wave," experienced by people on the ground as a "sonic boom" as it passed overhead. This aircraft noise led to many countries banning supersonic flights from their airspace, limiting the number of routes the Concorde could fly.[51]

There has been a revival of interest in supersonic flight since the end of the Concorde in 2003. In addition to the time that can be saved traveling at supersonic speeds, the advancement of technology, materials and composites, aircraft design, and manufacturing can make the aircraft lighter, improve fuel efficiency, and reduce noise impacts. Several domestic and foreign airlines have already purchased options for supersonic aircraft in design and testing, and the first delivery of a supersonic aircraft to an airline may occur as early as 2025.[52]

SUPERSONIC AIRCRAFT INTEGRATION AND CHALLENGES

There are several challenges to the integration of supersonic aircraft into U.S. airspace, beyond aircraft design and public acceptance. Today, there are no international certification, noise, or emission standards for supersonic aircraft under development.[53] In addition, varying operational standards from country-to-country will prohibit many routes at the start. For instance, FAA regulations prohibit supersonic flight in the continental United States that cause a sonic boom.[54]

Congress sought to address some of these issues in the *FAA Reauthorization Act of 2018*. The law requires the FAA to exercise international leadership in the creation of Federal and international policies and standards regarding the certification and operation of supersonic aircraft. The FAA is required to submit a report to Congress with recommended regulatory changes related to supersonic aircraft and a timeline for executing those changes. The law also requires that, within the next 2 years, the FAA issue notices of proposed rulemaking to update noise standards for supersonic aircraft and to modernize the application process to operate supersonic aircraft.[55]

OTHER FUTURE AEROSPACE TECHNOLOGIES

Looking ahead to 2050, there are a number of exciting technologies, designs, and operational models that have the potential to vastly change transportation. Advances in aircraft, commercial space vehicle, and engine designs, such as the use of composite airframes and parts, hybrid-electric and all-electric engines, and highly flexible, lightweight wings, as well as new commercial space transportation launch vehicles are under development and promise more efficient and environmentally friendly operations. Alternative fuels and fuel sources also show great promise to reduce aviation's environmental footprint. Commercial space transportation will continue to grow and will need to be safely integrated into the NAS. What this new mode of transportation will mean for travel and shipping on a global level is still to be determined. Technologies to improve air traffic control and space traffic man-

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[48] CRS, *Supersonic Passenger Flights*, 1 (Nov. 14, 2018), available at https://fas.org/sgp/crs/misc/R45404.pdf.
[49] *Id.* at 1–3.
[50] *Id.*
[51] *See id.*
[52] *See id.* at 6–7.
[53] *Id.* at 7.
[54] *Id.* at 3, 8.
[55] *See* Pub. L. 115–294, § 181.

agement will need to keep up with new entrants, technologies, and business models. In the next 30 years, there will doubtless be other examples of American innovation and ingenuity that cannot even be conceived of today, but will change and improve the safety, availability, and efficiency of the National and global transportation system.

WITNESSES

- Mr. David McBride, Director, Armstrong Flight Research Center, National Aeronautics and Space Administration
- Ms. Diana Cooper, Senior Vice President, Policy & Strategy, PrecisionHawk, Inc.
- Dr. Eli Dourado, Head of Global Policy and Communications, Boom
- Mr. Eric Allison, Head of Elevate, Uber Technologies, Inc.
- Captain Joe DePete, President, Air Line Pilots Association, International

LOOKING FORWARD: AVIATION 2050

TUESDAY, MARCH 12, 2019

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON AVIATION,
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:01 a.m. in room HVC–210, Capitol Visitor Center, Hon. Rick Larsen (Chairman of the subcommittee) presiding.

Mr. LARSEN. The subcommittee will come to order. I will start with my opening statement, and then I want to say good morning and thank you to today's witnesses to join the subcommittee's discussion on aviation 2050.

However, I do want to start today by acknowledging the tragedy of Sunday's crash of Ethiopian Airlines flight 302 near Addis Ababa, Ethiopia. Eight Americans and twenty-one United Nations employees were among the 157 people who died in the crash.

Chair DeFazio, committee staff, and I have been in contact with the National Transportation Safety Board, the Federal Aviation Administration, and Boeing about the accident, and we continue to closely monitor the investigation.

I want committee members to know a couple of things. First, that the NTSB, the U.S.-accredited representative and lead for the United States, will assist and is assisting Ethiopian authorities in this investigation, and currently has people in Ethiopia. Right now the important thing is that relevant agencies are allowed to conduct a thorough and careful investigation. The Ethiopian Accident Investigations Bureau is the lead on this investigation, with support from NTSB and others.

Second, the FAA and Boeing, as well, have personnel in Ethiopia to assist the investigation.

Third, the FAA issued a continued airworthiness notification to the international community yesterday stating pilots should continue to use Boeing's operational safety protocols, as previously directed, following the Lion Air crash, and American carriers must install design changes no later than April of 2019.

The notification does not currently call for the grounding of the 737 MAX fleet.

I encourage all Members to monitor the situation themselves, and I want you to know that staff is available to any Member for any questions that you have surrounding the investigation, and can provide updates to you as they become available.

Now on with my statement for the hearing.

Certainly with safety as a guiding principle for this subcommittee, I look forward to spending time exploring what is on the horizon for aviation and aerospace. For this subcommittee, aviation and aerospace 2050 means fostering technological innovation and improving the Nation's competitiveness in the global marketplace.

One of the reasons we are holding this hearing is because we want to set the record of this subcommittee for the future. Today's witnesses represent several of the emerging entrants in the national airspace, from unmanned aircraft to passenger air vehicles and supersonic flight.

I am also very pleased current users are at the table. You will all play a vital role in the discussion on how to safely integrate these new technologies in our national airspace.

As we discuss the possibilities for aviation and aerospace in the next 30 years, Congress must also ensure the U.S. remains the global safety standard in flight.

Last fall Congress passed the longest Federal Aviation Administration reauthorization in decades. The bipartisan 5-year agreement supports important aerospace jobs across the U.S., as well as better prepares and diversifies the aviation workforce. The new law raises the bar on aviation safety, increases global competitiveness of domestic aerospace manufacturers and suppliers, and safely advances drone operations in U.S. airspace.

With the FAA bill as a foundation, the subcommittee can now look ahead to explore not only what is possible and on the horizon in aviation and aerospace, but what is needed to ensure the United States keeps innovating.

One area we will continue to see tremendous growth is in unmanned aircraft systems, or UAS, or drones. UAS are flourishing in the skies at a pace we did not imagine 10 years ago. The FAA estimates that the use of small hobbyist drones will double in size to more than 3 million units by 2022, and the commercial drone fleet will quadruple to approximately 450,000 units in that same timeframe.

There is no denying the extensive societal and commercial benefits of unmanned aircraft and their applications. Drones are used to perform critical infrastructure inspections of bridges and railroads, and assist in recovery efforts following natural disasters and wildfires.

With new and advanced operations aiming to take flight, several issues need to be explored. Inherent in the growth of this technology are the risks to critical assets, like airports. And while we want UAS integration to be efficient, we first must ensure it is safe.

Just skipping ahead, on supersonic, because of the advancements in technology, materials, and manufacturing, supersonic aircraft are on the horizon. Actually, they are back on the horizon. These flights can cut trans-oceanic traveling times in half, supporting passengers and international business. The United States does not yet have the regulatory framework to allow supersonic flight, and Congress must stay ahead of the curve or this may lead to missed opportunities.

One question you might answer in today's testimony is how is this different from what is currently available. Foreign airlines are already investing in a U.S. supersonic aircraft company.

Last year's FAA reauthorization directs the agency to exercise leadership in the creation of Federal regs and standards relating to the certification and safe and efficient operation of civil supersonic aircraft. The FAA says it will initiate two rulemaking activities on civil supersonic aircraft. Congress must ensure these initiatives stay on track.

I look forward to hearing from today's witness about the potential benefits of supersonic transport and challenges we have to address to ensure there is safe and appropriate integration of technology.

With timely input from new entrants and legacy users, U.S. aviation will be able to tailor products and services to better meet growing passenger demands and address local challenges, such as noise and greenhouse gas emissions. Two weeks ago the Transportation and Infrastructure Committee held a hearing about pragmatic solutions to address the impacts of climate change, as well as the aviation industry's role in these efforts.

The aviation industry has already committed to improving fuel efficiency by 1.5 percent per year, which began in 2010, achieving carbon neutral growth starting next year, and cutting net carbon dioxide emissions by 50 percent by 2050. I have had the chance to visit a few of these companies in my district at the forefront of innovative, energy-efficient aviation technology.

For example, Zunum Aero in Bothell, Washington, is developing hybrid electric aircraft capable of flying up to 12 people between 350 and 500 miles. The company aims to bring the aircraft to market as soon as 2022. Zunum projects its electrical propulsion prototype will cut community and cabin noise by an estimated 75 percent, and emissions by 80 percent.

And finally, the future of work. Emerging tech advances in U.S. aviation are only possible if Congress invests in and supports the next generation of engineers, mechanics and innovators. Unfortunately, the U.S. is not keeping pace with growing demands for talented individuals in the STEM fields. According to the Boston Consulting Group, there are 25,000 unfilled STEM jobs in Washington State alone, just in 1 State.

Last year's FAA bill includes a comprehensive workforce development title, including my provision to create a new task force to come up with ways to encourage high school students to enroll in aviation manufacturing, maintenance and engineering apprenticeships. The bill also creates two new grant programs to support pilot education and recruit aviation maintenance workers. Improving access to workforce training and preparing students to succeed is an all-around win for employers, job seekers, and the aviation and aerospace sectors.

U.S. innovation is the backbone of the Nation's economy and culture, and aviation 2050 is the next chapter in our leadership in this field. Communities have already seen and experienced the significant impact of emerging technologies, and we must prepare for what is to come.

The future of U.S. aviation and aerospace industries is bright. But Congress must play an important role to ensure the FAA takes steps to outline today in a timely manner, so U.S. companies can continue to innovate and remain globally competitive.

So again, thank you to today's witnesses. I look forward to this discussion.

[Mr. Larsen's prepared statement follows:]

Prepared Statement of Hon. Rick Larsen, a Representative in Congress from the State of Washington, and Chair, Subcommittee on Aviation

Good morning and thank you to today's witnesses for joining the Subcommittee's discussion on "Aviation 2050."

I want to start today by acknowledging the tragedy of Sunday's crash of Ethiopian Airlines Flight 302 near Addis Ababa, Ethiopia.

Eight Americans and 21 United Nations employees were among the 157 people who died in the crash.

Chair DeFazio, Committee staff and I are in contact with the National Transportation Safety Board, the Federal Aviation Administration and Boeing about the accident and continue to closely monitor the investigation.

Committee members should know:

First, the NTSB, the U.S. accredited representative and lead for the United States, will assist Ethiopian authorities in this investigation and has people in Ethiopia.

Right now, the most important thing is that relevant agencies are allowed to conduct a careful and thorough investigation.

The Ethiopian Accident Investigations Bureau is the lead on the investigation with support from NTSB and others.

Second, the FAA and Boeing have personnel in Ethiopia to assist in the investigation.

Third, the FAA issued a Continued Airworthiness Notification to the International Community yesterday stating pilots should continue to use Boeing's operational safety protocols as previously directed following the Lion Air crash, and American carriers must install design changes no later than April 2019.

The Notification does not currently call for the grounding of the 737 MAX fleet. I encourage all Members to monitor this situation themselves, but staff is available to Members for any questions you have surrounding the investigation and can provide updates as they become available.

With safety as the guiding principle for this Subcommittee, I look forward to spending time today exploring what is on the horizon for aviation and aerospace.

For this Subcommittee, aviation and aerospace 2050 means fostering technological innovation and improving the nation's competitiveness in the global marketplace.

One of the reasons we are holding this hearing is because we want to set the record of this Subcommittee for the future.

Today's witnesses represent several of the emerging entrants in the national airspace from unmanned aircraft to passenger air vehicles and supersonic flight.

I am also pleased current users are at the table. You will play a vital role in the discussion on how to safely integrate these new technologies.

As we discuss the exciting possibilities for aviation and aerospace in the next 30 years, Congress must also ensure the U.S. remains the global safety standard in flight.

Last fall, Congress passed the longest Federal Aviation Administration (FAA) reauthorization bill in decades.

The bipartisan five-year agreement supports important aerospace jobs across the U.S., key to my home state of Washington, as well as better prepares and diversifies the aviation workforce.

The new law raises the bar on aviation safety, increases the global competitiveness of domestic aerospace manufacturers and suppliers and safely advances drone operations in U.S. airspace.

With the FAA bill as a foundation, the Subcommittee can now look ahead to explore not only what is possible and on the horizon in aviation and aerospace, but what is needed to ensure the United States keeps innovating.

One area where we will continue to see tremendous growth is in unmanned aircraft systems (UAS), or drones.

UAS are flourishing in the skies at a pace we did not imagine ten years ago.

The FAA estimates the use of small hobbyist drones will double in size to more than 3 million units by 2022 and the commercial drone fleet will quadruple to approximately 450,000 units in that same timeframe.[1]

There is no denying the extensive societal and commercial benefits of unmanned aircraft and their applications.

Drones are used to perform critical infrastructure inspections of bridges and railroads and assist in recovery efforts following natural disasters and wildfires.

With new and advanced operations aiming to take flight, several issues need to be explored.

Inherent in the growth of this technology are the risks to critical assets, like airports.

While we want UAS integration to be efficient, we first must ensure it is safe.

The FAA reauthorization bill includes a robust title on UAS to help the commercial drone industry safely thrive, while also addressing the complexities of integration into U.S. airspace.

Paramount to any comprehensive regulatory framework for drone operations is the development and implementation of the FAA's remote identification rule.

Without a reliable mechanism to remotely identify and track drones, successful and advanced UAS operations will be nearly impossible.

The U.S. aviation economy cannot risk domestic companies going abroad for testing, development and deployment if this rule is not in place.

There are lessons to be learned from the FAA's efforts to integrate drones to keep the agency ahead of the curve when it comes to future entrants.

I look forward to exploring these topics with today's witnesses.

Further, passenger air vehicle concepts will continue to expand and have many potential benefits to communities like reducing traffic congestion.

These vehicles can reduce demand on structurally compromised roads and bridges by carrying commuters through the air, at low altitudes.

Because of the advancements in technology, materials and manufacturing, supersonic aircraft are on the horizon.

These flights can cut trans-oceanic traveling times in half, supporting passengers and international business.

The United States does not yet have the regulatory framework to allow supersonic flight. Congress must stay ahead of the curve or this may lead to missed opportunities.

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The aviation industry has already committed to improving fuel efficiency by 1.5 percent per year, which began in 2010, achieving carbon neutral growth starting next year and cutting net carbon dioxide emissions by 50 percent by 2050.

I have had the chance to visit a few companies in my district at the forefront of innovative, energy efficient aviation technology.

For example, Zunum Aero in Bothell, Washington, is developing hybrid electric aircraft capable of flying up to 12 people between 350 and 500 miles. The company aims to bring the aircraft to market as soon as 2022.

Zunum projects its electric propulsion prototype will cut community and cabin noise by an estimated 75 percent and emissions by 80 percent.[2]

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[1] *FAA Aerospace Forecast Report Fiscal Years 2018 to 2038: Unmanned Aircraft Systems*, available at https://www.faa.gov/data__research/aviation/aerospace__forecasts/media/FY2018-38__FAA__Aerospace__Forecast.pdf.

[2] https://zunum.aero/our-charge/

Emerging technological advances in U.S. aviation are only possible if Congress invests in and supports the next generation of engineers, mechanics and innovators.

Unfortunately, the U.S. is not keeping pace with growing demands for talented individuals to work in STEM fields.

Part of global competitiveness means ensuring a robust pipeline of talent.

According to the Boston Consulting Group, there are 25,000 unfilled STEM jobs in Washington state alone.

Last year's FAA bill includes a comprehensive workforce development title, including my provision to create a new task force to come up with ways to encourage high school students to enroll in aviation manufacturing, maintenance and engineering apprenticeships.

The bill also creates two new grant programs to support pilot education and recruit aviation maintenance workers.

Improving access to workforce training and preparing students to succeed is an all-around win for employers, job seekers and the aviation and aerospace sectors.

U.S. innovation is the backbone of the nation's economy and culture.

Aviation 2050 is the next chapter in our leadership in this field.

Communities have already seen and experienced the significant impact of emerging technologies and must prepare for what is to come.

The future of U.S. aviation and aerospace industries is bright. Congress must play an important role to ensure the FAA takes the steps outlined today in a timely manner, so U.S. companies can continue to innovate and remain globally competitive.

Again, thank you to today's witnesses. I look forward to this discussion.

Mr. LARSEN. And I call on the ranking member of the subcommittee, Mr. Graves, for an opening statement.

Mr. GRAVES OF LOUISIANA. Thank you, Mr. Chairman. And I want to thank all of you for being here today. And similarly, before I start my opening remarks, I do want to make note that we certainly are paying close attention to the multiple aviation accidents that have occurred in recent days, and paying a special attention to the Ethiopian Air accident that occurred that killed 157, including 8 Americans.

We have also been in touch with Chairman Larsen, with FAA, NTSB, Boeing, and other stakeholders.

But I also want to point out, as included in Mr. McBride's testimony, that air travel is the safest form of transportation in the world today. That doesn't mean we need to stop. We need to continue striving to ensure that it becomes even safer every single year, as we learn lessons from different incidents and accidents.

We don't know yet what caused these accidents, but we are going to be paying close attention, and ensure that lessons learned from these accidents are applied to the future, as well.

It is important with this hearing focusing on 2050 that we actually take a look back, and look at how air travel—for example, back in 1988, you had well over 700 deaths from air travel from different airlines. I think it was nearly 30 different accidents across the world. And looking back at the extraordinary reduction in deaths, while we have seen an exponential increase in the number of airline passengers that are boarding airplanes annually.

Back in 1988 Chairman DeFazio just finished his first congressional hearing. Don Young, after teaching pilgrims how to grow corn, became the longest-serving Republican Member of Congress from Alaska. And I want to make note that just in recent weeks Congressman Young is the longest-serving Republican Member of Congress ever. Nineteen eighty-eight was a while ago. Airlines like Pan Am, TWA, and Eastern were crossing our skies. We had just implemented the smoking ban on airplanes in that year. We have

come a long way, and it is an exciting opportunity to think about what 31 years from now will truly look like.

We have a chance to totally reinvent the airspace, not only incorporating new entrants like drones, flying cars, commercial space travel, but also the chance to pave the way for the next big idea that changes the way that Americans travel.

We in Congress usually are responding or being reactive. We are dealing with how things are, not the way that we want them to be.

And having worked for many years in areas like water infrastructure and transportation infrastructure, aviation is exciting. And that, as witnessed by the folks on the panel today—this industry is driven by the private sector and obviously, Mr. McBride, as you note in your testimony, with much R&D and support from NASA and our Federal partners, but it is driven by the private sector.

And as Ms. Cooper notes in her testimony with part 107 implementation it somewhat allowed us to lead the world in different types of innovation and technology. But we also, if we do not continue to be pushing, to be planning for the future, to listen to folks like you on how we can lay the groundwork to continue innovation, we risk losing that competitive edge. We risk losing innovation. We risk losing the opportunity to truly lead the world in infrastructure.

My home State of Louisiana, Baton Rouge and New Orleans are two of the most traffic-congested areas in the Nation. And looking at technologies like we are going to hear from Mr. Allison on Uber Elevate, and how that type of technology can play into addressing our traffic transportation and infrastructure planning in the future, is truly exciting.

And Captain DePete, hearing about how we are going to address, as is noted in testimony, the nearly 790,000 pilots that are going to be needed in the future, and addressing that demand for aviation travel, is something that we are going to need to be spending a lot of time on.

Last note. When you look back at the onset of aviation travel, we were using prop planes. And when we transitioned into jets, we were able to reduce to nearly one-third the amount of time it took to travel. With technology—we are going to hear from Mr. Dourado today—we could potentially cut that again by one-half. I mean this is really exciting times. It is not like transportation infrastructure or water infrastructure, roads and water. This is an opportunity for us to be thinking forward, leaning forward, and truly planning for the future.

I am looking forward to hearing your testimony and learning how we can lay the groundwork to ensure that we are a partner, and not an obstacle.

[Mr. Graves's prepared statement follows:]

Prepared Statement of Hon. Garret Graves, a Representative in Congress from the State of Louisiana, and Ranking Member, Subcommittee on Aviation

Thank you, Mr. Chairman, for calling today's hearing.

Before we begin, I want to acknowledge the multiple aviation accidents that occurred worldwide over the weekend, including the crash in Ethiopia that killed 157 people, eight of whom were Americans. While we don't yet know what caused the

accident, it is a sobering reminder that safety must always be our first priority. That is true today, and will still be the case in 2050.

It's hard for me to imagine what our aerospace industry will be like that far in the future, so it's worth looking at what it was like 31 years ago in 1988.

Chairman DeFazio had just finished up his first year in Congress. Representative Don Young was already the longest serving House member in Alaskan history.

Only 450 million passengers boarded airlines and 481,000 people worked in an industry that still included airlines like Pan Am, TWA, and Eastern. The skies weren't as safe—729 passengers died in 28 fatal airline accidents, including the bombing over Lockerbie, Scotland that killed 259.

The planes we flew were different too; twin-engine flights over oceans had just been permitted by regulation, so many flights across the Atlantic or Pacific were still using 727s, 747s, and DC–8s. Many planes had three people on the flight deck, having been designed to require the use of a flight engineer. And Americans were just getting used to breathing easier as the aircraft smoking ban began phasing in that year.

When we look at how far we've come over the past 31 years, it's clear that our future possibilities are endless. We have the chance to totally reinvent the way our airspace is used, not only incorporating today's new entrants like drones, flying cars, and commercial space transportation, but also the chance to pave the way for the next big idea that changes the way Americans travel.

We in Congress usually have to deal with how things are, not how we want them to be. We have to think in terms of three- or four- or five-year reauthorizations or 10-year budget windows. Today, we're asking you to imagine what's possible eight FAA authorizations into the future.

What will the aircraft we fly look like? What will the flight deck look like? How are Americans going to use the airspace? How do we ensure the continued safety of the system? And what role is our aviation system and industry going to play in our economy?

We want to hear what's possible, and we want to hear how Congress can ensure that there is the space and collaboration necessary to turn these dreams into reality. We can't predict what the future will be, but I hope when someone in 2050 looks back on this hearing record, they not only get a good laugh at what we thought would happen, but they see where we took a moment to step back and consider what the future might hold for aviation. Finally, I hope they will be able to recognize that we seriously considered how our actions now helped lay the groundwork for the aviation system of the future.

Mr. LARSEN. Thank you, Representative Graves. I now want to welcome our witnesses: Mr. David McBride, Director, Armstrong Flight Research Center of NASA; Ms. Diana Cooper, senior vice president of policy and strategy, at PrecisionHawk, Incorporated; Mr. Eli Dourado, head of global policy and communications at Boom; Mr. Eric Allison, head of Elevate, Uber Technologies, Incorporated; and Captain Joe DePete, president of the Air Line Pilots Association, International.

Thank you all for being here today, and we all look forward to your testimony. I ask unanimous consent that our witnesses' full statements be included in the record.

Without objection, so ordered.

Since your written testimony has been made part of the record, the subcommittee requests that you limit your oral testimony to 5 minutes.

And with that, we will start with Mr. David McBride of NASA.

You are recognized for 5 minutes.

TESTIMONY OF DAVID MCBRIDE, DIRECTOR, ARMSTRONG FLIGHT RESEARCH CENTER, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION; DIANA MARINA COOPER, SENIOR VICE PRESIDENT OF POLICY AND STRATEGY, PRECISIONHAWK, INC.; ELI DOURADO, HEAD OF GLOBAL PUBLIC POLICY AND COMMUNICATIONS, BOOM SUPERSONIC; ERIC ALLISON, HEAD OF ELEVATE, UBER TECHNOLOGIES, INC.; AND CAPTAIN JOSEPH G. DEPETE, PRESIDENT, AIR LINE PILOTS ASSOCIATION, INTERNATIONAL

Mr. MCBRIDE. Thank you for that opening comment. Chairman DeFazio, Ranking Member Sam Graves, Chairman Larsen, Ranking Member Garret Graves, and members of the committee, thank you for this opportunity to testify on the vision of the national airspace for 2050 and NASA's role in shaping the future developments of the airspace.

Imagine with me for just a moment a vision of what our Nation's transportation system could look like in 2050. Imagine you are a businessperson in Arlington, Virginia. You leave home early, you hop in a rideshare to the airport, a car, or an air taxi. A supersonic passenger jet takes you from DC to Seattle in about 2 hours. Upon arrival you fly from the airport to your meeting in an air taxi. Your business partners order a fresh lunch delivered by a drone. And perhaps you are studying wildfire damage with images sent in real time from first responders using unmanned vehicles flying over remote areas. By early afternoon you head back to the airport. That evening you are at home in time for dinner with your family.

Enabled by aviation, this is a world with urban air taxis, drones delivering packages and collecting data, new opportunities for mobility benefitting consumers and passengers, expanding tourism and business travel, and U.S. companies delivering these products and developing aviation services of the future, creating high-quality manufacturing and service jobs.

Aviation generates $1.6 trillion in total U.S. economic activity per year, and contributes about 5 percent to U.S. GDP. Aviation in the U.S. supports 10.6 million direct and indirect jobs, and generates the largest positive trade balance of any manufacturing sector, over $84 billion a year.

Innovation and growing economies will double global passenger air travel in the next 20 years. Industry predicts the demand for over 42,000 new transport aircraft in the next 20 years, and a market worth over $6 trillion, plus another $3 trillion in after-market services.

This growth in aviation means jobs. Industry estimates that aviation will need almost 800,000 new pilots by 2037, and there will be similar growth in jobs for manufacturing, technicians, and aviation services. Global competition is fierce in this sector, as companies and countries seek to capture a larger share of this growing market and high-wage jobs.

NASA Aeronautics is uniquely positioned to be the catalyst for this exciting future, and to ensure the U.S. maintains a strong leadership role. NASA research is in the DNA of every aircraft flying today. The United States has the safe global air transportation system we have today because of NASA research. We also work closely with FAA leaders and technical experts to ensure our re-

search meets their long-term goals and can inform their investment decisions. Our research transition teams serve as the bridge between NASA's long-term, game-changing technology R&D and FAA's near-term R&D to support implementation and certification.

NASA is investing in the discovery of new concepts and technologies in key areas. Over the past decade, NASA fundamental research has demonstrated the possibility of supersonic flight with greatly reduced supersonic booms. NASA is now building a quiet supersonic experimental aircraft, the X–59 QueSST, to provide proof. While subsonic aircraft will still carry the majority of passengers in 2050, those aircraft will be different from today.

Large leaps in aircraft efficiency, coupled with reductions in noise and harmful emissions, are critical to the sustainability of aviation. Future aircraft will look different, will be made from different materials, will be powered differently, and will even be designed and manufactured differently. NASA is leading research into new components, technologies, and architectures for electric or hybrid electric systems that can bring about revolutionary improvements in small and large transport aircraft. Ground tests this year and flight tests next year will provide valuable insights into the challenges and opportunities of electric aircraft and serve as the building blocks for industry to create future safe and certifiable aircraft designs.

Autonomy and increased automation will also bring new opportunities to do the things we do already even better. In 2050, UAS, or unmanned aerial systems, will be fully integrated into the airspace. NASA research will enable the safe integration with the ability to detect and avoid other aircraft, assured command and control communication between the UAS and the operator on the ground, human systems integration capability, and approaches to determining airworthiness requirements.

The potential benefits of UAS grow exponentially if they can operate safely in great numbers. NASA has developed a concept called UAS traffic management, or UTM, to overcome this challenge. UTM developed software tools used by air traffic controllers and airlines to fly more efficiently in increasingly congested airspace and investigate applications of UTM concepts to the entire airspace.

NASA is preparing a series of grand challenges that will provide a means to assess maturity of key systems for urban air mobility. And although initially UAM operators are likely to use piloted vehicles, autonomy and increased automation will make it truly accessible to all citizens.

NASA is developing software tools used by air traffic controllers and airlines to fly more efficiently in increasingly congested airspace, and NASA will hand off research results of our cutting-edge research to U.S. industry for further development and commercialization.

Thank you for the opportunity to testify today, and I look forward to your questions.

[Mr. McBride's prepared statement follows:]

Prepared Statement of David McBride, Director, Armstrong Flight Research Center, National Aeronautics and Space Administration

Chairman DeFazio, Ranking Member Sam Graves, Chairman Larsen, Ranking Member Garret Graves, and members of the Subcommittee: thank you for this opportunity to testify on the vision of the National Airspace for 2050 and NASA's role in shaping future developments of the airspace.

Imagine with me for just a moment a vision of what our nation's transportation system could look like in 2050 and the possibilities that are unlocked for our citizens.

Imagine you are a business person in Arlington, VA. You wake up early in your home, then hold a quick virtual meeting with your staff. You hop in a ride share to the airport . . . car or air taxi, whichever is faster at the moment. A supersonic passenger jet takes you from DC to Seattle in about 2 hours. Upon arrival at the airport in Seattle, you fly from the airport to your meeting in an air taxi for a morning meeting.

You and your business partners order a fresh seafood lunch delivered by drone to a portal in the office building.

Perhaps you are studying wildfire damage in the state, with images sent in real time from first responders using unmanned vehicles flying over remote areas. Or you are reviewing construction of a new renewable energy infrastructure monitored by security drones. Or perhaps you are meeting with business leaders to discuss the new local manufacturing facility being built to assemble the new commercial aircraft for export around the world.

By early afternoon you wrap up your meeting and head back to the airport. On the plane ride home you remember you forgot to reorder your dog's heart medication, so you order an emergency shipment to be delivered by drone to your house, and it is waiting for you when you arrive.

That evening you are home in time for dinner with your family and a good night's sleep in your own bed.

This is a world enabled by aviation, where you can fly across the country in 2 hours, or to the other side of the world in five. A world with:

- Urban air taxis, drones delivering packages and collecting data, all available at your fingertips;
- New opportunities for mobility we haven't yet thought of across America and around the world benefiting consumers and passengers;
- Booming tourism and business travel fueled by inexpensive and quiet air travel for vacationers and business people alike; and,
- U.S. companies capitalizing on this vision to deliver these products and develop aviation services of the future, creating high quality manufacturing jobs.

This vision is closer than you might think. NASA and the U.S. aerospace industry currently are working on the technologies to make this vision a reality.

Today's aviation system moves the world—moving people and packages around the world contributing to jobs and trade. Today's aviation system is safe and efficient. It is centered around commercial air travel and airports. U.S. companies are global leaders in aircraft and engine manufacturing, commercial airlines and cargo delivery.

Aviation generates $1.6 trillion in total U.S. economic activity a year, and contributes about 5 percent of the U.S. Gross Domestic Product.[1] Aviation in the U.S. supports 10.6 million direct and indirect jobs,[2] and generates the largest positive trade balance of any manufacturing sector, over $84.8 billion per year.[3]

Tomorrow's aviation system will change the world. People and packages will move more quickly, and in new ways. Tomorrow's aviation system will still be safe and efficient, but now much more widely accessible to all citizens. Aviation enables new ways of living, working and connecting with others. Exciting new technology and changing consumer demand will change our relationship with aviation. Today's explosion of new business models for ground transportation (such as ride sharing and package delivery) is taking to the air, enabling an entirely new aviation mobility market and opportunity space for tomorrow.

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[1] "The Economic Impact of Civil Aviation on the U.S. Economy," Federal Aviation Administration, November 2016, Page 20, PDF

[2] "The Economic Impact of Civil Aviation on the U.S. Economy," Federal Aviation Administration, November 2016, Page 20, PDF

[3] "Leading Indicators for the U.S. Aerospace Industry," International Trade Administration, March 13, 2018, PDF

These trends are real. Innovation and growing global economies will double global passenger air travel in the next 20 years as new products are introduced. Air travel will expand as economies grow and develop.[4] Boeing predicts demand of 42,730 new aircraft in the next 20 years and a market worth over of $6 trillion.[5] According to Airbus, there will be another $3 trillion in aftermarket services needed in that time period.[6] High speed flight—faster than the speed of sound—will open up new routes and new opportunities for air travel around the world.

This growth in aviation means jobs. Boeing has projected that aviation will need 790,000 new pilots by 2037 to meet growing demand, with 96,000 pilots needed to support the business aviation sector.[7] There will be similar growth in jobs for manufacturing, technicians, and aviation services, as well as new jobs created as a result of new economic opportunities which will be created.

Global competition is fierce in this sector as companies and countries seek to capture a larger share of this growing market and high wage jobs. U.S. and European companies traditionally have divided the global market for large civil aircraft and equipment. Now China is investing heavily in aerospace, starting up a new company to build large commercial aircraft to lure some of the large civil aircraft market share. Russia and Japan are seeking to break into the regional jet market, and companies from all around the world are seeking market share for smaller unmanned systems and vehicles.

NASA Aeronautics is uniquely positioned to be the catalyst for this exciting future, and to ensure that the U.S. maintains a strong leadership role. We have been a global leader in creating and realizing amazing advances in aviation for generations, developing new technologies and new concepts for how the aviation system can be better, faster, and more efficient. NASA Aeronautics research is in the DNA of every aircraft flying today. The United States has the safe, global air transportation system we have today in part because of NASA research.

NASA's cutting edge research today in areas such as composite materials, new airplane concepts, air traffic management, and safe routine integration of unmanned aerial systems (UAS) into the National Air Space is forging the path to this new vision for 2050.

NASA works with the U.S. aviation community and government partners to create opportunities for American businesses, raising the level of performance for all participants. NASA has a vision of what is possible, based on deep insight into the goals and needs of the aviation community and U.S. industry engagement early in the technology development cycle. We invest in aeronautics research to address the most critical challenges, always with an eye toward the practical application of the results. We bring the most promising technologies to flight to demonstrate them in a realistic environment, in collaboration with our U.S. industry partners whenever appropriate. Partners leverage NASA's investments through joint efforts that complement the agency's internal capabilities, provide access to a wide range of technologies beyond the traditional aeronautics portfolio, and facilitate technology transfer to more mature states of development and eventual implementation.

One critical government partner to NASA is the Federal Aviation Administration. We work closely with FAA leaders and technical experts in Washington and around the country, and the FAA Technical Center in Atlantic City to ensure our research meets their long term needs, and the results of our research can be transitioned and inform their investment decisions. Our successful model for collaboration is embodied in Research Transition Teams (RTTs), which are designed to enhance progress for NextGen advancements in critical areas and effectively transition advanced capabilities to the FAA for certification and implementation. RTTs serve as the bridge between NASA's long term, technology R&D, and FAA's near term R&D to support implementation and certification. Under RTTs, NASA and FAA develop joint research plans and fund their respective portions of the planned research according to the nature of the research, stage of research, and their relative capabilities. Data from our research results are used to develop standards and regulations through rulemaking committees and domestic and international standards bodies.

To achieve our vision for 2050, NASA is investing in discovery of new concepts and technologies in a few key areas.

Routine supersonic passenger travel will enable passengers to make current long journeys into day trips. However, current rules prohibit supersonic flight over land,

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[4] "2036 Forecast Reveals Air Passengers Will Nearly Double to 7.8 Billion," International Air Transport Association, October 24, 2017, Web Page

[5] https://www.boeing.com/commercial/market/commercial-market-outlook/

[6] https://www.airbus.com/newsroom/press-releases/en/2016/07/airbus-forecasts-3-trillion-commercial-aviation-aftermarket-services-over-the-next-20-years.html

[7] https://www.boeing.com/commercial/market/pilot-technician-outlook/2018-pilot-outlook/

the result of public objection to noisy supersonic Concorde flights in the 1970's. Over the past decade, NASA fundamental research and experimentation has demonstrated the possibility of supersonic flight with greatly reduced sonic boom noise, but the rules prohibiting over-land supersonic flights remain. In order for this sector to take off, regulators need to know how quiet the public will want these supersonic flights to be. NASA now is building a quiet supersonic experimental aircraft—X–59 QueSST—to help answer this question.

NASA researchers will measure public acceptance of the technology by flying the X–59 over a handful of U.S. cities. This data will be delivered to the Federal Aviation Administration and the International Civil Aviation Organization to allow these organizations to develop new regulations that permit commercial supersonic flight over land under conditions acceptable to the general public. This capability will position the U.S. aviation industry to supply global customers with future supersonic aircraft products.

As we push for ever faster flight we may even see initial applications of hypersonic flight. The challenges are enormous for commercially feasible hypersonics, but with NASA's productive partnership with the Department of Defense, we continue to make progress on key technical challenges that may 1 day unlock a high-value commercial market.

Subsonic aircraft will still carry the majority of passengers in 2050, but those aircraft will be different from today. Large leaps in aircraft efficiency coupled with reductions in noise and harmful emissions are critical to the environmental sustainability of aviation. Future aircraft will look different, will be made from different materials, will be powered differently, and will even be designed and manufactured differently.

NASA is collaborating with U.S. industry to investigate innovative technology for subsonic aircraft such as advanced configurations and wing design, transformative structures, propulsion-airframe integration, and small core turbine engines.

NASA also is leading research into new components, technologies and powertrain architectures for electric or hybrid electric systems that can bring about revolutionary improvements in small and large transport aircraft. NASA work on the X–57 Maxwell aircraft—an all-electric, general aviation size plane—already is delivering to the community important lessons about designing, building and operating an all-electric system.

Ground tests this year and flight tests next year will provide valuable insights into the challenges and opportunities of electric aircraft and serve as the building blocks for industry to create future safe and certifiable aircraft designs.

NASA recently completed single-aisle transport aircraft concept studies with industry to develop hybrid gas-electric propulsion concepts and assess the potential benefits for larger vehicles such as regional transports and airplanes as large as a Boeing 737.

Building on these activities, NASA has begun a multi-year effort to solve the technical challenges of a 1-Megawatt (MW) power electric propulsion system—enough energy to power 165 homes. NASA will refine concepts and technologies and validate new electric systems through ground and flight tests. High power electric propulsion systems represent a potential major change for aviation propulsion similar to moving from turbojets to modern turbofan engines. Realizing a practical 1-MW electric propulsion system has never been accomplished and is an area of notable international competition. To support this work, NASA has developed a world-leading NASA Electric Aircraft Test Facility (NEAT) capable of conducting full scale ground test of high-power electric propulsion systems.

Aerospace design and manufacturing processes in 2050 will be more efficient, reducing the time and cost required to build aircraft. Future computational design and certification capabilities of advanced materials required for emerging aeronautical vehicle applications are identified in NASA's "Vision 2040: A Roadmap for Integrated, Multiscale Modeling and Simulation" report. Next year, NASA will complete the Advanced Composites Project, a 6-year focused effort with industry to significantly reduce the time needed to develop and certify new composite structures for aerospace applications.

Autonomy and increased automation bring new opportunities to do the things we already do even better, but also hold the potential to open new markets and create new benefits that are not yet possible.

In 2050, UAS will be fully integrated into the airspace. These could be large, high altitude UAS providing communications relays or gathering scientific data; mid-sized drones delivering cargo through mid-altitude airspace; or small surveillance drones operating at low altitude. An increasing number of UAS will operate safely and securely over cities, suburban areas and in congested skies.

NASA is developing the building blocks for safe UAS integration:

- the ability to detect and avoid other aircraft, currently the ultimate responsibility of the pilot on board an aircraft;
- assured secure command and control communications between the UAS and the operator on the ground;
- human systems integration capabilities; and,
- approaches to determining airworthiness requirements.

NASA is developing this technology for the most basic business case—one remote pilot, one UAS, one mission. In this model, FAA manages the UAS operations like that of any other aircraft, or requires to UAS to operate entirely separate from other aviation traffic, such as low altitude operations over a farmer's field or surveying a historical building or inspecting a power plant.

NASA will conduct a series of test flights next year and will deliver data on these UAS technologies to FAA rulemaking committees to serve as the basis for certifying UAS for safe flight.

The potential benefits of UAS grow greatly if multiple aircraft can safely perform the same mission simultaneously or if UAS can be used for a broad diversity of missions. This means enabling one pilot to control multiple UAS, or removing the pilot entirely from fully autonomous vehicles. In this model, it is impossible for the FAA to manage the UAS operations like all other aircraft—there are too many vehicles to control, and there may not even be pilots to talk to.

NASA has developed a concept called UAS Traffic Management or UTM to overcome this challenge. UTM enables widespread low altitude UAS operations by providing air traffic management services to UAS operators, as an intermediary between the FAA and UAS operators. NASA has collaborated with industry and the FAA to develop and test the UTM system through increasingly complicated flight trials at FAA test sites across the U.S. The final demonstrations—flying UAS in dense urban environments—will take place in Reno, Nevada, and Corpus Christi, Texas, this summer. Companies participating in these demonstrations are maturing and proving their technical capabilities. Industry-led domestic and international standards development organizations and trade groups have established working groups focused on UTM Services and supporting UAS technologies utilizing NASA research, prototypes, and specifications to form the basis for UTM standards.

Data from these demonstrations inform FAA rulemaking, technology development and investments. NASA's UTM Flight Information Management System (FIMS) is being used for FAA's UTM Pilot Program, and NASA partner-developed UTM services are being used at most of the awarded test sites for the DOT UAS Integration Pilot Program. The FAA has adopted the UTM architecture and deployed the first operational UTM service, low altitude authorization and notification capability (LAANC), which reduces UAS airspace access approval from weeks to near real-time. NASA has provided the FAA requested information and research results to inform upcoming rulemaking activities (e.g. Remote UAS Identification, Operation over people, etc.)

As a result of these technical innovations and a clear path to implementation, we have jump started a fledgling U.S. industry of UTM service providers and drone manufacturers and operators.

These efforts provide the foundation for another major transformation of the aviation sector being led by NASA—creation of an urban air mobility or UAM system that is safe, economical and environmentally friendly to move people and packages in population centers, forever changing how citizens around the world benefit from aviation. UAM vehicles might range from small delivery drones to passenger-carrying air vehicles that have electrically powered Vertical Take Off and Landing (eVTOL) capability.

NASA is preparing a series of "Grand Challenges" that will provide a means to assess the maturity of key systems for Urban Air Mobility. Through these Grand Challenges, NASA will serve as a catalyst for companies to rapidly develop and demonstrate their capabilities, while setting the course for the research and investment needed to realize the potential of UAM. One key objective of the Grand Challenges is to provide the means and opportunity to develop and test UAM innovations in the U.S. so that U.S. companies don't have to go overseas to test their vehicles and systems. Another is to provide opportunities for close collaboration among NASA, FAA, industry and local authorities to understand and overcome together the challenges facing UAM, enabling innovation to take place within our borders.

Although initial UAM operations are likely to use piloted vehicles, autonomy and increased automation will be a game changer for UAM, making it truly accessible to all citizens. The demand for ride-sharing or ride-hailing aviation operations is likely to be constrained by a lack of certified pilots available to operate the vehicles.

The aviation community will need new technologies and operational concepts to manage this higher operational tempo air travel. The UTM system provides a look

at what the future might bring for the entire airspace in 2050. UTM has a user service-oriented architecture where third party service providers deliver the various services that make up the airspace environment. A similar federated, user service-oriented architecture for the National Airspace, where third party service providers play critical roles in a collaborative air traffic management structure, provides the scalability to accommodate the large number of expected operations in the airspace in 2050. This new system will need to provide seamless access to the airspace for all users and missions ranging from traditional operations to on-demand UAM, UAS and to emergent scheduled services such as supersonic travel and space launch. It will be scalable for increased demand across users and missions, flexible whenever possible, and will provide structure only when necessary. The system of the future will also be collaborative through integrated information exchange, and resilient to uncertainty, degradation, and disruptions.

The path toward this future airspace vision is being forged today as NASA develops software tools used by air traffic controllers and airlines to fly more efficiently in increasingly congested airspace. Through a series of Airspace Technology Demonstrations with the FAA, airlines and airport operators, NASA is demonstrating new capabilities for managing efficient airline operations. These capabilities are fundamental building blocks of the Next Generation Air Transportation System, or NextGen.

The first set of demonstrations focused on enabling efficient arrivals utilizing the FAA's precision navigation RNAV/RNP approaches into the most congested airports at peak traffic volume times. This essentially has eliminated the practice of airlines circling while waiting for a landing spot at a busy airport, saving fuel, time and reducing noise. The second set of demonstrations is delivering technologies to the FAA and airlines for efficient terminal area operations. This represents a significant step toward user preferred service options—where the airline gets to choose what they would like to do within the constraints set by the FAA. This is being demonstrated in Charlotte, NC, and soon Dallas, TX, in preparation for national deployment in FY2021. The third set of demonstrations is focused on providing services to airlines to allow them to fly around weather, and supporting efficient traffic flows from gate departure to gate arrival. In each of these cases, NASA is handing off these software tools and concepts to the FAA to inform their investment and rulemaking decisions.

How do we get all of this innovation into the system? Commercial aviation is the safest mode of travel today, a result of decades of continuous improvement through proactive hazard management. As I have described, aviation is on the verge of a significant transformation with the rapid evolution of new technologies, vehicles, and operations on the horizon. Maintaining a safe system will require recognition and timely mitigation of safety issues as they emerge, before they become hazards or lead to accidents. We must adopt a proactive risk mitigation approach, using aviation data, commercial data analytics methods, architectures, and the "internet of things" to monitor ongoing operations, assess operations in real-time for emerging risks, and provide in-time strategies to mitigate those risks.

We must also mature our ability to Verify and Validate (V&V) that these new systems are safe, of particular concern in light of significant technical challenges associated with certifying increasingly complex and autonomous systems. The methods to assure the safety of autonomous systems are in their infancy, and thus approaches will need to be investigated and evaluated for effectiveness. Given our past success in applying new safety assurance methods to autonomous systems for space missions, NASA is uniquely positioned to address this challenge. We have already performed initial demonstration of some valuable tools and capabilities in this area with industry partners, and are collaborating with other governmental agencies, like FAA and the Air Force, to map a course to our future vision.

The nature of the aerospace industry and workforce will also be different in 2050. The increasingly entrepreneurial nature of the aerospace industry enabled by increases in computing power, design tools and high-fidelity Multi-disciplinary Analysis & Optimization (MDAO) analytic tools will enables smaller teams to rapidly produce high-confidence, complex system designs. Advances in manufacturing such as additive manufacturing and robotic assembly will enable smaller and more agile manufacturing teams.

We need a next generation workforce with the mindset, system ideas, and capabilities to work in this future. NASA has a long history of collaboration with academia to explore new ideas and foster the next generation aerospace workforce. We have expanded and deepened this engagement through our University Leadership Initiative, where we provide opportunities for universities to identify the most important challenges facing aviation and collaborate across institutions and disciplines to develop solutions.

NASA will enable this future as a partner to government and industry, providing test infrastructure to evaluate and demonstrate new concepts in ground and flight tests, such as ranges at NASA's Armstrong Flight Research Center to test everything from unmanned systems and x-planes to high speed vehicles.

NASA is developing the technology that enables continuous innovation in aviation and leads us to reach this vision for 2050. U.S. companies are well positioned to build on discoveries and knowledge resulting from NASA research, turning them into commercial products that will enable this exciting vision of the future, benefiting the quality of life for our citizens, providing new high-quality engineering and manufacturing job opportunities, and enabling the U.S. to remain competitive in the global economy.

Mr. LARSEN. Thank you, Mr. McBride. I now turn to Ms. Diana Cooper, who is a senior VP, policy and strategy, at PrecisionHawk, Incorporated.

Ms. COOPER. Chairman Larsen——

Mr. LARSEN. Recognized for 5 minutes.

Ms. COOPER. Chairman Larsen, Ranking Member Graves, and Ranking Member Graves, members of the subcommittee, thank you for calling this hearing and for the invitation to testify on behalf of PrecisionHawk. PrecisionHawk is emblematic of the current and future state of the growing commercial UAS industry. I appreciate the opportunity to appear today on this distinguished panel representing the future of American aviation.

I would like to begin by thanking Congress for passing the FAA Reauthorization Act of 2018, and for providing the necessary funding to the FAA to integrate UAS into the national airspace. These measures establish critical building blocks to help the U.S. realize the economic, consumer, environmental, and humanitarian benefits of drones.

PrecisionHawk employs 187 people, with offices in North Carolina, Virginia, Illinois, and California. We provide advanced drone software and services across agriculture, energy, construction, insurance, and Government sectors. Our algorithms detect plant disease, forecast crop yield, and assess storm damage, and our LATAS platform provides safety information that supports geofencing technology in roughly 80 percent of civilian drones in the U.S.

We pride ourselves in conducting operations that serve the public interest. With Booz Allen Hamilton and Concourse, we use drones to support an environmental impact study for the Department of Veterans Affairs' West L.A. campus. The data collected was used to build a digital twin to support master planning and redevelopment efforts.

Last fall PrecisionHawk deployed drone teams to aid in the response efforts after Hurricanes Florence and Michael. Working with the North Carolina DOT, we used drones to deliver imagery and video of impacted bridges, dams, and roads. This enabled real-time decisionmaking about road closures and evacuation routes. The data collected was also used to support the expansion of a Federal disaster declaration to additional counties in the State. PrecisionHawk also worked with utilities to locate downed power lines and flooded substations to help restore power faster. Additionally, we use drones to assess storm damage to help process claims to get people back into their homes more quickly.

UAS are having a positive impact on the American workforce. The low cost and ease of use of consumer drones has made the

practice of aviation accessible for the first time in history. For some pilots, flying begins as a hobby and later turns into a career.

Drones enable worker safety in the mining, energy, and insurance industries. Climbing roofs or utility poles can be hazardous tasks. By outfitting workers with UAS, we are helping them perform their jobs more safely.

Drones are also opening up employment opportunities for people who face mobility challenges. In rural Missouri, Andrew Kuster suffered a tragic injury that left him partially paralyzed and confined to a wheelchair. Andrew started his own drone business inspecting power lines on rooftops, surveying farms and construction sites. Drones provide him with the ability to be gainfully employed, doing work that would otherwise be impossible.

The future-use cases of drones are only limited by our imagination. By 2050 we will achieve full integration of the national airspace at low and high altitudes, including all of the vehicles represented today on this panel, and vehicles not yet imagined.

We will break the paradigm of a single drone completing a single mission. Drones will also trigger automated actions, including inspection, repair, and insurance claims processing.

Drones will prevent disease outbreaks from happening, and will provide early warning signals when plants and animals are about to become endangered.

In 2016 the U.S. took the global lead in establishing regulations that govern basic commercial operations. We must act today to maintain our leadership by setting the standard for remote identification. Remote ID will enhance safety, security, and privacy. In 2017 the FAA convened an advisory committee to make recommendations on remote ID, but the wait for a proposed regulation continues. The Government has made it clear that remote ID must be implemented before any additional rulemaking for advanced operations.

We respectfully ask Congress to ensure that the FAA publishes proposed remote ID regulations without any further delay. It is critical that the Federal Government open the door to the promises that UAS are certain to yield.

Thank you again for the opportunity to appear today. I look forward to your questions.

[Ms. Cooper's prepared statement follows:]

Prepared Statement of Diana Marina Cooper, Senior Vice President of Policy and Strategy, PrecisionHawk, Inc.

Chairman DeFazio, Ranking Member Graves, Chairman Larsen, Ranking Member Graves, and distinguished members of the Subcommittee, thank you for calling this important hearing and for the invitation to testify on behalf of PrecisionHawk, Inc. ("PrecisionHawk"). I would like to begin by thanking Congress for passing the FAA Reauthorization Act of 2018 and for providing the necessary funding for the Federal Aviation Administration (FAA) to continue integrating unmanned aircraft systems ("UAS"), also known as drones, into the National Airspace System. Through these measures, Congress has set up critical building blocks to help the United States realize the economic, consumer, public safety, environmental and humanitarian benefits of UAS.

PrecisionHawk is a success story for the current and future state of the growing commercial UAS industry. We currently have 187 employees with offices in North Carolina, Virginia, Illinois and California. We provide advanced UAS software and services across a variety of industries including agriculture, energy, construction, in-

surance and government. Our algorithms can detect plant disease, forecast crop yield, assess storm damage, detect the risk that a solar panel will catch fire, and predict the likelihood that a distribution pole will fail at a particular wind speed. Our unmanned traffic management ("UTM") platform, known as LATAS, provides safety information that supports geofencing technology included in roughly 80% of the drones in the United States including airspace maps, runway locations, prisons and critical infrastructure. We also have a distributed pilot network with thousands of Part 107 operators across the country; they can be hired on demand through our national Droners platform to perform services in their local communities including in Oregon, Missouri, Washington, Louisiana, North Carolina, California, Texas, New York and Illinois.

To date, we have raised $107 million from leading investors[1] and last year we acquired five thriving startups[2], allowing us to expand in new markets. In 2016, the World Economic Forum named PrecisionHawk among the Top Technology Pioneers, and in 2017 we were ranked among the Top 100 Global Cleantech Companies by the CleanTech Group.

PrecisionHawk is dedicated to working with the FAA and other agencies in support of UAS integration. We performed ground-breaking research on beyond line of sight operations under the FAA Pathfinder Program and we received a waiver to fly commercially beyond line of sight on the day that Part 107 was implemented. We are also participating in the UAS Integration Pilot Program in North Carolina and Virginia, in addition to serving on the FAA Drone Advisory Committee and the FAA Unmanned Aircraft Safety Team.

LEVERAGING OUR CAPABILITIES FOR THE PUBLIC GOOD

We take pride in conducting operations that are not only commercially beneficial but also serve the public interest. In 2018, PrecisionHawk partnered with Concourse Federal Group and Booz Allen Hamilton to deploy UAS in support of an environmental impact study for the Department of Veterans Affairs West Los Angeles Campus (the "Campus"). The vast Campus spans 388 acres and provides care for the largest homeless veteran population in the United States. Using UAS with visual and Light Detection and Ranging or LiDAR sensors, we were able to identify and geolocate over 130 species of trees and plants on the Campus. We also captured high quality data on building and pavement conditions across the entire Campus—in only a few days. The data we collected was used to build a "digital twin," which is a 3-D rendering of the Campus that depicts environmental conditions. The environmental impact study is being used by the Department of Veterans Affairs to support the master plan and redevelopment of the Campus to facilitate delivery of services and shelter to several thousand homeless veterans.

We have also seen what a powerful tool UAS can be in emergency response operations. Last fall, PrecisionHawk deployed UAS teams to aid in the response efforts in Hurricanes Florence and Michael. During Florence, we worked with the North Carolina Department of Transportation ("NC DOT") Division of Aviation. We used UAS to capture and transmit real-time imagery and video of mobility infrastructure flood and damage assessments including impacted bridges and dams, road washouts, and eroded beaches across the south-eastern part of North Carolina. The data captured enabled NC DOT to facilitate real-time decisionmaking around road closures, evacuation routes, and re-opening thoroughfares. The images captured served as a baseline record that was used to support the expansion of a Federal disaster declaration to additional counties devastated by the storm.

PrecisionHawk also worked with two large east-coast energy utility companies after Hurricane Florence in South Carolina, and Hurricane Michael in Florida, to survey outage areas. During these operations, we located down powerlines and flooded substations to determine where to safely deploy repair crews and what equipment they would need to bring. We also deployed UAS to locate safe access points for repair crews and to help them avoid using roads that were flooded. These missions helped restore power faster to homes and businesses in South Carolina and Florida. Even 1 day of energy disruption can cost millions of dollars.

In partnership with an insurance company, we are working to expedite the insurance claims process by using UAS data to assess damage to structures after natural

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[1] Intel Capital Corporation, Verizon Ventures LLC, Comcast Ventures LP, USAA Property Holdings, Inc., Pioneer Hi-Bred International Inc., Constellation Technology Ventures, ClearSky Power & Technology Fund I LLC, Third Point Ventures LLC, Syngenta Ventures Pte. Ltd., Senator Global Opportunity Master Fund LP, Millennium Technology Value Partners II L.P., Indiana University Foundation, Inc., and Innovate Indiana Fund I, LLC, among others.

[2] PrecisionHawk acquired all or substantially all of the assets of AirVid Inc. (assets acquired from Acend, Inc.), Droners L.L.C., InspecTools, Inc., Hazon, Inc. and Uplift Data Partners LLC.

disasters. For people who have lost their homes or businesses, the emergency continues until after their insurance claims are processed and their properties are rebuilt. I would like to thank Congress for responding to our request to expand the circumstances in which civil operators can benefit from the Emergency Certificate of Authorization (e-COA) process in Section 353 of the FAA Reauthorization Act of 2018 to facilitate claims processing and reconstruction efforts. Thank you for sharing our passion to help people get back into their homes and businesses in the aftermath of a disaster.

UAS ARE ENGAGING OUR YOUTH IN AVIATION AND CREATING THE JOBS OF THE FUTURE

UAS are bringing new excitement and engaging our nation's youth in aviation, in a way that we haven't seen in decades. The low cost and ease of use of consumer UAS has made the practice of aviation accessible for the first time in history. We are seeing more and more high schools and colleges integrate UAS into their program offerings. For some pilots, flying begins as a hobby and later turns into a part-time job and possibly a career. At PrecisionHawk, we have hired many college students during their summers and they have had the opportunity to travel across the country with us and learn to fly. Some of these students have stayed on with us after graduation, as employees.

UAS are also opening up employment opportunities that may not otherwise exist, particularly for persons who have mobility challenges. For example, in rural Missouri as a young man, Andrew Kuster suffered a tragic injury that left him partially paralyzed and confined to a wheelchair. His interest in drone technology started as a hobby, but before long he figured out how to put the technology to productive commercial use. He started a drone business, Tri County Drone, which inspects power lines and rooftops, surveys farms and constructionsites, and takes action videos of motocross sports, across all of southern Missouri. UAS provide Mr. Kuster with the ability to be gainfully employed doing work that would be impossible for him to do otherwise, and to provide for his family including his young daughter[3]. In his own words, Mr. Kuster states that "Being self-sufficient is something I pride myself on".

UAS are also being used across several industries including mining, energy, and insurance to enhance worker safety and efficiency. Climbing roofs or utility poles can be hazardous tasks—by outfitting adjusters and inspectors with UAS, we are helping them perform their work safer and faster. We often focus on the risks that UAS may introduce into the NAS, and forget to consider the risks that they mitigate in terms of worker safety. For example, 34 individuals lost their lives due to tower-related incidents between 2013 and 2016.[4]

LOOKING FORWARD: UAS IN 2050

The future uses for drones are only limited by our imagination. By 2050, we will have full integration of airspace at low and high altitudes, including a variety of vehicles of all sizes, passenger drones, traditional aircraft, and even vehicles we have yet to imagine. We will break the paradigm of a single drone completing a single mission. In the future, a single drone will conduct multiple missions simultaneously. For example, a drone on a mapping mission will also monitor traffic during rush hour, detect fires, and automatically report accidents to authorities, enabling quicker response times. Different drones will also communicate with each other to complete a single mission, such as search and rescue, or delivery. Drones will trigger automated actions including inspection, repair, insurance claims processing, and even the ordering of materials.

Larger drones will launch smaller drones to perform rapid-response missions. They will detect small atmospheric and geological changes, and provide us with early warning signals to help us prevent disasters, such as mud slides, earthquakes and tsunamis before they occur. By monitoring water and food quality and insect populations, drones will prevent disease outbreaks. They will monitor the population of animal and plant species to give us early warnings before they become endangered. Drones of the future will be a combination of aircraft and ground autonomous vehicle, roaming the streets to compete missions and recharge power, and then flying to a location where they are needed for the next mission.

These applications will all be developed by people who have access to UAS technology and use their imaginations to discover solutions and push the boundaries of

[3]An interview with Mr. Kuster is available here: https://www.youtube.com/watch?v=3LT__CIEl__sE

[4]Occupational Safety and Health Administration: https://www.osha.gov/doc/topics/communicationtower/index.html

what is possible. The key to unlocking the limitless future potential of drones is simple: put in place the regulatory building blocks to enable flight in more ways and in more places: flights over people, flights at night, flights in controlled airspace, flights beyond visual line of sight, and fully autonomous flights managed by a UTM system.

ACHIEVING GLOBAL LEADERSHIP THROUGH FORWARD-LEANING REGULATIONS

With the implementation of Part 107 in August 2016, the United States took the global lead in establishing a set of reasonable regulations to govern basic commercial operations. Those regulations have opened up many of the commercial and societal benefits that I have mentioned. More than 2 years later, many other jurisdictions, such as Canada, Japan, and the European Union, have yet to finalize their basic commercial rules.

The United States must continue to lead with forward-leaning regulations. The FAA has the opportunity, right now, to lead the world in creating remote identification ("Remote ID") regulations and standards. This is a topic that many of us in the industry spent months of time on during an FAA Aviation Rulemaking Committee that spanned the summer of 2017, where it was impressed upon us that the need for these solutions was urgent. Remote ID is considered essential by national security stakeholders in order for the FAA to proceed with any other rulemaking for advanced UAS operations, such as flight over people. Nearly 2 years later, we are still awaiting a proposed regulation from the FAA on this topic. The industry is eager for this to move forward, and some companies have even deployed remote identification solutions in advance of the FAA's rulemaking, in order to start solving safety and security challenges. We respectfully ask Congress to ensure that the FAA proceed with the next steps in this process as soon as possible, and to also complete the pending rulemaking for flight over people and night operations, which will unlock even more beneficial operations.

One way the United States could easily lose its global leadership advantage is to pursue policies that create a patchwork of inconsistent, confusing, or burdensome UAS regulations that differ from state to state, city to city, or even block to block. Proposals in Congress over the last 2 years to carve up the airspace arbitrarily, and undermine the FAA's exclusive jurisdiction over the safety of the skies is the largest regulatory threat our industry faces. Last August, I wrote an editorial on this topic[5]. We thank Congress for codifying the UAS Integration Pilot Program—which will further an understanding on the possible state, local and tribal government interests in UAS—while maintaining the FAA's exclusive jurisdiction over airspace.

Congress recently directed the Government Accountability Office to prepare a report on fee mechanisms concerning UAS. While we need FAA and other agencies to have sufficient resources to support our industry, we are just in our infancy. The imposition of new fees or other costs could severely damage operators like us. We believe the drone industry is worth an investment by the country as a whole, during this period, and ask that new fees be deferred until stable and repeated sources of revenue are well established, similar to the early years of traditional commercial aviation in this U.S. The industry is also working hard to shoulder much of the research and development, infrastructure, and network costs of technology solutions such as Remote ID, the Low Altitude Authorization and Notification Capability, and UTM, so that the FAA can be most efficient with the resources it has available for UAS programs. Thank you again for the opportunity to testify today and I look forward to your questions.

Mr. LARSEN. Thank you for your testimony.

And I want to turn now to Mr. Eli Dourado, head of global public policy and communications of Boom. Thank you.

Mr. DOURADO. Thank you, Mr. Chairman. And thank you to you and to the members of the Aviation Subcommittee for hosting this hearing, and for the opportunity to share how today's advanced civil aviation technology is creating a more accessible world through a supersonic renaissance.

At Boom, our mission is to eliminate the barriers to experiencing the planet—time, money, and hassle—starting with the long hours

[5] "Drone Benefits Are Here to Stay—The FAA's Drone Oversight Should Be Too", Diana Cooper, The Hill (Aug. 24, 2018): https://thehill.com/blogs/congress-blog/politics/403420-drone-benefits-are-here-to-stay-the-faas-drone-oversight-should

spent on long-haul flights. Why do these barriers to experiencing the planet matter? Because when those barriers are in place, people simply don't travel as often.

For context, think about the world before jet airplanes. In the late 1930s, flying on Pan Am from LaGuardia to Lisbon took more than 24 hours. Only 20 years later, at the dawn of the jet age, the same flight took only 7 hours. Travel skyrocketed. You might think that, since jets were three times faster than the airplanes that they replaced, people would spend about one-third of the time on airplanes. In fact, with the burden of a 24-hour flight removed, people spent much more time on airplanes, because they traveled much more often.

Speed, therefore, isn't about saving time, it is about new possibilities for travel and human connection. While the world got a glimpse of another travel speedup in the 1970s with Concorde, it wasn't an economically sustainable advance. Although the program was a marvelous technical success, only 14 Concordes saw service, and even though the airlines bought them for 1 British pound, they weren't profitable to operate, sometimes flying with 75 percent of the seats empty.

The world has now gone six decades without a lasting increase in the speed of long-distance travel. Crossing the Atlantic takes as long today as it did in 1959. We believe the world is long overdue for a speedup. And in 2019 we have all the technology needed to build an economically viable, environmentally responsible supersonic airliner.

Applying technologies developed for the subsonic market to a supersonic design, Boom will deliver a Mach-2.2 airliner called Overture by the mid-2020s. Overture is designed to profitably replace today's transoceanic business-class service.

With Overture, as with the first jets, faster speeds are about new possibilities rather than just less time on airplanes. Today, a flight from New York to London takes around 7 hours and is often flown as a redeye. On Overture, because the flight takes only 3 hours and 15 minutes, a New Yorker can take a 6 a.m. flight out of JFK, arrive at Heathrow in the early afternoon, travel downtown, meet with clients, and take them to the pub before catching a 9 p.m. flight home, arriving back in New York in time to tuck her kids into bed at night.

Today a flight from San Francisco to Tokyo takes around 11 hours, and to attend a Monday morning meeting in Tokyo you leave the U.S. on Saturday. With Overture, because the flight takes only 5½ hours, you can leave a full day later, arrive on Monday morning, have a full day of meetings, fly home, and be back 24 hours after you left. The full trip shrinks from 3 days to 1 day.

Importantly, this isn't a science project. No fundamental research is necessary. All the technology to build Overture exists. And later this year, we are rolling out our supersonic demonstrator aircraft, called XB–1, which is now under construction in our hangar in Colorado. When XB–1 flies its design cruise speed of Mach 2.2, it will earn the distinction of history's fastest civil aircraft.

XB–1 and Overture are only the first steps in achieving our mission. To truly make our planet accessible for all, we need further to increase speed, reduce costs, increase passenger comfort, relax-

ation, and productivity. We expect to make progress on all of these fronts with each airliner model we design. Eventually, we see a world in which no trip anywhere on the planet takes more than a few hours, fares are lower than today's economy prices, and the experience of travel is serene and productive. Travelers should look forward to the few hours they will spend in an airline seat.

I look forward to discussing the future of flight with this subcommittee, and to working with you all to build a more accessible world. Thank you.

[Mr. Dourado's prepared statement follows:]

Prepared Statement of Eli Dourado, Head of Global Public Policy and Communications, Boom Supersonic

Mr. Chairman, and members of the Aviation Subcommittee:

Thank you for hosting this hearing and for the opportunity to share how today's advanced civil aviation technology is creating a more accessible world through a supersonic renaissance. At Boom, our mission is to eliminate the barriers to experiencing the planet—time, money, and hassle—starting with the long hours spent on long-haul flights. Why do the barriers to experiencing the planet matter? Because when those barriers are in place, people simply don't travel as often.

For context, think about the world before jet airplanes. In the late 1930's, flying on Pan Am from LaGuardia to Lisbon took more than 24 hours. Only 20 years later, at the dawn of the jet age, the same flight took only 7 hours. Travel skyrocketed. You might think that since jets were three times faster than the propeller aircraft they replaced, people would spend around a third as much time on airplanes. In fact, with the burden of a 24-hour flight removed, people spent more time on airplanes because they traveled much more often. Speed, therefore, isn't only about saving time—it is about new possibilities for travel and human connection.

While the world got a glimpse of another travel speedup in the 1970's with Concorde, it wasn't an economically sustainable advance. Although the program was a marvelous technical success, only 14 Concordes saw service, and even though airlines bought them for £1, they weren't profitable to operate, sometimes flying with 75% of the seats empty.

The world has now gone six decades without a lasting increase in the speed of long-distance travel—crossing the Atlantic takes as long today as it did in 1959. We believe the world is long overdue for a speedup. And in 2019, we have all the technology needed to build an economically viable, environmentally responsible supersonic airliner.

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Today, a flight from San Francisco to Tokyo takes around 11 hours—and to attend a Monday morning meeting in Tokyo, you leave the US on Saturday. With Overture, because the flight takes only 5 and a half hours, you can leave a full day later, arrive on Monday morning, have a full day of meetings, fly home, and be back 24 hours after you left. The full trip shrinks from 3 days to 1 day.

Importantly, this isn't a science project. No fundamental research is necessary. All the technology to build Overture exists. And later this year, we are rolling out our supersonic demonstrator aircraft, called XB–1, which is now under construction in our hangar in Colorado. When XB–1 flies its design cruise speed of Mach 2.2, it will earn the distinction of history's fastest civil aircraft.

XB–1 and Overture are only the first steps in achieving our mission. To truly make our planet accessible for all, we need further to increase speeds, reduce costs, and increase passenger comfort, relaxation, and productivity. We expect to make progress on all these fronts with each airliner model we design. Eventually, we see a world in which no trip anywhere on the planet takes more than a few hours, fares

are lower than today's economy prices, and the experience of travel is serene and productive—travelers should look forward to the few hours they'll spend in an airline seat.

I look forward to discussing the future of flight with this subcommittee, and to working with you all to build a more accessible world.

Thank you.

Mr. LARSEN. Thank you, Mr. Dourado.

I now want to turn to Mr. Eric Allison, head of Elevate, Uber Technologies.

You are recognized for 5 minutes.

Mr. ALLISON. Thank you. Mr. Chairman, Ranking Member Graves, and members of the subcommittee, it is a privilege to be here today before you to discuss the role that Uber will play in delivering aerial ridesharing services in the years ahead.

My name is Eric Allison, and I am excited to lead Uber's Elevate initiative. Last year Uber changed its mission statement to reflect its ambition and purpose: We ignite opportunity by setting the world in motion. Elevate is an embodiment of this mission. We envision a future where anyone can open the Uber app, push a button, and get a flight, setting people in motion like never before as we radically improve urban mobility.

To enable this future, we are developing our Uber air product, a real-time, on-demand network of short-range intracity aircraft that will deliver time savings on a massive scale.

So why is Uber doing this? We know that every year millions of hours are wasted in traffic, worldwide. In fact, the Los Angeles Times reports that L.A. is the most congested city in the world, where residents lose over 100 hours each year to traffic. This problem will only get worse as populations grow and ground infrastructure is unable to keep up.

Today around half of the world's population resides in urban areas. And the United Nations predicts an additional 2.5 billion city residents by 2050, overwhelming already strained infrastructure. Uber believes that solving these problems is core to our business. We can't ignite opportunity when the world is stuck in traffic.

Since publishing our Elevate white paper in 2016, we have worked diligently to answer the following questions. Why don't people fly in cities today? And what are the barriers to urban aviation becoming a large-scale mode of transportation? We have identified an approach to systematically tackle each of these challenges, and our analysis projects that aerial ridesharing is not only feasible, but can be offered at rates affordable enough to make everyday flight accessible around the world.

To achieve this vision, over the next 3 years we aim to conduct meaningful demonstrations of all electric vertical takeoff and landing aircraft in Texas and California, and commence certified commercial operations in 2023. In order to deliver on this ambitious timeline, we recognized early on that we can't do this alone. Broad-based partnerships with Government and industry are critical to achieving our vision. We are partnering with companies such as Boeing, Bell, Embraer, Pipistrel, and Karem Aircraft. These leading manufacturers and innovative new entrants are perfectly positioned to pave the way for quiet, safe, reliable, and affordable Uber air taxis.

The Federal Aviation Administration is another incredibly important partner in this journey to make urban aviation a reality. We firmly believe that certification of air taxi vehicles through the recently revised part 23, which was supported by this subcommittee in the form of the Small Aircraft Revitalization Act, is the best path forward. We encourage the FAA to commit to using part 23 to safely and expediently certify these new aircraft, firmly establishing United States global leadership in this innovative new category.

In addition to our partnership with the FAA, we are pleased to have signed two Space Act Agreements with NASA, one for the development of UAS traffic management concepts and technologies, and another to explore urban air mobility. UTM is paving the way for Uber and other companies to drive innovation and develop airspace services that manage vehicles safely and efficiently without putting an undue burden on existing air traffic operations or air traffic controllers.

At Uber we are investing in aerial ridesharing because we believe in the future of aviation and changing the way the world moves. By 2050 we will no longer be discussing our work to develop battery technology, our transition from piloted aircraft to autonomous, or our ability to fully integrate into the urban airspace. Rather, in 2050 we intend to be safely and autonomously operating millions of daily flights, fully integrated into the National Airspace System, and with zero carbon emissions. Working with world-class leaders in the aerospace industry and our Government partners, we believe we can bring about lasting positive change for the world through 2050 and beyond.

In addition to our daily work to advance urban aviation, this June we will be holding our third annual Elevate Summit right here in Washington, DC, presenting never-before-seen developments, and showing exactly how close we are to making aerial ridesharing a reality. We want to do this in concert with policymakers like yourselves, as we move closer to bringing Uber Air to major cities in the United States. We hope you will join us for what will undoubtedly be an exciting 2 days.

To give you a sense of how users will live this future transportation experience, I would like to close with a short video illustrating Uber Air. I hope you enjoy this fast-forwarding to the future, and look forward to answering your questions about our vision and approach. Thank you.

[Mr. Allison's prepared statement follows:]

Prepared Statement of Eric Allison, Head of Elevate, Uber Technologies, Inc.

Mr. Chairman, Ranking Member Graves, and Members of the Subcommittee, it is a privilege to be here before you today to discuss the role Uber will play in delivering aerial ridesharing services in the years ahead.

My name is Eric Allison and I am excited to lead Uber Elevate. Last year, Uber changed its mission statement to reflect its ambition and purpose; we ignite opportunity by setting the world in motion. Uber Elevate is the embodiment of that mission statement. Our vision of the future provides users an opportunity to substantially reduce their commuting time while simultaneously utilizing a carbon neutral option that requires minimal infrastructure and can all be summoned through the Uber app. The product, Uber Air, will be the result of our development of a real-

time, on-demand network of aircraft that will deliver time savings on a massive scale.

When we envision aviation in 2050, Uber sees a future that looks substantially different from what we rely on today. Autonomous control of aircraft and airspace will ultimately enable a fully scaled network that can support thousands of flights per hour—over every major city in the world. This scaled network is key to Uber Elevate and our vision of urban aviation.

The United Nations predicts that 68% of the world's population will reside in urban areas by 2050, up from 55% today. To support an additional 2.5 billion residents, something drastic must be done to address the transportation problems created by this increased population density. The Los Angeles Times reports that L.A., one of our pilot markets, is the most congested city in the world, where residents spend over 100 hours annually stuck in traffic. This problem will only continue to worsen as populations grow and ground infrastructure is unable to keep up. Time spent in traffic ultimately represents less time with family, fewer hours growing our economies, and more pollution in our world.

As a multimodal transportation platform, Uber believes solving this problem is core to fulfilling our mission. Just as cities looked to the skies to expand, urban aerial ridesharing will use three-dimensional airspace to alleviate transportation congestion on the ground. We started this journey in 2016, publishing our *Elevate White Paper*[1] to answer the following questions: why is urban aviation not a viable form of mass transportation, and what barriers must be overcome.

Since 2016, we have worked diligently to answer these questions. Our analysis projects that aerial ridesharing is not only feasible, but can be launched at affordable prices. Once at scale, we believe we can operate at rates that may be cheaper than owning and driving your own car, making everyday flight accessible around the world.

To achieve this vision, we aim to conduct meaningful demonstrations over the next 3 years in Texas and California and commence certified commercial operations in 2023. We know this timeline may sound ambitious, but we believe that big, bold bets require pushing the boundaries of what's possible. During our demonstration phase, we intend to prove the safety, reliability, and low noise footprint of our aircraft while working with the respective communities to ensure we receive their feedback on how to best serve their residents. In all markets, our service holds the promise of reducing congestion and improving quality of life.

Ultimately, no one company can do this alone. We recognized early on that broad-based partnerships with government and industry are critical to achieving this vision. Partnering with industry leaders in aircraft manufacturing, infrastructure development, battery engineering, and forward-thinking regulators will ensure our product best serves the community.

Together with our partners we are actively designing new aircraft to lead a revolution in urban aviation in cities around the globe. We're proud to be collaborating with these job creators to chart the future. Our partners include Boeing, Bell, Embraer, Pipistrel, and Karem Aircraft; these leading manufacturers and innovative new entrants are perfectly positioned to pave the way for safe, reliable, and affordable Uber air taxis.

The Federal Aviation Administration (FAA) is another incredibly important partner in this journey to make urban aviation a reality. Our collaborative work to develop this new ecosystem has made us increasingly optimistic about the future of air transportation in the United States. We encourage the FAA to continue its innovative approach to aircraft and operational certification without sacrificing safety. Specifically, if we want to see aircraft certified safely and expeditiously, we implore the FAA to commit to a certification pathway that considers long term operational impacts and does not stifle innovation. We firmly believe that certification through the recently reorganized Part 23 structure, which was supported by this subcommittee in the form of the Small Airplane Revitalization Act (SARA), is the best path forward for all manufacturers and operators.

In addition to our partnership with the FAA, we're pleased to have signed two Space Act Agreements with NASA, one for the development of UAS Traffic Management (UTM) concepts and technologies, and another to explore Urban Air Mobility (UAM). UTM is paving the way for Uber and other companies to drive innovation and develop airspace services that manage the vehicles safely and efficiently without putting an undue burden on existing air traffic operations or air traffic controllers. Both of these efforts are essential to achieving fully scaled operations by 2050.

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[1] Uber Elevate: Fast-Forwarding to a Future of On-Demand Urban Air Transportation: https://www.uber.com/elevate.pdf

Our plan is to operate our aircraft along precise virtual route networks that can be dynamically adjusted to the needs of air traffic safety and control, noise and other community considerations as well as air traffic demand. These networks will provide high predictability and transparency of our operations. In developing these systems, we are taking a highly systematic approach to integration and validation in simulations and field testing to ensure interoperability with the FAA's air traffic systems as well as other UAS service suppliers. These partnerships are critical for devising the path for safely sharing the airspace amongst all users.

The FAA and NASA's ongoing investment in the future of aviation is partially thanks to committees like this one working to encourage our government partners to embrace the future. We ask Congress to continue prioritizing this developing ecosystem, and we look forward to extending our collaborations with government partners to work on aircraft and pilot certification, airspace integration, and air traffic management.

In addition to our daily work to advance urban aviation, this June we will be holding our 3rd annual Elevate Summit right here in Washington DC, presenting never before seen developments and showcasing exactly how close we are to making aerial ridesharing a reality. We want to do this in concert with policymakers like yourselves as we move closer to bringing Uber Air to major cities in the United States. We hope you'll be able to join us for what will undoubtedly be an exciting 2 days.

At Uber, we are investing in aerial ridesharing because we believe in the future of aviation and changing the way the world moves. We see incredible and growing demand across all urban markets for safe, reliable and fast transportation services, and our network will be an excellent supplement to public and private transit options. In 2050, we will no longer be discussing our work to develop battery technology, our transition from piloted aircraft to autonomous, or our ability to fully integrate into the urban airspace. Rather in 30 years, we intend to be operating millions of daily flights; safely, autonomously, fully integrated into the National Airspace System (NAS) and with zero carbon emissions. Working with world class leaders in the aerospace industry and our government partners, we believe we can bring about lasting positive change for the world in 2050 and beyond.

To give you a sense of how users will live this future transportation experience, I would like to close with a short video illustrating Uber Air. I hope you enjoy this fast-forwarding to the future, and look forward to answering your questions about our vision and approach. Thank you.

Mr. LARSEN. Thank you. Are we going to run that video right now?

[Video shown.]

Mr. LARSEN. Thank you. I think you also proved how quiet it can be in the future.

[Laughter.]

Mr. ALLISON. That is very nice music.

Mr. LARSEN. Thank you. And now I want to recognize Captain Joe DePete, who is the president of ALPA, the Air Line Pilots Association, International.

I recognize you for 5 minutes.

Mr. DEPETE. Thank you, Chairman Larsen, Ranking Member Graves, and the subcommittee for the opportunity to be here today.

Before I begin, please let me take a moment to recognize the Ethiopian Airlines and Atlas Air accidents recently. Our thoughts are with all those affected, and ALPA is committed to helping the industry take every possible action to prevent such tragedies in the future.

Regarding today's hearing, we at ALPA understand the economic and societal value of the safe integration of new types of operations into the airspace. As a 40-year pilot, I can also tell you that airline pilots are very excited about flying in the future.

Wilbur and Orville Wright were original innovators in aviation, and the first of many innovators in the United States airline industry. With every year innovation has brought greater safety to our

skies, and I am proud to say that I believe that ALPA's work in safety, security, and pilot assistance, and our support for technological innovation are among the reasons why flying is the safest mode of transportation today.

As head of the world's largest nongovernmental aviation safety organization, I can tell you that maintaining one level of safety throughout the national airspace is essential to fostering the innovation of tomorrow.

The national airspace is a shared resource for all Americans, whether it is passenger and cargo airliners, UAS, urban mobility, super and hypersonic flight, or commercial space; the same high standards must apply to all who use it, or all are at risk.

The United States owes it to our future to benefit from the lessons of the airline industry's past. One lesson we learned is that innovation is key to solving the greatest challenges, and to keeping flying safe. From developing center-line approach lights, to using technology to reduce inflight collisions, and helping shift the industry to a proactive safety culture to prevent accidents, ALPA is all about innovation.

In fact, one of our industry's most valuable safety tools—voluntary, nonpunitive safety reporting programs—sets the stage for this innovation. These safety reporting programs allow pilots and other aviation professionals on the front lines of daily operations to report safety hazards before they cause accidents. Safety risk issues are then prioritized by the commercial aviation safety team, or CAST, and used to improve policies, procedures, equipment, and training. Made up of representatives from the Government, labor, airlines, manufacturers, the CAST is a synergy on a massive scale. And it has saved lives.

Together, CAST representatives focus on reducing U.S. commercial aviation fatality risk. The team exceeded its initial 80 percent target, and I am proud to say it has reduced the current risk rate now today by 91 percent, a remarkable achievement by any measure. The CAST model is one of aviation industry's best practices, and it shows how U.S. innovation and collaboration have created an extremely safe air transportation system.

Another aviation best practice is our recognition that the most important safety asset on any commercial passenger or cargo airliner are at least two fully qualified, highly trained, and well-rested pilots in the cockpit. This lesson is critical to consider as many new types of flight operations are envisioned to be autonomous, meaning no pilot is involved in the flight.

When it comes to integrating new types of operations into the national airspace, we have the opportunity today to do it right the first time. Expanded markets and technical advancement are creating exciting developments in aviation. Accommodating that growth presents regulatory and shared public resource challenges. We need Congress to lead our industry, and planning for that now. We must be bold. The FAA and the TSA must be given the resources to innovate through programs like NextGen. And a Government shutdown can never again be allowed to stop the FAA's lifesaving work.

ALPA offers decades of experience, combined with our unique perspective from the cockpit. We are committed to collaborating

with all who share the national airspace to ensure safety. So as we consider aviation in 2050, we have an opportunity to innovate not only on how we use our national airspace, but how we keep it safe. Together we can protect what is most important to us all: our passengers, participants, crew, and cargo.

Thank you very much.

[Mr. DePete's prepared statement follows:]

Prepared Statement of Captain Joseph G. DePete, President, Air Line Pilots Association, International

Mr. Chairman and members of the committee, thank you for giving me the opportunity to join you today to talk about Aviation 2050, the future vision for how our National Airspace System (NAS) evolves to serve the changing needs and demands of commerce, transportation, and the public at large. But before I share our thoughts on this important subset of the industry, please allow me to introduce my organization to you.

I'm the president of the Air Line Pilots Association, International (ALPA), which represents more than 61,000 professional airline pilots flying for 33 airlines in the United States and Canada. ALPA is the world's largest pilot union and the world's largest non-governmental aviation safety organization. We are the recognized voice of the airline piloting profession in North America, with a history of safety and security advocacy spanning more than 87 years. As the sole U.S. member of the International Federation of Airline Pilots Associations (IFALPA), ALPA has the unique ability to provide active airline pilot expertise to aviation safety issues worldwide, and to incorporate an international dimension to safety advocacy.

ALPA has seen incredible change in aviation over our history. We've seen airplanes evolve from doped fabric and wood, to carbon fiber and titanium alloys. We've seen radial piston engines give way to turbojets and, now, to the latest geared turbofans that can run on biofuel. And we've seen navigation evolve from spotting landmarks and light beacons to satellite-based positioning that can tell you where you are within a few feet, even at 600 miles per hour at 39,000 feet over the ocean. What is common to all of these changes is that they have moved from the realm of bleeding edge technology to being integrated as a routine part of operations.

AVIATION SAFETY IN 2050

When I think about aviation in 2050, there is one aspect above all others that I sincerely hope continues to improve: aviation safety. It is clear that the commercial aviation industry has reached unparalleled levels of safety in the United States, and I like to attribute that to a couple of key activities.

First, the efforts of the Commercial Aviation Safety Team (CAST) combined with Aviation Safety Information Analysis and Sharing (ASIAS) have led to dramatic improvements. Data analysis by CAST and ASIAS has resulted in a proactive safety culture that cuts across all airlines and stakeholders with unprecedented levels of collaboration, even when those same stakeholders often find more than enough to disagree about on any other part of industry policy. But safety isn't one of those areas. The predictive risk analysis conducted by the CAST and ASIAS allows the aviation community to collectively reach heightened levels of safety without waiting for a single drop of blood to be shed.

The second major breakthrough in safety was the improvements that Congress introduced and were signed into law as part of the FAA Authorization Extension Act of 2010. Unfortunately, these safety enhancements came about after four fatal airline accidents in a relatively short amount of time, including the crash of Colgan Flight 3407, which resulted in 50 fatalities. We recently marked the 10-year anniversary of that accident with resolve that the events of that night resulted in something better. We mourned the loss of those who perished, but we took solace in the levels of safety that have resulted from the legislation passed soon after that tragic accident. Thank you for your leadership and oversight on that law. Since we are discussing innovation and technology today, I wanted to highlight the fact that, as a result of the legislation, there has been significant innovation on pilot training of upset prevention and recovery and extended envelope for flight crews.

As a result of the Colgan Flight 3407 accident, as well as a Pinnacle flight that crashed in Jefferson City, Mo., on October 24, 2004, ALPA promoted innovations in pilot training and has been a stalwart advocate and leader in upset prevention and recovery training. The requirements for this upset prevention and recovery training,

which was called for in the FAA Authorization Extension Act of 2010, go into effect for airlines this month. The pioneering strategy deployed to improve the simulation devices for this training was no small task. Improvements on aircraft performance data as well as software enhancements to simulators were needed in order to provide pilots with this new training. The collective work of many organizations has led to better trained pilots in phases of flight that previously could not be simulated on the ground.

Suffice it to say, it is my hope that in 2050 the safety improvements directed by Congress in 2010 will still be in place and will no longer be the target of those who wish to roll them back. But I also hope that by 2050, we will have taken safety a step further and will have raised the bar of airline safety so that all commercial airline operations are on the same level of safety. Today, Part 121 commercial all-cargo safety levels are lagging the safety levels of Part 121 passenger operations. We must make this a focus area immediately, and we need to apply just as much focus on this safety issue as we have on passenger airlines.

While it is way too early to know what caused the Atlas 3591 accident, we do know that it is yet another fatal Part 121 all-cargo accident in a period of time where there has been only a single passenger fatality in the United States on U.S. passenger airlines. I believe that I can speak for all airline pilots when I say that we need to identify the safety gaps in all-cargo airline operations and put a plan in place to ensure that the safety levels we have come to expect with passenger airlines are also achieved by the all-cargo operating community. Our society certainly benefits from the innovations of all-cargo package delivery operators; we should expect the same level of commitment to safety as consumers have come to expect on efficiency.

NEW ENTRANTS BECOME ESTABLISHED NAS OPERATORS

It is with this keen eye on safety, that we offer our enthusiastic support to those organizations who are diligently looking to deploy new capabilities in the NAS. With the knowledge, experience, and operational perspectives that ALPA can bring to the table, we also extend our offer to help usher in these new capabilities safely.

As we look toward 2050, we need to recognize that the new entrants of today will be just another operator in the future. In fact, the FAA is already well underway in laying the foundation for integration of both Unmanned Aircraft Systems (UAS) and commercial space operations into routine NAS operations. Thanks to FAA leadership, and the direction provided by Congress in last year's FAA reauthorization, we can already start to envision the day when all UAS operations are performed safely and within the law, and space launches occur routinely without partitioning or blocking off large sections of airspace. As UAS and commercial space transition from new entrants to established NAS users, we can see the next opportunities on the horizon: urban mobility, the return of commercial supersonic transportation, the building of wireless data infrastructure through high-altitude long-endurance vehicles, and even suborbital hypersonic transportation. As a long-time pilot first in the military and then at both passenger and cargo airlines, these are exciting concepts that I look forward to seeing come to fruition. However, we note that many of these new types of operations will not have pilots on-board the aircraft, and most are striving for autonomous flight, which means that there will be no pilot in command of the flight. Understanding the implications of this fundamental change bears careful examination.

UNMANNED AIRCRAFT SYSTEM INTEGRATION

ALPA recognizes that UAS represent a significant potential for economic and societal benefit. They are uniquely suited for performing many types of dangerous flying that can keep pilots out of harm's way. ALPA supports robust development of this technology with one single overriding condition: integration of UAS into the NAS must be done safely, deliberately, thoughtfully, and with full understanding and effective mitigation of the possible risks. We must do this right, or the enviable safety record we have achieved in airline operations will be at risk and, with it, the promise of employing UAS for the benefit of the population.

Recently, a company approached the FAA to obtain exemptions that would allow them to bypass more than 200 Federal Aviation Regulations (FARs) in order to start a commercial UAS package delivery service without any limitations to flying over residential or other populated areas.

Granting this petition for exemption would allow the petitioner to bypass the FAA UAS implementation policy of "crawl, walk, and run" for the introduction of new technology, capabilities, and procedures. The FAA has historically established regulations based on accidents and incidents to establish the current FARs. Aviation reg-

ulations represent a safety framework for which commercial for-hire operations are conducted. Issuing exemptions to so many of the requested areas appears to erode the safety levels established by the FAA through regulation, many of which were established as a result of accidents and incidents with injury and loss of life to passengers and people on the ground.

As required under 14 CFR Part 11.35 (b), the FAA withheld proprietary company manuals and related material, including the petitioner's safety case justification. Therefore, many of the exemptions requested could not be thoroughly evaluated by industry stakeholders. If successful, we can anticipate that other manned and unmanned operators would seek similar exemptions from the same regulations included in this Petition for Exemption, awarding them to others without a clear safety justification. This is not how UAS operations should be implemented in the NAS if the objective is to make UAS a standard participant in routine NAS operations.

As we have for many years, ALPA continues to be an active partner with both government and industry in developing standards that will lead to safe operation of UAS in the NAS. Concurrently, we recognize that these standards are far from complete. Defining a safety framework for any new technology is necessarily a painstaking process, and ALPA, along with hundreds of extremely talented representatives from across aviation, is diligently pursuing that goal.

While it is tempting to leap-frog this process and accelerate approvals for implementation, the only way to ensure safety is to methodologically work through each step of risk assessment. We believe there may be ways to accelerate the integration, with additional resources and innovative use of technology for data collection. But we would be concerned if the process were to be accelerated without systematically working through all of the risks.

ALPA believes that safe integration of UAS includes four fundamental elements:

1. *Education*: Anyone who plans to fly UAS must understand their aircraft, the airspace, and the other aircraft that could be encountered while flying.

   In the case of UAS that might be flown for compensation or hire in civil airspace, the pilot must hold a commercial pilot certificate to ensure he or she possesses the appropriate skill and experience to meet safety standards designed to protect the flying public.

   Those flying UAS for recreational purposes must adhere to the FAA regulations and guidelines, including potential minimum age requirements, keeping the UAS within line of sight, and flying at heights under 500 feet.
2. *Registration*: Gathering basic information about the identity of the individual purchasing the UAS not only allows law enforcement authorities to identify the owner if the UAS were to encounter a problem, but it also helps make clear the serious nature of operating a UAS in the NAS and the responsibility to safeguard public safety. We continue to urge Congress and the FAA to require registration to occur at the point of sale of the UAS.
3. *Technology*: If UAS, either intentionally or unintentionally, are operated in airspace that airliners use, airline pilots need to be able to see them on cockpit displays, controllers need the ability to see them on radar scopes, and the UAS must be equipped with active technologies that ensure that it is capable of avoiding collision with manned aircraft. In these types of operations, technology must enable the pilots to control and interact with them in the same manner as if the pilot were on board.

   If a UAS is restricted by regulations from operating in a particular geographic area and/or altitude, it must have technology that cannot be overridden that limits the geographic areas and altitude in which it can operate. This may include permanent locations such as the White House and all public airports, as well as temporary restrictions such as for wildfires or natural disaster areas.
4. *Penalties and enforcement:* UAS pilots must be properly trained and understand the consequences of unsafe operations. Anyone flying a UAS that is a hazard to other aircraft in the airspace, especially those who choose to do so recklessly near airports, must be identified and appropriately prosecuted. We support the criminalizing of intentionally unsafe operation of UAS and penalties for unintentional unsafe UAS operations. If additional funding is needed for this purpose, Congress should provide the resources needed without delay.

ALPA applauds Congress for its clarification of FAA's authority to fully regulate all UAS operations in the 2018 FAA Reauthorization (P.L. 115–254), to include model and hobby operators, who previously were exempted from regulation. We are especially grateful for this subcommittee and Chairman DeFazio for the dedication to promote safe UAS operations. We are also grateful to observe that the FAA has already made progress in addressing all four of these elements.

URBAN MOBILITY—ANOTHER AIRSPACE USER

Another new type of operation that is relatively close to earth is emerging with tremendous momentum and energy: urban mobility aircraft. Several companies have visions for urban mobility that in some cases involve an autonomous or remotely piloted aircraft that carries passengers. Again, the challenges of certification and economic viability are significant, but so are the challenges with integration of the airspace. In fact, urban mobility aircraft may need to integrate with low-altitude piloted aircraft such as rotorcraft as well as small UAS, in airspace managed by Air Traffic Control. But because some of their concepts include operations at large air carrier airports, they will also need to interact with the traditional national airspace system. Because almost all of us had to sit in traffic to get here today, I don't think anyone wants progress for this type of aircraft operation to be slowed for any reason. And so again, just like with other types of innovative operations envisioned for the NAS, ALPA will be ready to offer our assistance and knowledge to ensure that this integration challenge is successful and safe.

REDUCING THE IMPACT OF COMMERCIAL SPACE

Commercial space operations are not new. In fact, it has been more than 30 years since Congress established a the Office of Commercial Space Transportation in the Department of Transportation (DOT), which now resides at the FAA. The industry is mature, and thanks to a series of events over the past decade, it is thriving through an expansion in proposed spaceports and significantly increased operational frequency. I was excited to see that the SpaceX Crew Dragon spacecraft undocked from the space station and returned to earth safely in its test run, before launching with astronauts.

These are truly exciting times for America as we experience innovation and advancements that are literally blasting off before our eyes. However, we must keep commercial aviation part of a discussion on commercial space. Future growth and success of U.S. commercial aviation depends upon continued safe, dependable, and efficient access to shared public resources such as the National Airspace System, air traffic management, ground infrastructure, and airport services. The need to integrate commercial space operations and commercial aviation operations into the NAS is an urgent need that will require careful planning and commitment from many different parts of the industry.

One thing is clear, expanded markets and technology advances in space are enabling new commercial companies to access these limited resources, which has become a critical challenge for the aviation community. Air traffic management, airports, and the NAS are regulated and managed according to strict operational and safety regulations, which will not sufficiently accommodate the projected growth and evolution of space transportation, without enhancements to how space flight is accommodated by the NAS. There must be a means to safely integrate with existing aircraft operations and infrastructure without decreasing the level of safety or efficiency for existing operations. Full integration will allow space operations to plan and execute launches without extensive coordination like they do now, and full integration will also eliminate the need for segregation of space operations from commercial airline flights. Bottom line: Commercial space integration improves safety and efficiency of the NAS for all airspace users. A strategy to fully integrate commercial space operations into existing NAS operations is a critical first step to achieving this important goal.

Neither industry would be successful today without the other. Each sector generates hundreds of billions of dollars in annual economic returns for the United States and immeasurable benefits to society. The FAA has coordinated the activities of both airplanes and rockets successfully for more than 60 years. In many ways, there is a false distinction between the two sectors, since several aircraft types travel into outer space, and all space vehicles travel through the atmosphere. As spaceflight becomes more diffuse and routine, both sectors must cooperate to create policies, regulations, and procedures to manage shared national aerospace resources safely and efficiently.

An important reason to keep the commercial space industry a part of the aviation 2050 discussion is that there are going to be innovations in safety and efficiency that will likely find their way into commercial aviation. For example, Virgin Galactic plans to utilize a spacecraft for multiple flights with paying passengers (technically speaking, they are participants), and this experience will likely help the commercial airlines better understand the interest in hypersonic travel and the potential issues that would accompany a transition to this type of travel in the future.

ALPA is very interested in supporting the commercial space industry's efforts to advance through the full integration into the NAS. To fully articulate the com-

plementary nature of commercial space and commercial aviation, we published a white paper that documents the role of the government agencies and industry, both historically as well as today. That whitepaper can be found at www.alpa.org/whitepapers.

SUPER AND HYPERSONIC TECHNOLOGIES

ALPA recognizes that super and hypersonic technology will continue to advance and provide for the significant potential for economic and societal benefit. Although supersonic commercial airline transportation itself is not new, it is also not routine. Supersonic technology was birthed in commercial aviation in the 1970's with the introduction on the Concorde. Pilots of the Concorde routinely logged more supersonic time in a year than military pilots logged in their entire military career. What few people may remember is that Braniff, an ALPA carrier, briefly operated a Concorde on a route from Dallas-Fort Worth to Washington Dulles using Air France and British Airways aircraft.

Although the Concorde is long retired, a new generation of aircraft manufacturers is looking to develop supersonic civilian aircraft. Aside from the challenges of economic viability and community acceptance of noise from possible sonic booms, these aircraft will also need to integrate into the NAS. While the aircraft are anticipated to cruise much higher than current air transport aircraft, they still must climb and descend through congested airspace and take off and land at busy airports. Depending on their performance at lower altitudes, this could present additional integration challenges to operations and ATC automation.

Supersonic aircraft technologies allow for significant reductions in flight times, which is realized on long distance routes. While this technology continues to develop, supersonic technology may be quickly overcome by hypersonic flight, as the aviation industry saw with the microwave landing system. ALPA supports the robust development of this technology, but we must ensure that the integration of this technology is done safely.

A step beyond supersonic aircraft is hypersonic or suborbital vehicles. Several commercial space companies have already presented visions of flights from Asia to the East Coast of the United States taking 90 minutes or less. While these spacecraft may have fewer concerns when it comes to sonic booms, they still must integrate with the rest of the NAS and ATC. Depending on their exact flight profiles, this operation may look like a conventional aircraft, a spacecraft, or something in between, thus presenting its own integration challenges.

SUPERSONIC AND HYPERSONIC CERTIFICATION STANDARDS MUST ACCOUNT FOR TECHNOLOGY ADVANCEMENTS

This month we celebrated the 50th anniversary of the first flight of the Concorde, but when it comes to large transport category aircraft, the materials used to reinvigorate such travel are still in their infancy. Although the use of carbon composite structure dates back before the 70's, it was the Boeing 787, unveiled in 2007, that broke world records with the use of carbon composites in more than 50 percent of the airplane's primary structure.

Carbon-based and other composite structures bring a great advantage to the aviation industry. They are lightweight, easy to configure into complex geometries, and can be easy to repair. However, because composites are a newer manufacturing technique to the aircraft manufacturing industry they are also more difficult and subjective to inspect, not standardized similar to metallic materials, and have less empirical data providing a clear picture of the their damage tolerance and fatigue capabilities, even less so when considering the large disparity in operational environments between current large-transport aircraft and those operating in a super or hypersonic regime.

Additive manufacturing, more commonly known as 3D printing, is another area in which technological enhancements to materials are reinvigorating the exploration of super and hypersonic air travel. By printing an aircraft part from scratch, manufacturers have discovered a way to reduce material waste, increase part quality, and reduce weight while enabling the manufacture of complex parts previously impossible to machine. Although "printed" rather than forged or cast, these parts can be manufactured with the same properties of their parent materials. But with any new technological advancement, such strides are accompanied by new deficiencies not previously envisioned.

Printed aircraft parts are, similar to composites, beholden to the process under which they are manufactured. And although composites have been used for many years, 3D printing only recently became economically viable on a large scale. As such, testing and airworthiness guidance has not been thoroughly developed, tested,

or used. Certification standards must now account for the effect process has on the material integrity as well as initial part design and continued durability.

ALPA supports the enhancements that material development such as proliferation of composite structures or 3D printed parts can have on the aviation industry. To ensure the safety of the NAS and the traveling public, this technology must be fully vetted and completely mature before it can be used in commercial service.

SUPER AND HYPERSONIC POWERPLANT RELIABILITY MUST BE MAINTAINED AND IMPROVED

Advancements in propulsion technologies are a huge key to the proliferation of super and hypersonic commercial aviation because it impacts fuel efficiency, operational costs, environmental impact, and safety. This was a primary driver in the retirement of the Concorde from commercial service almost two decades ago. A large part of increasing fuel efficiency, and thus operational costs, is to reduce the weight of the engine. However, to do so, engine tolerances must become smaller, which leads to an engine that may be more susceptible to failure.

ALPA continues to be an active stakeholder in ensuring engine testing is robust, both from a certification and a continued operability standpoint. Although we have certification standards for debris ingestion, continued operational power, and contained failures, to name a few, we must continue to ensure that engine designs become more reliable. The criticality of powerplants cannot be understated for commercial aviation, and even more so when operating at super and hypersonic speeds.

ENVIRONMENTAL IMPACT OF SUPER AND HYPERSONIC OPERATIONS MUST BE ADDRESSED

One of the challenges the Concorde faced was sonic booms. In the United States, supersonic flight is restricted to eliminate the impact of sonic booms on people and wildlife. Sonic booms can be disruptive to wildlife, which is damaging to our ecosystems. Sonic booms are also a nuisance to people and can damage property. In recent years, several studies have researched the effects of wing shape with the goal of developing a wing that will create a softer or nearly imperceptible sonic boom. While these technologies are being developed to reduce the noise footprint for the sonic boom, the environmental impact of these technologies must be fully researched and clear standards developed.

SUPER AND HYPERSONIC OPERATIONAL REQUIREMENTS MUST PROVIDE AN EQUIVALENT LEVEL OF SAFETY

Super and hypersonic aircraft will, by their nature, be traveling much faster than aircraft currently flying today. This type of air travel will likely not be replacing today's but rather augmenting it. For this reason, consideration must be made of how to safely and successfully integrate super and hypersonic transportation into the NAS infrastructure.

ALPA's position is that the foundation of operating an aircraft, regardless of altitude and speed therein, in a safe and responsible manner must be maintained at the same level of safety. Super and hypersonic aircraft operators must be required operate to an equivalent level of safety to air carrier operations, and regulations must ensure that the unique operational needs are addressed to ensure the safety of the NAS and the traveling public. These must include provisions for the unique environment that the operations are conducted.

FAA MODERNIZATION: IMPROVED NAS CAPABILITIES FOR SAFE INTEGRATION

In addition to robust design standards and safe rules of operation for the new aircraft described above, another key for successful integration is to improve the capabilities of the NAS itself. This might include development and integration of a UAS traffic management system that can interoperate in real-time with the Air Traffic Control system when necessary or procedures and automation to handle high-altitude/long-endurance aircraft. For commercial space, capabilities include the development of real-time data sharing of spacecraft launch and trajectory information with ATC, so that large blocks of airspace are not closed for hours at a time but instead can be managed in real-time.

Better integration will make it easier for UAS and commercial space to meet their operational goals while maintaining the target level of safety for pilots, passengers, and the public on the ground.

An example of a potential near-term NAS improvement with both safety and efficiency benefits is Space-Based Automatic Dependent Surveillance—Broadcast (ADS–B), or the use of satellites to receive position reports from aircraft, and potentially spacecraft, while over the ocean. The beauty of this capability is that it does not

require the aircraft to be equipped with any additional equipment beyond what is already required for flight after January 1, 2020. Space-Based ADS–B allows ATC to receive position updates every 8 seconds, as compared with today's minimum update interval of 14 minutes. One immediate improvement to aviation safety is that near-real-time tracking of aircraft becomes a reality. This will hopefully make delays in accident investigations like Air France Flight 447, in which the main part of the aircraft wreckage was not located for 2 years after the crash, a thing of the past. It may also help prevent another Malaysia Airlines Flight 370 incident, as the location of this aircraft is still unknown.

Beyond the safety improvement, trials are already planned for reduced separation based on this new surveillance improvement. With additional improvements in communications capability to go with Space-Based ADS–B, a revolution in how oceanic operations are performed could occur, leading to significant increases in both safety and efficiency. The FAA is already evaluating how to incorporate Space-Based ADS–B into operations, and ALPA fully supports these initiatives.

It appears that there is now a need for a broader oceanic airspace modernization initiative. For example, in addition to Space Based ADS–B, we anticipate that improvements in communications between pilots and air traffic controllers will also be needed for the continued reduction of aircraft separation. Voice communications via satellite relay are currently carried out via a third-party relay—it is not like domestic VHF radio communications where the pilot and controller speak directly with each other using a simple press of their radio button.

At some point, oceanic communications will limit the extent to which reductions in aircraft spacing can be achieved. Today's use of voice communications in the oceanic environment is cumbersome, and most pilots would say that voice communications are generally inadequate for real-time air traffic control communications with flight crews. As satellite technologies continue to evolve, the use of direct controller-pilot voice communications in a manner similar to domestic en route airspace may make oceanic operations significantly safer and more efficient. With the ability for controllers to give revised clearances quickly, pilots would be able to reduce time spent flying through turbulence and avoid hazardous weather conditions, thus improving safety for passengers and crews. With the correct planning, the airspace over the oceans may not require the use of preestablished "oceanic tracks" for aircraft to navigate. Someday, just like domestic airspace, the oceanic airspace may allow airline aircraft to fly the most direct and efficient path between departure and destination airports. Improvements to the oceanic airspace environment may also assist commercial space operators through increased real-time access to be able to launch on an orbital trajectory from the coastlines of the United States. However, to define and implement these visionary concepts by 2050, we must get started right away.

NASA CONTRIBUTION TO AVIATION 2050

When we talk about air and space, the National Aeronautics and Space Administration (NASA) is a key research organization that has laid the groundwork for many of the innovations we see in commercial aviation today. ALPA applauds NASA's past efforts, and we encourage NASA to expand the scope of its research to work much more closely with the FAA to ensure that new concepts and technology not only work as a proof of concept, but also meet the needs of the FAA and industry. This will assist the FAA and industry in taking the next steps toward integration. Examples of excellent NASA research that would have benefited from further maturation and closer collaboration with the FAA include use of Automatic Dependent Surveillance—Broadcast (ADS–B) for spacing applications as well as its air traffic management automation research programs. NASA's goal should extend beyond the research and include the collaboration and work necessary to see research through to implementation.

Looking at the UTM concepts, the NASA work does not appear to provide FAA with an implementable solution, but rather is a series of technology demonstrations that may or may not be usable by the FAA for establishment of traffic management at low altitude airspace for UAS, rotorcraft, and urban mobility concepts. There is a need for additional discussion about the role of the FAA in managing low-altitude airspace, as well as public debate on whether the FAA should turn over air traffic management in low-altitude airspace to commercial vendors. To date, that discussion has not yet occurred, but ALPA believes it should begin in earnest.

WORKFORCE FOR THE FUTURE

As we look toward the future, aviation faces a challenge also seen by other technology-focused industries: how to develop and shape today's youth to become tomor-

row's high technology workforce. The FAA is already seeing significant challenges in replacing the Air Traffic Controller workforce as today's controllers reach retirement age. ALPA sees many opportunities to improve our overall education and training system, which will serve aviation and the country well.

First, to get the sheer numbers of people needed to work in all aspects of aviation, we must improve diversity in the aviation workforce and harness the limitless talent available in the United States, which can be accomplished through easy and affordable access to education beginning in elementary and secondary education with a focus on developing a passion for Science, Technology, Engineering, and Mathematics in our youth. This must be followed by affordable college educational opportunities at traditional 4-year institutions, but also should include new and expanded use of community colleges and vocational or apprenticeship programs. For example, the Community College of Beaver County, PA., and Green River Community College of Auburn, WA., are just 2 of 36 institutions offering programs that can lead to jobs in air traffic control or aviation maintenance technology.

Taking action now is the only way to ensure a sufficient workforce will exist to fly airplanes, control air traffic, maintain aircraft and ATC equipment, and develop the new capabilities that will be needed for aviation into the future.

In closing, ALPA sees a bright and exciting future that builds on the past century of aviation development. As with the past, the new types of aircraft operations we are discussing today will become the established operators of tomorrow—and new ideas and technologies are already on the horizon to take their place. All of these great ideas must be introduced with safety as the top priority to ensure that the airline industry can continue to improve upon the impressive safety record that we have worked together to attain. This level of safety was not created by luck, but by hard work to ensure that current operations are safely performed and that new operations can be safely integrated with those already in place. To maintain and improve this level of safety, we must ensure that this hard work continues and make investments now in our workforce so that we have the people with the skill, expertise and passion to ensure that the future public can be as confident in our aviation system as we are today.

Thank you for the opportunity to participate in this important discussion today.

Mr. LARSEN. Thank you, Captain, very much for your testimony and your service to the flying public.

Mr. DEPETE. Thank you.

Mr. LARSEN. I want to now recognize Members for Member questions. Each Member will be recognized for 5 minutes. I will start with myself, and I will start with Mr. McBride.

I do want to correct your testimony. Your business traveler in your example would have flown from Arlington, Virginia, to Seattle, and she would have stayed and had her family then fly out to meet her, and they would have stayed and not flown back here.

[Laughter.]

Mr. LARSEN. So if you fix that, I think we will be all right.

Now, in your written testimony you state that UAS will be fully integrated in the airspace in 2050. In your view, and NASA's view, looking at your research, what is the first and most important step to make that happen?

Mr. MCBRIDE. Well, the things we are working on with the UAS and the NAS activity. NASA has been involved with integration of unmanned aircraft for the past 20 years. The latest effort is UAS and the NAS.

The key technologies that we are working on is detect and avoid to assure the piloting community and the FAA that UAS can detect and avoid autonomously, or with equal acuity as a human pilot, other aircraft in flight.

Mr. LARSEN. So in airplanes now there is—we call it detect and warn, I suppose, detect and warn the pilot. How advanced are we in the detect-and-avoid technology deployment?

Mr. MCBRIDE. The detect-and-avoid technology has come along well, good sensors on board with both cooperating and noncooperating aircraft. The cooperating aircraft would be aircraft with transponders or—broadcasting their location, but also with noncooperating flying vehicles, from balloons to simple GA airplanes that may not have a transponder on board.

So making good progress. We did have a good demonstration this past summer at No Chase COA with our MQ–9 Ikhana aircraft, and that activity was recognized with an Aviation Week Laureate award this past week.

Mr. LARSEN. Ms. Cooper, you were on the Remote Identification Aviation Rulemaking Committee in 2017 for the FAA. Why do you think it has taken so long for the FAA to get that rulemaking in place?

Ms. COOPER. Thank you for your question, Chairman Larsen. I can't speak for the FAA, so I am also wondering why it is taking so long, since industry as a whole provided great recommendations on how to roll out remote identification.

I understand there are security agencies that also need to take a look and weigh in on the rule. I am hoping that this committee can help us, you know, unlock the rulemaking for remote ID so we can move forward.

Mr. LARSEN. So explain to the Members what moving forward means. Why is remote ID, a remote ID rule, needed?

Ms. COOPER. Thank you for your question. A couple of years ago the FAA was ready to put out a proposed rule for operations over people, and it was clawed back due to security agency concerns.

The concept was today we understand if we see a drone flying over a crowd it is generally—we understand it is illegal, so we know that that is a threat we need to take action against. But if everyone is generally allowed to fly, under a rule, over people on a regular basis it will be very difficult to discern a friendly drone—you know, say, operated by a news agency—versus a rogue drone looking to do some harm.

And so the idea is let's implement remote identification requirement across the board with UAS operators, so that law enforcement can easily identify through the electronic license plate who is operating in the airspace, and to understand if they are a threat or not.

Mr. LARSEN. Well, thank you. We will look—I think we ought to look further into that.

Mr. Dourado, what is different about Overture, compared to SST? What has changed in 30 years in the technology to make this project more of a reality?

Use your microphone, please.

Mr. DOURADO. Thank you, Mr. Chairman. I think there has basically been three major advances that make now the right time.

So one is computational methods for design. So hard to believe, but Concorde was designed on paper, with slide rules. And it is a remarkable achievement, we have discovered. We continue to be impressed with what the engineers of that era were able to accomplish in designing a Mach-2.0 airliner with Concorde.

With computational methods, we can do sort of a virtual wind tunnel test daily, you know, run several in parallel. Whereas these

wind tunnel tests took, you know, 6 months of time and several million dollars for Concorde to do. So we can iterate more quickly, and improve the aerodynamics.

Another huge advance is improvements in materials. So Concorde was designed out of aluminum. Aluminum is very expensive to tool in a way that has the flowing shapes that our aerodynamics require. And it also does not hold—the thermal stability is not as high. So Concorde actually would grow over a foot in length over the course of each flight, and then shrink as it cooled off.

And then the third major advance is in propulsion technology. So jet engines get better at a rate of about one-half of 1 percent to 1 percent every year, which, over 50 years, is, you know, a nontrivial improvement in fuel efficiency and so on. So, whereas Concorde flew with four turbojet engines with afterburners, we are down to three engines with modern turbo fans and no afterburners. So it is much more fuel efficient, it is quieter, and it pollutes a lot less.

So it is just huge advances applying the subsonic improvements of the last 50 years to a supersonic design. And we look forward to innovating in the future with supersonic-specific technologies. But none of those are needed for the first model.

Mr. LARSEN. All right, thank you. I have further questions, but in fairness to the committee members I will move to Mr. Graves of Louisiana for 5 minutes of questions.

Mr. GRAVES OF LOUISIANA. Thank you. I want to thank you all again for being here and for your testimony. And I want to reiterate it is very exciting to be able to think forward and be able to plan for what we need to be doing now to prevent Government from becoming an obstacle or impediment, but rather a partner with you in your innovation efforts.

I want to ask each of you just to simply answer the question. What do you see as being either the biggest opportunity or the biggest impediment for Government to step in and to help facilitate innovation, to help facilitate some of the technologies that particularly the three of you in the middle are working on right now? I am curious. Your response?

Mr. MCBRIDE. So I think the biggest opportunity we have covers all three aspects that we impart here today, advancements in supersonic aircraft that will open up the high end of the market; improvements in subsonic aircraft which will greatly improve the efficiency of today's aircraft, although the picture you presented, Mr. Graves, from 1988 shows a great improvement from then to today. There is still room for aircraft efficiency, maybe on the order of 50 percent improvement yet by this 2050 goal. And then integration of unmanned aircraft. That is a market that 5 or 10 years ago we didn't see expanding and exploding as it is now, with urban air mobility, and the ability to transport packages and people and sensors.

So all three aspects are ripe for commercialization and further market improvement.

Ms. COOPER. Thank you for your question. Unmanned traffic management is the biggest opportunity for our industry and for our—many of the vehicles represented at this table to be able to share the same airspace safely.

UTM is a concept borne out of NASA's work at Ames, and many industry players, including our company, have already developed commercial aspects of UTM technology.

Congress also directed the FAA in the Reauthorization Act to figure out a process for rolling out early phases of UTM in low-risk areas, so thank you very much for your support with that provision. And we look forward to the FAA rolling that out.

Mr. DOURADO. For supersonics I think the two opportunities are for FAA to continue the two rulemakings that they have underway that were in the FAA reauthorization bill. So one is to create noise standards for takeoff and landing. No airplane can be certified without a noise standard, and none exists for supersonic airplanes. So FAA is working to put a standard in place.

And the other is to clarify the testing rules for supersonic aircraft over the United States. It is illegal to operate supersonically without a special authorization. And the way that you get that, or how that is going to work affects our ability to test aircraft and to do certification testing and production flight testing.

Mr. GRAVES OF LOUISIANA. And, of course, NASA is working on technology right now that would believe to help—and I guess building an aircraft—to help demonstrate a technology where you are reducing the sound.

Mr. Allison?

Mr. ALLISON. Yes, thank you for the question. I think in general, we all work in this very highly regulated industry. And it is going to remain that way, and it needs to remain that way to ensure the safety of operations that we all care deeply about every time we fly on an airliner.

But I think that what we need from regulators is clarity of pathway, which I think is very—is, essentially, what we have all been saying here, that we need to have clarity on the rules that manufacturers and operators in these new fields, and in these new types of technologies that we are working on, so that they can innovate. Because setting the fences—you know, clearly defining the fences and allowing the innovators to innovate within those boundaries is the best way to unlock the speed of innovation that we all want to see.

And in urban air mobility, in particular, I think what we see the FAA doing a good job at is starting to define this pathway for certification of the vehicles. And then how does the operations come in, as well, because what we are talking about is a different type of vehicle and different type of operations from the way that the rules have kind of grown to be, based on the technology that existed when they were written.

And so we have to see that continued progression toward clarity of the rules, so that the manufacturers and the operators can innovate within those——

Mr. GRAVES OF LOUISIANA. Thank you.

Mr. DEPETE. Thank you, Representative Graves. I think the biggest opportunity is the success that led us to the safest period of time in aviation history—was through collaboration and leadership.

I have never—pardon me while I fall back to my Marine Corps days, but I haven't seen a situation that either couldn't be solved or better managed through good leadership. And we have got that.

And, in fact, I think I owe everybody in this room a debt of gratitude, because this latest FAA reauthorization was just a fantastic achievement. And closing the gap with the hobbyists was a fantastic move. You made it safer for everyone that flies.

Having said that, I think some of the biggest challenges would be a steady stream of reliable income for the Government to stay open. Closing down Government, to have a 5-year FAA Reauthorization Act, and to have so many good plans and good ideas, and go through the starting and stopping, I just don't see how we can achieve our goals efficiently in that manner. So——

Mr. GRAVES OF LOUISIANA. Thank you.

Mr. LARSEN. Thank you. I recognize Representative Lipinski of Illinois for 5 minutes.

Mr. LIPINSKI. Thank you, Mr. Chairman. I thank all the witnesses for testifying today. It is fascinating to think about what the possibilities are that are available, and more than, I think, most people know is already possible.

I wanted to ask Mr. McBride a little bit more about the—if you could, expand on the types of testing that NASA and the FAA are doing with regard to UTM, and how this is going to change as we go forward. There is, you know—is it—I assume it is simulation-based testing right now. And what about moving to real-world testing, as this progresses, so that we actually know that it is going to all work when it gets going?

Mr. MCBRIDE. It is simulation-based testing, but also integrating actual UAS or UAV flight tests, and surrogates in flight test. We are doing a virtual airspace test for a weekend, fly over restricted airspace at Edwards Air Force Base, but overlay that data real-time with real traffic in busy FAA traffic sectors. So we are flying UAVs in restricted airspace with no traffic around it, but the FAA controllers are seeing that flight overlaid on top of actual busy traffic.

We are taking that also to flying our UAVs in busy traffic corridors. Again, I mentioned this past summer we did the UAS, the NAS No Chase COA, where we flew through the Central Valley of California in and amongst air traffic, and air traffic controllers saw and spoke to the aircraft, as if it were a manned aircraft.

So we are doing both virtual and simulated, and overlaying both of those together to mimic the real airspace.

Mr. LIPINSKI. And how do you envision the certification working for the new unmanned systems?

Mr. MCBRIDE. NASA is working together with the FAA to develop minimum operating procedures and standards to develop those basic rules.

The original starting point for FAA is with a manned pilot with detect-and-avoid, as a human eye could detect and avoid and maneuver to avoid other aircraft or terrain. And so NASA is developing, along with FAA and our partners at DHS and DoD, standards that will enable a baseline for that, minimum operations standards the industry could then manufacture or design to.

Mr. LIPINSKI. And I wanted to ask Mr. Allison. You know, right now we have a robust network of businesses that support aircraft operations, companies that provide ground handling, fueling, main-

tenance, passenger accommodations. How do you see all this changing?

Mr. ALLISON. Thank you for the question. We have taken a very partnership-forward approach in everything we have done with Elevate. And so we actually look forward to partnering with many of the companies that do various different types of operations right now in the current types of typical commercial operations, as we develop the Elevate network of air taxis going forward.

So we think there are great opportunities to both expand businesses and create new businesses around these types of electric aircraft, which will have some new and unique types of maintenance and operational considerations, but an opportunity to expand existing offerings to partner with us to bring this to the world.

Mr. LIPINSKI. And where do you envision this—the maintenance and all the other ground operations happening? At airports as they exist now, or do you envision something else?

Mr. ALLISON. So we envision a network of relatively short-range, all-electric aircraft. So our mission specification that we have derived from very extensive simulations that we do of existing traffic patterns in cities suggests that an aircraft with a range of something like 60 miles, max range of 60 miles plus a reserve after that, will then operate within the network, kind of in an average trip length of about 25 to 30 miles. And so they are relatively short-range things.

And so what we have to do is have, essentially, maintenance depots and hubs on the outskirts of the areas where we will be operating, where there will be the—kind of the ongoing types of maintenance that we hope is actually dramatically less than typical aircraft today, because, with all-electric aircraft, just as with all-electric cars, the maintenance requirements are much, much lower, because the mechanicals are just vastly simplified in these vehicles.

Mr. LIPINSKI. All right. Thank you very much. I yield back.

Mr. LARSEN. Thank you, Mr. Lipinski.

Before we move on I just want to remind people we are calling folks in the order of seniority at which you were here at the gavel. Then if you were here after the gavel, then you are put on the list in the order that you were here. So it may seem a little random, but it is—there is a method to the calling of folks.

Before calling on Representative Spano from Florida, just a headsup that Mr. Allred from Texas will be the next Democrat called upon.

But for 5 minutes, Mr. Spano from Florida.

Mr. SPANO. Thank you, Mr. Chairman, and thank you for putting together this meeting together—very, very informative. And thank you all for your input today. I am very grateful for it.

One of the things that we talk about a lot—and it is true, but we discuss it a lot—is the importance of having people who are able and willing and knowledgeable to serve in the economy, as we are moving forward, right?

And so one of the big things—if we are expecting the aviation industry to boom, like we hope it will, and expect it will, we are, obviously, going to have to have people, young people now, that are getting educated, that are excited, that are motivated to get into

the industry. So I would love to hear what your various opinions are, if you can answer just briefly for me, each one of you.

What is it that we can do to encourage this next generation of people that are going to be working in the aerospace industry?

Mr. MCBRIDE. Well, one thing we do is provide interesting and exciting technology for young people to work on. I started my career with NASA in 1982, as an intern, as a cooperative education student. And that helped me get through college and become an engineer. I think what we can do is continue that path, and keep providing exciting work in the work we heard described here at the table today. It certainly merits and would bring on that next generation of students.

Ms. COOPER. Thank you for your question. Drones provide a perfect entry point for the youth to get engaged in aviation. The low cost and ease of use of the technology, it is being spread through STEM programs across high schools across the country, and it is bringing new life into the aviation space.

So, you know, I think one thing we can do is keep that in mind, that often the youth are engaging from a hobbyist perspective, and then they will grow to be aviators as a career. We need to keep that in mind when we are looking at rules that regulate the very young novel users of this technology.

Mr. DOURADO. I want to echo what Mr. McBride said, that it is, I think, really about inspiring people by the amazing things that we can do as an aerospace industry. I think right now, when young people look into what career they want to do, they don't want to spend their whole career as an aerospace engineer designing a slight tweak to a winglet on a subsonic airliner. That does not spark joy.

And I think if we can show that aerospace really can change lives and can develop rapidly and can be an exciting field to work in, that is how you get people into those fields.

Mr. ALLISON. I want to agree with everything he said. I—thank you for the question. I think it is really, really, important to think about this. How do we inspire the next generation of both leaders and engineers that will be creating this?

I remember back when I was a young child and the first space shuttle was launched, and I remember the National Geographic magazine that had the picture of that on the cover. And I think that probably was pretty formative, in terms of the way I thought about things that I wanted to do.

And I think that that is why we have placed a pretty heavy emphasis on telling the story of what we are doing pretty early on, and being pretty public about that, and really trying to lean into that, because we think it is really, really important to inspire the community, the ecosystem of companies that have to exist, but also of dreamers that have to exist to then be participating in this to bring the next generation to bear to create these amazing technologies.

Thank you.

Mr. DEPETE. Thanks for the question. This is a particular area where I feel like ALPA really, truly shines. We have been involved in the effort for a really, really long time. In fact, our top three strategic plan priorities at the Air Line Pilots Association is safety

and security, pilot representation, and then the future of the profession.

Last year alone we visited over 15,000 secondary and primary education universities around the country. And, in fact, a week from now I will be at Embry-Riddle Aeronautical University to do the same, to inspire youth. We are also heavily invested in promoting STEM programs.

And so every step of the way we are trying to build a future and a pipeline for new pilots to come into the programs.

But importantly, all those other factors I talked about, the safety and the representation end, to maintain a viable profession that people would want to come. I mean love of flying is great, it is what truly inspires us all. But you have to have a viable career along with it all. So it is a package.

Mr. SPANO. Yes. Thank you.

Mr. DEPETE. Thank you.

Mr. SPANO. Mr. Chairman, I yield back.

Mr. LARSEN. Thank you.

Mr. Dourado, five points for the first pop culture reference for the day, minus five for your choice.

[Laughter.]

Mr. LARSEN. I recognize Mr. Allred for 5 minutes.

Mr. ALLRED. Thank you, Mr. Chairman, and thank you to all the witnesses for being here today.

Mr. Allison, I will largely be directing my questions to you, because I represent Dallas and the northern suburbs of Dallas. And we are one of the fastest-growing cities in the country, and we are grappling with the traffic congestion problems that come along with that growth, and our growth is not going anywhere, right?

And we also have, I think, a rich history of aviation. We have a number of great aviation companies and transit hubs in our area. And so, you know, I am extremely excited about your pilot project in Dallas.

But while the idea of hopping on an air taxi and being able to leave all of that congestion behind sounds great, we obviously have to address some of the hurdles and safety issues that might come up as part of that. And I want to talk to you a little bit about that.

Uber Elevate has plans to begin flight tests in Dallas next year, with commercial operations beginning in 2023. In addition to pilots, what types of jobs will these commercial operations bring to my area?

Mr. ALLISON. Great. Thank you for the question. Yes, we intend to, working in conjunction with our partners, who are actually building the vehicles, start demonstration flights to be able to demonstrate to the communities we are working in, like the Dallas metroplex, the value proposition, essentially, the quietness, and kind of helping people to understand where the technology is going. That is really why we are leaning into doing this as early as we can. We won't do it any earlier than it makes sense to do it safely.

And we think that, by moving expeditiously through the certification process, it is possible to get to certified commercial operations by 2023. But obviously, that depends on the regulators and the companies that are working with the regulators to kind of move through that process in the right way. We can't start operating

things until they are certified, and we won't start operating them until we are sure that they are safe and meet the standards that we think are necessary to operate this type of a network.

So there will be lots of different types of jobs that will be created in this type of a service, everything from pilots—because we believe that these vehicles will be piloted in the initial iteration of this type of a service.

We think in the long arc—when you are thinking 2050, we think that there is this long-term trend toward autonomous operations, especially for smaller vehicles. It makes a lot of sense. But we think that there is every reason to start with pilots in these vehicles to get going quickly and operate as safely as possible in the near term with them.

And then there is all the support services. So there is both engineering, there is the maintenance repair and overhaul, if we are able to develop the network in the way that we think the demand will push it from our simulations. There will be demand for many, many, many aircraft in this type of a network over each of the cities in which we operate.

And so there is all the corresponding jobs that come with that, in terms of the maintenance types of jobs, in terms of just operations. So there would be some number of operators in each of the sky ports in which we operate from that will be very interesting jobs. And these are all very localized jobs, too, so it is not like you have to go far from home on a daily basis to work in this type of a network. And so that is our vision for it.

Mr. ALLRED. As part of that, how are you planning to work with the city of Dallas on building the infrastructure necessary to service this—service you are offering to provide, and with other cities, as well? Because, obviously, cities plan long term, and they need to have some kind of ability to plan for this. And if we are going to really integrate this, how is Uber planning to work with cities on that?

Mr. ALLISON. Thank you for the question. So we are trying to work pretty tightly, coupled with the cities, all the different cities in the Dallas metroplex that we are talking to, including not just Dallas, but Fort Worth and Frisco and others.

What we are trying to do is make sure that we give them early insight into what we are thinking. But we are also partnering with private companies, real estate companies, on the sky port.

One of the nice things about this type of a network, vertical takeoff and landing aircraft, is that the infrastructure requirements are quite small compared to what you think if you wanted to put in a new road network, for example. It is a really interesting characteristic of these types of vehicles and networks that they scale by the nodes, essentially. And so you actually put in another—one more sky port, and you get connectivity to all the other sky ports, which scales much better than roads by the mile, from a cost perspective.

So we are working with private real estate developers to, basically, develop in a partnership model these types of sky port infrastructure that we need, and keeping the city apprised of what we are doing.

Mr. ALLRED. Well, thank you, Mr. Allison. My time has almost expired.

You know, obviously, I have some safety concerns, as well, that I might be reaching out to you about. And if you could submit some written testimony on that, as well, that would be great.

I yield back, Mr. Chairman.

Mr. LARSEN. Thank you, Mr. Allred. I now turn to Representative Stauber of Minnesota. And after that Mr. Payne will be the next Democrat. Mr. Stauber for 5 minutes.

Mr. STAUBER. Thank you, Mr. Chair and Ranking Member Graves.

I graduated in 1984, and one of my bucket lists was to become a private pilot. I can share with you that I am in 43 hours of the Cirrus SR20 and SR22. This congressional run and my current occupation here, serving the public, has stalled my training. But I can say the last flight my instructor says, "You are ready for solo," and I am not there yet. So I have been interrupted.

I would also share with you—you talk about the pilot shortage, and what have you. One of my boys is a senior in high school. And on March 22nd we will be going to the aviation career expo at Lake Superior College in Duluth, Minnesota, a very well-respected college that teaches pilots to fly, and gets them interested in aviation culture.

You know, something that I really want to detail—the NOTAM system. And this is for Captain DePete, primarily. We know that in 2017 in San Francisco the Air Canada bus nearly landed on a crowded taxiway, and they mistook it for a cleared runway. Information about that runway closure could have prevented that. The information was located on page 8 of the 27-page list of the San Francisco Airport NOTAMs. NOTAMs also frequently state there are birds in the area, what have you. We don't know what type of birds, if they are on the runway, in the air, or nearby.

So, Captain DePete, can you please discuss some of the issues with the current state of the NOTAM systems, and the concerns you have?

Mr. DEPETE. Yes, sir. And thank you for that question. I shared those same concerns for many, many years during my 40 years of flying. I haven't seen very many improvements.

In fact, I was really delighted when I heard the Chairman of the NTSB mention the problem. I have seen and heard of various efforts underway to streamline it. We have not—and my airline, the technology is such that I can use an iPad that will actually decipher that. But it is still buried, there are still too many.

You think about the expectation. You are showing up for a flight maybe an hour before, and especially if you are flying international, and you are literally presented with a paper stack about that tall, about that thick [indicating]. And you have to weed through that to see what is relevant and what isn't. And it is almost—I mean you really have to—you would have to show up—and we do, we do whatever it takes to make it safe.

But I share your concern with that, and we are actively working to try to fix that. We have got folks that are working in the—we have the largest, nongovernmental safety organization in the world. We are working with the FAA to somehow fix that.

But again, you know, this really comes down to the funding issue again. You know, the FAA is—there is so much coming at them from so many different angles, you know, between UAS and commercial space. And we are all a part of that effort. But a steady, reliable source of funding would be a step in the right direction.

So thank you for the question.

Mr. STAUBER. Thank you, Captain, for that answer. And as Ranking Member Graves talks about, aviation is an extremely safe way to travel. And we can—we are going to make it safer. And I appreciate you talking about the funding, because that is why—that is what we are meeting for today.

So, Captain DePete, I will say this, that I am introducing a bill to form a task force to address these concerns with the NOTAMs, and I hope you will take part in it. And I think that is one of a number of additional safety items we can bring to the pilots and the culture in aviation. And I hope you will support that.

Mr. DEPETE. Absolutely. Thank you very much.

Mr. STAUBER. Mr. Chairman, I yield back.

Mr. LARSEN. Thank you. Before recognizing Mr. Payne for 5 minutes, just a headsup for Mr. Perry, who will be the next Republican. Mr. Payne is recognized for 5 minutes.

Mr. PAYNE. Thank you, Mr. Chairman.

Ms. Cooper, Newark Liberty International Airport is in my congressional district. And on January 22nd, 2019, air traffic was suspended at Newark due to a drone sighting. Over 40 flights were held at the gate, while dozens of other planes were left circling, including a United Airlines flight from Jamaica just minutes away from running out of fuel.

In addition to being on this subcommittee, I am also a member of the Homeland Security Committee, and I am very concerned about the use of drones for the wrong reasons, reasons such as terrorist attacks, or to cause air traffic disruptions like we experienced in Newark.

Do you have any insight or suggestions about countermeasures that would be useful for the FAA to look into so that Newark and other airports across America can defend against terrorist attacks or other nefarious drone attacks?

Ms. COOPER. Thank you for your question. There are a couple of aspects to your question. So there are the careless and the clueless operators, and then the criminal and terrorist operators, and we deal with them separately.

In terms of the careless and clueless operators, educational initiatives similar to the Before You Fly campaign will help get us there. Remote identification, once that is in place and—implemented in a lot of the drones, already currently, but once the mandate is in place, that is going to go a long way to help with enforcement and additional education and compliance activities.

Our company provides a LATAS software solution. That is integrated into about 80 percent of the drones flying commercially and as hobbyist drones in the United States. And that geofencing solution actually marks where the airports are, as well as critical infrastructure, prisons, places that are too sensitive for people to fly, generally, without special permission. And so that technology is al-

ready available today, and industry has been helping things move forward to help prevent these types of incidents from occurring.

In terms of the criminal activities, we are going to need countermeasures in place, and Congress has acted to extend those authorities to a couple of agencies in their Reauthorization Act.

Mr. PAYNE. OK. And you mentioned the importance of remote identification in your testimony. Can you discuss the role that remote identification could play in stopping the use of drones for the wrong reasons, such as terrorist attacks causing air traffic disruptions, or illegal actions like smuggling narcotics?

Ms. COOPER. So remote identification is already implemented in a lot of the drones available today. However, there is not a legal mandate for operators to comply. Remote ID will help solve the needle-in-the-haystack problems. So currently you can't tell who is a friend versus a foe when you see a drone flying. So this will help with enforcing local laws, as well as Federal laws that are already in place that are technology-neutral.

Mr. PAYNE. Well, thank you, and, Mr. Chairman, I will yield back.

Mr. LARSEN. Thank you. Before we recognize Mr. Perry, just a heads up for Representative Davids from Kansas will be the next Democrat. Mr. Perry for 5 minutes.

Mr. PERRY. Thank you, Mr. Chairman, and thank the panel for taking the time to travel and be here. My questions specifically go to Ms. Cooper.

The FAA recently published their ANPRM regarding—I think it is overflight of people and safety and security. I am just interested in your views on the proposed rulemaking.

In particular, the FAA is asking questions on how an unmanned traffic management system should be implemented while NASA is completing its R&D work, and the FAA is in the midst of a congressionally mandated pilot, UTM pilot program, to answer some of these questions.

I am just wondering if—look, I am glad the FAA is moving forward, we all are. And we are very interested in seeing them complete a product. But I am wondering if this is—if you feel this might be premature, if they are on track.

Ms. COOPER. Thank you very much for your question, Congressman. During the Federal shutdown, as you noted, the FAA released two draft rules for operations over people and safe and secure operations. We are still working through what was provided in those draft rules.

In terms of operations over people, we believe that the kinetic energy limitations that were identified are a little bit too conservative and restrictive, and are perhaps not in line with the recent research that ASSURE completed on kinetic energy. So we would like to see that framework become a little bit more flexible, and to also see alternative means of compliance with a rule, once it is implemented.

In terms of safe and secure operations, there are various provisions in there. UTM is one of them. I think it is too early to be asking for a public comment on UTM, since UTM has already been implemented in stages, and there are various research programs looking at UTM currently that will help inform the draft rule.

So I think it is too early to ask for public comment at this stage, while industry and NASA and FAA are working on UTM implementation. Once we get to an actual proposed rule, then that would be the time for public comment. Thank you.

Mr. PERRY. All right, thank you for that.

And further, I think it has been since 2016 since the first regulations were issued. I think most of this is contingent—I think you already had a discussion with Mr. Payne about implementing remote ID.

Do you know what the—from your vantage point, what is your feeling on—what is the holdup on remote ID requirement, and that rule? What do you think the holdup is?

Ms. COOPER. Again, I can't speak for the FAA or for any other agencies. From my perspective, there seems to have been a disconnect in the discussions between the various agencies that need to work to get this rule implemented. And it has been difficult for industry to find out who actually holds the pen currently and who is the decisionmaker that will help put the rule out finally.

Mr. PERRY. So—and I am not going to try and put words in your mouth. And I am not asking you to speak on behalf of agencies. But I am interested in your opinion. So it sounds like it is not a technology issue.

Ms. COOPER. Absolutely not.

Mr. PERRY. It is not a technology issue. Right? It——

Ms. COOPER. The technology is already available commercially today.

Mr. PERRY. Right, right. And you even spoke about the software that your company offers. Probably there is a myriad of options there. But it is an issue of coordination and who wants to take the lead. Is that——

Ms. COOPER. That appears to be—that is my best guess.

Mr. PERRY. Is there any—I mean who else would take the lead, if not the FAA? Would it be homeland? Who else would take the lead?

Ms. COOPER. The security agencies are the reason why the rule needed to be drafted in the first place. And in the Reauthorization Act, Congress did direct DHS to identify a point person for UAS industry to work with on these types of issues.

Mr. PERRY. They—and I was there on the Committee on Homeland Security, when we did that, to work with the agency when they developed the issues. But it seems to me it is in the purview of the FAA. But if I am wrong, and if the industry thinks that that is not correct—that is what I am looking for, is your perception. Is the FAA, in the industry's perception, from your vantage point, the agency to take the lead on remote identification for UTM and UAS operations?

Ms. COOPER. Absolutely. The FAA held their rulemaking committee, and they would be the correct agency to move forward. Thank you.

Mr. PERRY. Thank you, and I yield.

Mr. LARSEN. Thank you. I recognize Representative Davids for 5 minutes.

Ms. DAVIDS. Thank you, Mr. Chairman. So I am actually going to start off with Mr. McBride and Dr. Dourado.

I am from a district in Kansas that—we—you know, we certainly have a lot of high-skilled, high-tech aerospace folks there. And we are building strong pipelines of students. And we have—in fact, at the Shawnee Mission School District I got a chance this year to see some of the students in action. But we have got a career and technical education pathways cluster at that school, and it allows students to start studying aerospace engineering before they head off to college.

And I heard earlier the Concorde, you know, being designed kind of pre-CAD and there were engineers designing this stuff before we had the technology that we have now. And so I wonder if both of you or either of you can talk to me about what should I talk to the students about. You know, what is the future going to look like in 2050? And what are the things that we can talk to our students about to get them excited and engaged in this?

Mr. MCBRIDE. One of the things to talk with the students about in aerospace and to get them engaged—that there is a bright future, and that aerospace, although it is—there is a lot of mature technology in there, mature aircraft for flying, there is a lot of opportunities for innovation yet.

The supersonic aircraft that Mr. Dourado's company is building and developing, and the X–59, are two examples of two different types of supersonic aircraft. The X–59's purpose is to validate NASA's understanding of supersonic sonic boom weight mitigation, and the physics of the sonic boom as it travels through the air. And it is really an experiment, testing people on the ground and their acceptance and ability to tolerate sonic booms in overland flight.

But for students, the message is—in aerospace is there is yet a lot of technology to be developed in supersonic, subsonic, and unmanned aircraft, as well.

Mr. DOURADO. And I agree with that, and I would say there is basically two things.

Talking to students, you can appeal to the benefits to humanity that come from enabling this travel. And I think it is remarkable that you can experience—enable people to experience different cultures. You can enable policymakers from different countries to get in the same room. You can start new businesses that employ people in other countries, and domestically.

So I think there is a huge benefit to improving human lives. And I think the other angle is that this is going to be a growing industry, in our view. As I testified, as speed increases people are going to fly more often. That means more planes, more operations, more everything. And so we really see aviation becoming a much bigger part of people's lives in the next 20, 30 years than it is today, even. So I think this is a very good career path to go down.

Ms. DAVIDS. That is great. And so I am really excited to hear that.

And then, Mr. Allison, as a company that I think probably plans on being a place for the young people coming out of my district and a lot of our districts, you know, you mentioned the number of jobs, and how many—the variety of jobs.

One of the reasons our aviation space is so safe is because we have folks like air traffic controllers, the pilots, the flight attendants, who all are, one, treated very well because they have unions

that help advocate for their safety and public safety. I am curious how you envision and what should I tell the students about the prospects for their jobs in the future when we have, you know, folks like Elevate out there, you know, providing these kind of jobs.

Mr. ALLISON. Thank you for the question. I think I echo the comments that have been made already, that there is just incredible potential here, and we are just scratching the surface of it, that there is just so much innovation that is yet to be done to create whole new sectors of the economy, essentially, that aviation will play an incredibly important role in.

And I think that there are many different business models that have yet to be explored. As we get, you know, in the next few years, that we will start to explore, that others will start to explore when these services become closer to launching in a commercial way.

But I think that—but, like all aviation jobs, the demand will be huge. And so there is going to be incredible potential for the types of work that different young people will want to do in the different sectors that I was mentioning before.

Ms. DAVIDS. Thank you. I yield back.

Mr. LARSEN. Thank you. I recognize Representative Balderson for 5 minutes.

Mr. BALDERSON. Thank you, Mr. Chairman. My question is going to Mr. DePete.

And everybody has kind of gone around this as I have been sitting here listening, regarding the importance of jobs and the lack of availability that is out there in people that are coming up. But what would you say?

I mean we have an expected, you know, need of 790,000 pilots by 2037. What is there for Congress to do to address this issue?

And I, myself, got in a flight simulator. And I want to be a pilot tomorrow, because my experience with it was just phenomenal. So what can we do, as Congress, to encourage some of the things that get people motivated and interested in this?

Mr. DEPETE. Well, I think, like I had mentioned earlier—thank you for the question, by the way. Maintaining a viable career is really a key component in attracting people into this profession. You know, we have worked very hard and diligently over the years to build the type of career that people would want to actually come to, they could actually raise their families, have viable jobs, be productive members of the community. And you know, right now we feel like we have a really good, safe system right now to attract people in.

But I think you have to really look at the fact that right now, as it exists, an OMB study, that there are twice as many airline transport rating pilots out there than available jobs today. So the question would become why aren't they coming forward, right?

And so they—you know, there have been improvements over the years, the last several years. So I think if Congress focuses on that to understand viability, and looked at the threats to our industry, as well—I mean if you asked me what I thought one of the biggest threats to the industry is, and to this profession, it is unfair foreign competition, you know, through the likes of, you know, subsidized airlines and also atypical employment models. Because all the won-

derful things that you worked so hard on to put in FAA reauthorization will be meaningless.

So that is a really—you know, setting—making a fertile ground to grow this industry is extremely important for Americans and American workers. So thank you.

Mr. BALDERSON. Thank you for answering that. And part of my followup is what you just went into. Regarding that, what technologies can we do to get our students interested in this career, or aviation, or having those cargo pilots move forward to the next level?

Mr. DEPETE. Absolutely, I—you know, and that is why we are so heavily invested in our future of the profession initiatives.

STEM programs, if you could support those—in fact, recently, several weeks ago, I met with Secretary Chao. And she is a very strong proponent of those programs. And building the pathways through a good educational system, accessible to all, is a clear win. So——

Mr. BALDERSON. OK, thank you very much.

Mr. Chairman, I yield back my remaining time.

Mr. LARSEN. Thank you, Representative Balderson. Representative Craig of Minnesota is recognized for 5 minutes.

Mrs. CRAIG. Thank you so much, Mr. Chairman.

Captain DePete, I just wanted to say hello to you. My district is home to over 1,000 Delta pilots. I am sure a few other airlines live there, as well. And they are proud to call Minnesota home.

Mr. DEPETE. Great.

Mrs. CRAIG. In your testimony you stated that in a future with autonomous flight there will be no pilot in command of various forms of aircraft. Can you talk a little bit this morning about how you think the role of pilots will shift in the coming decades? And what skills do you see in the future that will be necessary?

Mr. DEPETE. Thank you for the question. Yes, you know, I have been flying for 40 years, and I have seen the introduction of technologies that are assistive and work, and other ones that, quite honestly, are just burdensome and we have to work around. The level of artificial intelligence capability to equate to a human in a cockpit is, in my view, that is a pretty far reach.

I said earlier also in my testimony that the most important safety feature on any aircraft is two—a minimum of two, just for redundancy purposes, right—well-trained, well-experienced, well-rested flight crewmembers. I can give you an example.

You know, there is—if this was [indicating]—an envelope, you know—our acceptable level of risk that we fly in, we like to be at the top of the envelope, at the middle of the envelope. We don't like when we get to the bottom. But, you know what? Sometimes we find ourselves—think about, you know, out of the envelope, and think about Sully Sullenberger, what happened there. We are trained to deal with those kinds of situations.

So I think, as we envision this brave new world of autonomous flight, I think it is going to require also a level—and you mentioned Delta, so let me, if I could, just for a minute—there was a flight 86 in December of 2017. An engine failure had them land in Cold Bay, Alaska, with life-threatening freezing conditions. They had almost 300 people on board an airplane.

The town that they landed in on this World War II-era runway had six parkers. The one restaurant in the community was closed for the season. There were few townspeople. There was—you couldn't even get all the people off the airplane, so they had to separate the people from one building to another building, and then some on the airplane. The three flight crewmembers went out and bought frozen food at a supermarket and started to cook for the people on the plane, and the people in those other buildings.

What I am saying here is: autonomous? I would say that that emergency began the minute they hit the ground, it continued. And, you know, think about the level of infrastructure that would be necessary to sustain that model, to really build—to make that model truly what we are—you know, we talk about we are as safe as 10 to the minus 9, right? You know, 1 billionth.

And so we have the safest system, and it has been made through leadership, collaboration. And what I would like to see, in terms of—you know, particularly in drones and the new technologies, is a little—it needs to be a multistakeholder approach, because we all share this airspace, right?

And so if we could continue, we have the secret sauce, we know how to do this right. We are a perfect example of how to make it work, so—but thank you for that.

Mrs. CRAIG. Thank you so much.

Mr. DEPETE. Yes, I appreciate that.

Mrs. CRAIG. I want to follow up with a question that isn't related to today, but certainly related to the sentiment, and that is safety.

We are seeing this morning that the 737 MAX 8 fleet is being grounded in other countries. Do your flight—do your pilots feel safe right now flying that airplane?

Mr. DEPETE. Here in the U.S. they have been—FAA has been extremely proactive. And, you know, I am always reticent to want to comment on any, you know, investigation that is currently underway, because we really don't have the facts of the recent Ethiopian accident right now.

And, you know, as tough as it is—and it is terrible. I mean my heart goes out to all the families of the passengers and the crew. But we have to really avoid speculation at this point. But in general, answering your question, you know, we were—ALPA was very proactive, and so was the FAA, and so was Boeing, for that matter, to provide our crews here, which are highly trained crewmembers with minimum standards that don't necessarily truly exist in the rest—parts of the world, that gave us a methodology by which to deal with that safety of that airplane.

Now, things are changing really rapidly. I wouldn't be surprised if when we are done with this hearing, that there could be more news. So——

Mrs. CRAIG. I appreciate your response to that. Thank you.

Mr. DEPETE. Thank you.

Mrs. CRAIG. Mr. Chairman, I yield back the remainder of my time.

Mr. LARSEN. Thank you. I recognize Representative Smucker of Pennsylvania for 5 minutes.

Mr. SMUCKER. Thank you, Mr. Chairman, Ranking Member Graves. Thank you for holding this hearing. It is fascinating to en-

vision how air travel will change, and change our lives over the next few decades. So it is great to be part of this. I do specifically want to talk with Mr. Allison about urban air travel, and the potential there.

You have described it even as an entire new ecosystem. And I would be interested in hearing how you envision that will roll out and how it will develop. You already mentioned in answer to a previous question that you expected the average trip would be about 25 miles. Are you—do you envision that would start as travel from city to city, or within a city?

And then you also mentioned, I think, what you called a sky port. And I am interested in how much space that would take to develop that. And do you—at this point I guess it would be a point-to-point transportation, almost like a tram or a subway. But do you envision at some point that would be flying from building to building, or things of that sort?

Mr. ALLISON. Thank you for the question. Yes, so when I talk about an ecosystem, I mean that there are a number of technologies that have to all come together in different ways, through different forms of partnership with other players in the industry to make it happen. And so there are vehicles, and we have vehicle partners that I mentioned that we are working with. There is infrastructure. We have infrastructure partners, big real estate firms around the world that we are working with.

And then there is the network and the operations. And we are building a lot of that ourselves, because we think that is where our core competency lies. And so—but all these pieces have to come together in the right timeframe and in the right way to make this possible.

We envision this being a true multimodal journey. So that means that, through our back-end technologies, when you press a button to get a ride and to get a flight, that we will provide the—whatever the best form of transportation is to get you to the sky port, whether that is a car or an autonomous car or a bike or a scooter, as we are introducing in many different markets right now, to get you to the sky port, transition to the air vehicle, to the remote sky port, and then on—the same thing on the other side. And I am automatically provided with the right form of transportation to get you to your final destination, so you can minimize the number of sky ports that you need in a network to serve the area.

And so we think that is actually really important, to kind of make sure that the investment is correct, and to roll out these networks, to make sure that each sky port has the maximum effect, in terms of increasing connectivity to the rest of the network.

We do see this starting as a small network, thinking—we have talked publicly about something like five sky ports in an urban area to start with, like the Dallas metroplex, which is one of our launch markets. And then the—envision—way the network would work is that any vehicle could fly from any sky port to any other sky port. So they would be within kind of the range constraints of the vehicles, so that you have true one-to-many connectivity, though, between the sky ports, which makes the whole network work much better.

And then the size of the sky port depends on the scale of operations. We envision them starting out very modest, maybe perhaps a retrofit of a parking garage top deck. And we actually see, with the broader trends in the transportation industry, of the reduction in use of privately owned cars in different markets, that parking garages are becoming underutilized in certain areas. We think this actually provides a very——

Mr. SMUCKER. I am going to jump in, I don't have a lot of time. But I agree with you there is potential here. And my next question was exactly that, you know, we could solve a number of problems: parking would be one of them, congestion would be another. That is all dependent on the scale and, frankly, the pricing, the way the model could work.

Do you see this would initially be sort of a—maybe a luxury, only a few people could afford it, and gradually prices would reduce? What do you think it would take to get to the point of using it as mass transportation, maybe a daily transportation by folks?

Mr. ALLISON. We see this in three stages. We see initial launch in these small networks as—on a per-seat-mile basis, similarly priced to our UberBLACK product in many markets. So something like $5 to $6 per seat mile. We think that, with no changes to the vehicle but only with operational efficiency and higher utilization and load factor, we can get down to something like $1.50 per seat mile within a couple years of driving utilization.

We think that, ultimately, with the introduction of autonomy and the reduction in cap-ex of building these vehicles by applying automotive-type manufacturing technologies, we can get to something that is close to the marginal cost of car ownership per seat mile, which is something like 45 cents, I think, that AAA——

Mr. SMUCKER. And I don't have much time, but I agree with what Ranking Member Graves said earlier, you know. We here, our role is not to try—to sort of drive various technologies. Our role is to try to envision what the future could look like, and be sure that we have gotten out of the way so companies can innovate.

So I would be interested in continued discussion with you at some point in regards to what you think—what changes need to be made here to ensure that innovation could be driven not only by your company, but by others that are operating in this space. So thank you.

Mr. ALLISON. Thank you.

Mr. LARSEN. Thank you. The next three Members I have in order will be Representative Carbajal, Representative Katko, and Representative Titus. I recognize Representative Carbajal for 5 minutes.

Mr. CARBAJAL. Thank you, Mr. Chair. And thank you to all of you for being here today.

Mr. Allison, thank you for sharing a little bit about what aviation might be like in year 2050. There has been a lot of exciting and innovative technology and design that no doubt will have a major change in our transportation system in the future, advances to engine and commercial space vehicle designs such as hybrid electric and all-electric engines or alternative fuel sources, which could make flight operations more sustainable and environmentally friendly.

Could you please speak further on what this might look like for your industry?

Mr. ALLISON. Thank you for the question. Absolutely. We actually view the transition and technology to—the introduction of electric power trains into vehicles as one of the key enablers to make this whole industry of urban air mobility possible.

And so the key—the way this plays out is that with electric propulsion technology, the same types of technology that go into electric cars that enable them to be much simpler and cheaper to operate, allows you to create new topologies of aircraft that can take off and land vertically, like a helicopter, but can transition to a wing and fly much more efficiently and quietly.

And so you can reduce the energy cost dramatically in these types of vehicles by using electric technology, and that actually enables, then, this whole market to open up. But the key enabler is electric propulsion applied to aircraft to let them take off and land vertically in a quiet and safe way.

Mr. CARBAJAL. "The Jetsons" come to mind.

[Laughter.]

Mr. ALLISON. That is right.

Mr. CARBAJAL. Thank you.

Captain DePete, thank you for your testimony before our committee, as well. Some of the concerns I have heard from my constituents as we continue to develop new technologies are how do we maintain a competitive workforce for the future. What are some opportunities or recommendations you would propose to meet these challenges? One. And two, in your testimony you mentioned improving diversity within the aviation workforce. Can you explain further what this would look like?

Mr. DEPETE. Absolutely, thank you. And we are intimately involved in every aspect of diversity across the board, including participation now with the new requirement for the women in aviation working group that is going to take place. And we have already placed a person on that to represent us. There are 14 members, I believe, on that.

But this all comes under our efforts of what we call a professional development group in that area that I told you earlier was the future of the profession. So we are really heavily invested in encouraging people to come forward and get involved in studies that would help facilitate a career in aviation.

Of course, I was a poli sci major, I will say that. But I still got in. But having said that, I think that anything that Congress can do to help facilitate and support that kind of an educational process, as well as the career aspects that I mentioned earlier to make it a viable career, and to protect the industry as a whole—because if we lose the industry through unfair foreign competition, we lose everything.

So that would be my——

Mr. CARBAJAL. Thank you very much.

Mr. DEPETE. Thank you.

Mr. CARBAJAL. And semper fidelis.

Mr. DEPETE. Thank you. Thank you, I appreciate that.

[Pause.]

Mr. CARBAJAL. Mr. Chair, I yield back.

Mr. LARSEN. All right.

Mr. CARBAJAL. I forgot to say that.

[Laughter.]

Mr. LARSEN. I think we are all more than happy to sit here in silence for 1 minute and 30 seconds.

I recognize Representative Katko for 5 minutes.

Mr. KATKO. Thank you, Mr. Chairman, and thank you all for being here. It is truly fascinating. I finished a book recently about the Wright brothers. And when they started out they were bicycle shop owners, and they just started fiddling with the audacity of air travel. And by the end of their lives, one of them was riding on commercial airlines. So it is really amazing, what can happen in a lifetime. And so everything you are talking about sounds kind of out there. But, quite frankly, it did to the Wright brothers, too. So go at it and have it at, man.

But the question I have is on drone technology. In my district and my neighboring district we have one of the premier drone technology research corridors in the country. And, you know, I am vitally concerned about the amount of vehicles that are going to be in the air in 2050, and the amount of unmanned aerial vehicles that are going to be there. Package deliveries, all the things—lord knows what is going to be there.

But I would like to just kind of hear your opinions as to what you think is additionally needed in order to affect that. Obviously, geofencing and all those types of things we are going to need to keep those unmanned vehicles out of air traffic, commercial airspace is of vital concern. So anything—wide open, you guys. I want to hear what your thoughts about drone technology, where you think it is going to be, and what you need, what we need to be doing with it right now.

Ms. COOPER. Thank you for your question.

Mr. KATKO. We take you, Ms. Cooper, first. Go ahead.

Ms. COOPER. As the drone member on the panel, I will kick this one off for us.

As I mentioned earlier in my testimony, remote ID is sort of the next thing that we need to work on together. And once that is implemented, you know, we can deal with any concerns that are cropping up, perhaps in your district and others, in terms of privacy, trespass, and other laws that we already have in place that can deal with this new technology and all of its concerns. We just currently don't have a technological means to enforce those laws. And remote ID will help us get there.

Mr. KATKO. Great, great. Anybody else?

Mr. MCBRIDE. I have been working with the FAA and our industry partners to help establish the standards for performance and certification of these vehicles is going to be one of the key components to moving forward.

Mr. KATKO. Yes. And obviously, I also wear a terrorism hat from the Committee on Homeland Security, so I am also vitally concerned about weaponizing these unmanned vehicles, whether they are airplanes, or what have you. And also, from a cybersecurity standpoint, the ability to hack into some of these systems and maybe take over an airplane and weaponize that, as well.

So if you want to comment on that, as well, I would like to hear about that.

Mr. DEPETE. Thank you. And I would like to thank you personally for all the help that you have given us, in terms of the security aspects in relation to cargo.

Mr. KATKO. Yes. And more to go, though.

Mr. DEPETE. Yes, we have a bit of a way to go. But your interest and support in that has been very appreciated.

To answer your question, you know, a member of the joint advisory committee subcommittee, and we worked on looking at what type of infrastructure would be necessary. So right off the bat I would have to say sufficient funding, right, for the FAA, consistent funding.

And earlier, before you joined us, I had mentioned we had made so much progress in the FAA Reauthorization Act in terms of the 5-year plan, but yet we had to deal with a Government shutdown, and that was pretty—so I am really supportive of H.R. 1108, and like to see—so could we keep steady progress going.

But I think, if we focus on infrastructure and also on a—I happened to draw the lucky straw and get the funding model to try to figure out how we were going to pay for all this, you know.

And I think what we have to be careful about is we have to do this right. We have an opportunity to do this right the first time. Because if something doesn't go well, if we introduce risk too quickly and it is uneven, where other operators, you know, abide by a certain set of standards and the other ones don't, it raises the risk for everyone in the system.

Mr. KATKO. Oh, that is what happened with respect to the internet.

Mr. DEPETE. Absolutely.

Mr. KATKO. I mean it was introduced before they understood what cybersecurity was, and cyber vulnerabilities.

Mr. DEPETE. Absolutely.

Mr. KATKO. It is the same thing, yes.

Mr. DEPETE. I couldn't agree more. And what it will do is it will set back the industry for the folks that are trying to do it the right way.

Mr. KATKO. For sure.

Mr. DEPETE. So we do have a unique opportunity here. We just have to figure out how to fund it.

Mr. KATKO. Well, I encourage all of you to continue to look around the corner and think boldly, because that is how progress is made in this country. And—but to try—when you are doing that, also try and anticipate better than we did with—the internet is a great example of the vulnerabilities that are going to be there. And with unmanned aerial vehicles, there are tons of vulnerabilities. It is highly complicated, and we got to get it right.

If you get it right, I think the technology is going to be amazing for us in the next couple of generations. And—but we have got to be very mindful of the drone—the misuse of drones, misuse of unmanned vehicles, and we have got to do a better—we have got to anticipate that upfront.

So anything else anyone want before I yield back?

OK, I yield back, Mr. Chairman.

Mr. LARSEN. Thank you.

Mr. KATKO. Fourteen seconds ahead of time. That is a first for me.

Mr. LARSEN. I appreciate that very much, yes. We can all leave earlier. Thanks, Representative Katko.

Representative Titus for 5 minutes.

Ms. TITUS. Thank you, Mr. Chairman. You know, in the 2 hours that we have been sitting here, listening to all the exciting new technology and what we need to do and how we can be safer, all the developments that can be made, our President has tweeted out something pretty interesting. Airplanes are becoming far too complex to fly, pilots are no longer needed, but rather computer scientists from MIT. I see it all the time in many products. Always seeking to go one unnecessary step further, when often old and simpler is far better. All of this for great cost, yet very little gain. I don't know about you, but I don't want Albert Einstein to be my pilot.

I have a hard time interpreting anything the President says, but I don't know if this is a knock at Boeing, or if it is a knock at pilots, or if it is a knock at Einstein, or just—he is just a Luddite, and it is a knock at technology, general. But it doesn't seem to be the right attitude at this moment, and certainly not in this hearing.

I want to ask a general question. I believe we still have an Acting Director of the FAA and an Acting Deputy Director. Do you all find that this is a problem in trying to get advances made in this field? Has it put up obstacles? Or is there a reluctance by the agency to move forward because we don't have somebody in place? Anybody?

Mr. MCBRIDE. Well, from NASA's perspective, I think we have a great working relationship with the working-level people in the FAA. So progress continues to be made at the engineer-to-engineer and management levels at the agency. I can't really speak to higher levels of the agency.

Ms. TITUS. How about from the industry's standpoint.

Mr. ALLISON. Thank you for the question. We are part of the IPP, the integration pilot program, with the San Diego team. And we have been incredibly pleased with the way the FAA has been working with us. And we couldn't have a—it is just going extremely well. So kudos to them for really leaning in and engaging with industry in a very meaningful way to really try to do things right, but also try to move very quickly.

And so we have been incredibly pleased with how the FAA leadership has been working with their teams to get that done very, very effectively.

Ms. TITUS. That is good to hear.

Ms. COOPER. I agree with Mr. Allison's comments. Under the Acting Administrator's leadership, the FAA has rolled out several programs, including the IPP, very successfully, to date; the UPP, which was recently announced; and the proposed rules that we talked about that were dropped during the furlough. So I think they are doing a great job, and we look forward to continuing to work with them.

Ms. TITUS. We usually hear that they are pretty hidebound and very slow to respond, and they come along after the industry, which puts us behind the rest of the world. But perhaps maybe there has been some improvement, so that is good to hear.

I have a more specific question that is related to the UTMs that some of you mentioned, and how they can tie to the testing centers that exist in several States, including my State of Nevada. I know we are eventually going to develop a system that will be applicable to what I am going to mention. But in the meantime I wonder if you could give me some advice on what we might do to allow this to happen.

Some of the commercial users, like utility companies who have rights of way on the ground, would also like to have rights of way in the air to be involved with things like remote wires that are in areas of Nevada that you can't get to very easily, or perhaps fixing railroads or pipes. Is there any possibility, working with the testing centers, that we might develop some kind of airways that—where the drones can go that are tied to other infrastructure projects where they might have right-of-ways?

Mr. MCBRIDE. Well, that is certainly in our plans at NASA to work with the FAA. The established test centers at Edwards Air Force Base, where I am from, is located—we are in a restricted airspace. A lot of our initial work happens there without the need for FAA authorization to fly.

I did mention in my testimony the grand challenge activity, moving forward. The initial grand challenge is planned for our facility at Edwards in southern California, but we are looking at the Nevada test site as a potential alternative location to move some of our mobile facilities to, and do some of the grand challenge work there, as well.

Ms. TITUS. So do you think that the FAA should kind of carve out or create these restricted fly zones or corridors that parallel critical infrastructure?

Mr. MCBRIDE. That is going to be something for the FAA to decide. But certainly that is within the capability of UAS, to do monitoring of critical facilities and infrastructure like railroads, power lines, transportation throughways.

Ms. TITUS. How about you, Ms. Cooper?

Ms. COOPER. Thank you for your question. Congress directed the FAA, under the Extension Act, to set up, under section 2209, a process for a critical infrastructure facility owners and operators to seek no-fly-zone designation. That is another provision that we are still waiting for the FAA to implement, so that we can move forward and help protect critical infrastructure.

Ms. TITUS. Well, maybe since they are doing better, they will move forward quicker.

Ms. COOPER. I hope so. Thank you.

Ms. TITUS. Thank you. I yield back.

Mr. LARSEN. Thank you, Representative Titus. I recognize Representative Stanton for 5 minutes.

Mr. STANTON. Thank you very much, Chair Larsen. And thanks for this great panel. It has been so important that Congress take the time to do meetings like this, to hear from leaders thinking about the future. We so often deal with the immediate challenges,

sometimes crises right before us, so this is a very, very important thought process. And to have these thought leaders before us is very much appreciated.

I come to this committee as a new Member of Congress, but having spent many years as a mayor, mayor of a big city, Phoenix, Arizona, where I was, I guess, the chair of the board of Phoenix Sky Harbor Airport, and had a great working relationship with the airlines, the industry as a whole, a lot of the great employees that make up the industry.

I was also a champion of a major infrastructure investment initiative that we undertook in our city, transportation initiative, and a lot of the investment went to light rail and to improving our bus system. And many people challenged me and said, "Why would you invest in those old technologies, or those old systems, when transportation is going to look so different in the next 50 years? Are we going to need light rail in the future, when we have driverless vehicles or the ridesharing companies are taking over transportation?"

My response was, of course, that a great city has to have as many transportation options as possible. It is not an either-or proposition. And so we need to continue to invest in outstanding transportation options like light rail.

I am looking at this with very much the same mindset. I am excited about these new technologies and what they might mean for the American economy and American technological leadership in the world. But also, at the same time, hoping to get out of this committee a proposal for a major infrastructure investment act for the United States of America, and maybe ask your advice about what infrastructure investments should we be looking at differently, in light of some of the technologies that you are talking about, or some add-ons to the potential infrastructure investment that we recommended through this committee?

What does infrastructure look like differently, as a result of some of these exciting technologies? And that is open to anybody.

Captain, please?

Mr. DEPETE. Thank you, Representative Stanton. That is a great question. You know, we envision, you know, an airspace with multiple users, all trying to share that. So collaboration is really a key here.

And I am always a believer that if you have a goal in mind, and you crystalize that, you have a pathway now, instead of meandering back and forth. So I think an open, transparent, collaborative process, with the help of Congress in every way it possibly can to protect the industry, like I said earlier, and facilitate that dialogue—you see what goes on in the commercial aviation safety team that I mentioned earlier, that risk-predictive model is a very useful tool.

And it goes hand in hand with success, right, because if something goes wrong, or if you go a little too fast and you try to cut a corner, then it affects the whole thing, and it changes the perceptions to the public. So I think anything along those lines would be—but that is what it is going to look like, and including commercial space.

The Air Line Pilots Association—I was at a COMSTAC meeting last year, and when they said the mic is open, I grabbed it and I

said, "You know, from what I am hearing from everyone, it sounds like we could all benefit from"—because there was some concerns, right, between commercial aviation and commercial space.

It is not like they are a new entrant, like, say, drone users or anything like that. They just have an enhanced capability now, due to—but the methodology that we are using right now of, you know, segregating vast pieces of airspace, when we really—there is some low-hanging fruit right now that we can more dynamically manage that airspace. But that requires cooperation and leadership and—so anything along those lines helps——

Mr. STANTON. That is great advice.

Mr. Allison, how about your technology with Elevate? You talked a little bit about the infrastructure necessary. I am fascinated by the opportunities, the technology, and—as leaders on the infrastructure side, what should we be thinking about?

Mr. ALLISON. Yes, we actually envision—and thank you for the question—envision a combination of both private and public infrastructure that will develop over time to support this type of a network. And not just, like, physical, on-the-ground infrastructure, but the digital infrastructure, as well, that in order to do the right kind of collaborative aerospace management, kind of built up out under that UTM construct, there has to be the digital infrastructure that is run by the FAA to facilitate that. And we think that is incredibly important.

Mr. DOURADO. Congressman, I think as the flights—as flights get faster—so from Phoenix to Tokyo in, say, 6 hours, people are going to be more sensitive to the amount of time that they spent getting to the airport, right, which is where Mr. Allison's company comes in. But then also, the time that they spend at the airport, and going through security, and all the hassles, and so on.

So as wonderful as Sky Harbor is, I don't think everybody wants to spend most of their day there. And so speeding along the process of working through the airport and getting on the flight and so you can get on with your trip is——

Mr. STANTON. That is great. Sky Harbor is not perfect, we are just better than any other airport in America.

Mr. DOURADO. Right.

[Laughter.]

Ms. COOPER. Thank you for your question, Congressman. As Congress considers what should be included in a broader infrastructure investment package——

Mr. LARSEN. Excuse me, his time is up.

Ms. COOPER. Sorry.

Mr. LARSEN. Sorry. Thank you, though. We are going to go to a second round of questions. Because I have a few questions to ask, a few more followup questions to ask. But we will recognize Representative Stanton as having a fine airport.

[Laughter.]

Mr. LARSEN. So back to Captain DePete on commercial space. And the truth of it is we are going to have about the number of commercial launches this year that we had last year. But presumably, there is an increased interest in commercial space, both for tourism, as well as for traditional uses.

Can you describe the effect it might have on commercial airline travel, and maybe concerns, as well as what steps might be taken to accommodate commercial space?

Mr. DEPETE. Absolutely, and thank you for the question. And that is the opportunity that I think I saw. And right now, ALPA is really trying to facilitate that dialogue between commercial aviation and commercial space to work out those problems.

Because I think, you know, we are going to learn from one another, right? We have this incredibly great aviation ecosystem with all these multiple moving parts, and this elegant little dance it does, and with the end result of being very, very safe. And we think there is a lot that we can share, in terms of the data collection you have through the aviation safety information analysis and sharing program, a similar type approach that could be quite possibly helpful to them. But at the same time, their advancement in, like, suborbital flights, clearly is going to translate over to the airlines.

But the real key is going to be this coexistence in the airspace right now, and how they—since more and more launches will take place, how do we dynamically manage that airspace so we don't create undue burden for other users of the airspace during the launches.

There is a plan. I mean we can do this. It will take increased funding, of course. You know, there is a SDI, the space data integrator tool, that is available. That would help air traffic controllers manage some of that space. Unfortunately, there is no automatic link to the systems that the air traffic controllers use. It is manually—the information is manually taken from the SDI and brought over to the controller.

So just—there are steps that we could take right now, but we need a short-, medium-, and long-term vision, and a funding process along the way to achieve it. But I—it is an exciting time.

Mr. LARSEN. Thanks.

Ms. Cooper, I want to now give you a chance to answer Representative Stanton's question.

Ms. COOPER. Thank you, Chairman. In terms of the broader infrastructure investment package that Congress will be considering this year, I believe drone technology could be incentivized as a tool for master planning and redevelopment, similar to the work that I included in my testimony that we conducted with the VA.

Drones can help monitor existing infrastructure and help us understand how to best recapitalize that infrastructure, as well as help new projects stay on track and under budget. Thank you.

Mr. LARSEN. Mr. Dourado, have you all thought through the impact that Overture will have on airport infrastructure? Do you think there will be necessary changes? Can we use existing infrastructure as-is?

Mr. DOURADO. Thank you, Mr. Chairman. We are designing Overture as much as possible to work with the existing airport infrastructure. So it will use narrow-body gates, it will be able to take off and land in the same way that airliners can today.

The one thing where we are looking at an opportunity for improvement is in steep approach capability at a number of airports. So using GLS as an upgrade from the existing ILS systems at most

airports it is possible to have different glide slopes for different airplanes. And the opportunity with Overture and with supersonic airplanes in general is to come in at a steeper angle, and further reduce the community noise on approach. So we would like to see airports upgrade to have GLS systems that could enable something like that to exist, and further reduce noise exposure into communities.

Mr. LARSEN. All right. Thank you.

I yield back and recognize Representative Graves for 5 minutes.

Mr. GRAVES OF LOUISIANA. Thank you.

Ms. Cooper, in your testimony you made mention of concerns regarding a regulatory patchwork for the use of unmanned aircraft related to different cities and States and others. Would you mind submitting—and I am not going to ask you to do this from memory, but would you mind submitting to the committee in writing some examples of where that has happened, or just where some of your concerns are, so we can better understand, I guess, how that has thwarted or prevented some opportunity for your industry? Does that make sense?

Ms. COOPER. Absolutely. I will do that for the record, thank you.

[The information follows:]

Post-hearing response from Diana Marina Cooper, Senior Vice President of Policy and Strategy, PrecisionHawk, Inc., to request for information from Hon. Graves of Louisiana

According to the Consumer Technology Association (CTA), which tracks state and local UAS laws and bills, there are around 150 state laws that have been enacted to date that regulate UAS. At the state level, there are approximately 250 UAS related bills considered each year. Additional laws have been enacted at the local level, which are difficult to track without obtaining local counsel across each city or county. Due to the complex patchwork of bills and laws targeting UAS, our company (and many others across the industry including large public companies engaged in UAS activity) rely on weekly updates from CTA and other associations including AUVSI and the Small UAV Coalition so that we can attempt to keep pace with the ever changing landscape governing our operations. If this patchwork continues to spread across the country, UAS operations will be severely hampered and startups like ours will be particularly harmed by the increased cost of ensuring legal compliance with conflicting rules.

Legislation was also proposed in Congress in recent years that would allow state and local regulation up to 200 feet, which would compromise the longstanding Constitutional principle of federal preemption. These measures raised strong opposition across virtually the entire UAS industry as they would prevent many operations from occurring.

The following provides a few examples of laws and bills, enacted or proposed, that threaten the UAS industry by imposing harsh or duplicative restrictions.

North Carolina

State law requires UAS operators to complete a North Carolina test on UAS safety, and to obtain a state permit to operate, which may require fees in the future. These measures are duplicative of the FAA testing and permitting system and impose additional burdens on commercial operators in the state.

McAdenville, NC

A town ordinance prohibits the operation of UAS within the town limits during the month of December.[1] This ordinance prevents many beneficial operations from taking place including utility inspection and claims processing.

[1] https://www.mcadenville-christmastown.com/visitors.htm

Oklahoma

Senate bill 304 introduced in 2019 seeks to prohibit recreational operation of UAS over agricultural property without consent. This bill would effectively restrict recreational operations in the majority of the state, which includes 78,000 farms covering 34.2 million acres.[2] This large scale restriction encroaches on the FAA's exclusive jurisdiction over airspace. Although there is a commercial exception in the bill, as noted in my testimony, many commercial operators begin as recreational operators who turn towards commercial enterprise once they hone their skills. The proposed restriction could also open the door to future restrictions on commercial operations over agricultural areas.

California

California senate bills proposed in recent years would have restricted UAS operations below altitudes as high as 350 feet over private property without permission of the property owners. These restrictions would leave only 50 feet available for UAS operations (under FAA rules), forcing UAS traffic closer to manned air traffic, creating an increased safety risk.

Newton, MA

A 2016 ordinance was enacted prohibiting UAS flight under 400 feet without the permission of property owners, and requiring local registration of UAS. The impact on commercial operators was so severe that one operator based in Newton sued the city, and prevailed in court on preemption grounds. Commercial operators should not have to file lawsuits against their state, county or city governments in order to reaffirm the FAA's jurisdiction over aircraft operations. A congressional grant of authority to localities would have the devastating consequence of encouraging these types of unreasonable restrictions that impede commercial UAS operations.

Boulder City, NV

A proposal in Boulder City sought to impose a fee in the amount of $100 per UAS per day for commercial operations within the city limits. For independent contractor pilots on our Droners platform, these fees could make their operations economically infeasible, in particular in the early stages of building their business.

Washington

Washington introduced senate bill 5137 in 2019 which would impose an excise tax on commercial UAS operations. Such taxes would create an unnecessary financial burden for UAS operators.

Mr. GRAVES OF LOUISIANA. All right, Mr. Allison, I see some head-shaking over there. You want to add something? You good?

All right. You just recognized that that is a concern, as well? Got it, thanks.

Another question. Mr. McBride, you made mention of some of the coordination that you are doing with the FAA related to research and development. I made mention earlier to the sonic booms as one example. But obviously, there is a lot of technology crossover. Can you talk about how that relationship works, and sort of how you—you made mention to your—doing this from memory—is it RTTs that—and just how you basically commercialize or transfer some of your solutions for private-sector opportunity.

Mr. MCBRIDE. Yes, NASA does fundamental or initial research in air traffic management software methods, working with the experimental FAA sites, and transitions that software to the FAA, like ATT 2 and Mac software, which allows a better integration of aircraft coming into airports, and better coordination with FAA controllers.

Mr. GRAVES OF LOUISIANA. Can you talk specifically about how you all have worked together to actually improve the NAS and any technologies that have resulted from some of the R&D you have done?

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[2] https://www.farmflavor.com/oklahoma-agriculture/

Mr. MCBRIDE. I can take that one for the record and get you some written responses on—with specific examples how we have matured the technology on those on-ramps over the last few years.

Mr. GRAVES OF LOUISIANA. OK. And I am curious, Mr. Dourado or Mr. McBride. One of the big concerns with the overland regulations that you cite in your testimony, or—I think maybe both of you do—can you talk about the state of research related to that, and where we are in regard to being able to actually move forward on a regulatory change there?

Mr. MCBRIDE. Yes, the FAA currently restricts overland supersonic flight outside of restricted airspace or supersonic corridors.

The X–59 is leveraging on research that NASA has been doing since we had the first aircraft sonic boom in 1947, and our understanding of sonic boom shockwaves and how they coalesce off the aircraft and transition or transport down to the ground and impact people and things on the ground. So we are taking that understanding and putting that into tools which are helping to inform the design and the outer mold line, the shape, the engine placement of the X–59 aircraft, which, again, isn't a test vehicle as a prototype for a future transport aircraft, but is an experimental aircraft designed to test people and things on the ground.

We already know how to make aircrafts, high-performance aircrafts, and aircraft go fast and make sonic booms. The goal with the X–59 is to make a sonic boom—and the sonic boom doesn't go away, but to make a sonic boom soft enough that it is not annoying to people or things on the ground.

And so once we clear the envelope and assure that the aircraft is safe to fly, then we will fly over communities and monitor people's responses. We have been doing some initial work in coastal areas like Galveston and in Florida, where we can put partial sonic booms onto people. But the heavy sonic boom goes out over the water, you know, to measure their acceptance of the sonic boom and how it impacts them and their families.

Mr. GRAVES OF LOUISIANA. Is that also going to help stop my car from vibrating and shaking when someone next to me has a radio on that is too loud?

Mr. MCBRIDE. Probably not help that.

Mr. GRAVES OF LOUISIANA. Mr. Dourado, is there anything you would like to add there?

Mr. DOURADO. Yes, of course. So we are designing our Overture for—primarily for over-water operations, not over land. But we do—we are working very closely with NASA and with FAA and the international community on international rules for overland supersonic flight. And we expect those rules to come into place in the mid-2020s, right, when—you know, when we have delivered Overture, and we will be working designing our next planes.

So we expect future planes to have that technology. We do think it is important that the standard be written in a way that it is accessible to airliner, specifically, and Mach 2-plus airliner, because that is really what you need to get to fit into the airliner schedules.

So it is important that the standard does not be too strict that we can't meet it.

Mr. GRAVES OF LOUISIANA. Great, thank you.

Mr. LARSEN. Thank you, and I recognize Representative Lynch of Massachusetts for 5 minutes.

Mr. LYNCH. Thank you, Mr. Chairman and Ranking Member Graves, for your holding this hearing. I want to thank this distinguished panel, as well, for your insights.

Captain DePete, good to see you, sir. So I am a former union president myself, with the iron workers. I know you represent the Air Line Pilots Association. And for my men and women I was always nervous about their safety.

So I have got some nervous constituents this morning, and I actually represent a section of the city of Boston where the departing flights from Logan for a large commercial airline—basically, we live underneath that path. And so we have had the Lion Air crash and also the Ethiopia crash, both on takeoff. So not just the people who were flying in the planes, but the people who live under those flight paths are very nervous.

And, look, I know this is not—this was not what you signed up for this morning, but because my constituents are nervous, I am nervous. And it would be a dereliction of duty not to ask you about this if you have any insight on—in terms of how your pilots might feel about this, and what their perspectives are.

I do want to note that, as of this morning when I came in, there were 25 airlines that had stopped flying the 737 MAX. And at least two countries—I believe Australia and the U.K. have basically refused overflights of this aircraft.

So maybe you could—I don't want to spend a whole lot of time on this, but I have to ask you, you know, if—what are your views?

Mr. DEPETE. No, it is quite all right, and I really did sign up for this, so——

Mr. LYNCH. Oh, OK, fair enough.

Mr. DEPETE. In that email, right? And so, you know, we have the integrity of a process that we have had for a very, very long time, right?

So right now, you know, ever since the first accident involving a 737 MAX, you know, very engaged with Boeing, very engaged with the FAA, and they created some airworthiness directives that helped some of our pilots, you know, who are very experienced. You know, we don't have any 200-hour pilots sitting in the seats any more——

Mr. LYNCH. Right.

Mr. DEPETE. You know, no on-the-job training any more. So we are very proud of that process.

And with that process, though, the difficulty with this is, right, is that we are closely monitoring the situation. It is—like you said, it is changing by the second.

Mr. LYNCH. Yes.

Mr. DEPETE. But the process that we have, that integrity of that process right now, where during an ongoing investigation it is, you know, speculation because we don't really have all the facts from the most recent accident, from Ethiopian Airlines.

So once we get all that—but I think the—you know, the certification standards that were set up with the—and the discussions with the FAA and Boeing, and the information that was passed to our pilots, I feel like we can adequately fly that airplane very safe-

ly. But if we hear differently—I understand there is some new changes in software and——

Mr. LYNCH. Right.

Mr. DEPETE [continuing]. Programs that are going to begin to implement. And, quite honestly, we knew about that as early as November.

So I think it will be—I think we have to, you know, rely on the data, and rely on the process that has gotten us to the point where this is the safest—you know, there has been a lot of sensationalism, and rightfully so, I mean, this is a tremendous loss of life here.

Mr. LYNCH. Right, absolutely.

Mr. DEPETE. And, you know, we—and we don't want to have that happen again. But the process we need to follow, as difficult as it is, will help us prevent that in the future.

Mr. LYNCH. Right. Well, I just hope that your pilots are keenly involved.

Mr. DEPETE. They are.

Mr. LYNCH. Obviously.

Mr. DEPETE. Yes, sir.

Mr. LYNCH. I do have great confidence in Boeing. I think they are a wonderful company, and they have been a real success story. I want to make sure that all of their sort of review is being done as it should be.

Mr. DEPETE. Right.

Mr. LYNCH. Make sure we are working this through. You know, I am just concerned. If there were ever—so we have had two strikes here.

Mr. DEPETE. Right.

Mr. LYNCH. Strike 1 in Lion Air and strike 2 in Ethiopia. If we lost another passenger aircraft——

Mr. DEPETE. Right.

Mr. LYNCH [continuing]. Large, commercial airliner, you know what the repercussions of that would be. It would be a complete loss of trust in——

Mr. DEPETE. Yes.

Mr. LYNCH [continuing]. That aircraft, and it will go much further than that. So I just want to make sure we get it right for the safety of the flying public, and all of our pilots, right?

Mr. DEPETE. Absolutely. And we share that concern. And, you know, it isn't lost on me that we are talking about a lot of technology developments here.

Mr. LYNCH. Yes.

Mr. DEPETE. And how important it is to have a well-trained crew on board the airplane.

Mr. LYNCH. Right.

Mr. DEPETE. Thank you, though, for the question.

Mr. LYNCH. Thank you, sir.

Mr. DEPETE. It is——

Mr. LYNCH. Mr. Dourado, you did talk about sort of shifting flights over the water with your earlier remarks. That is one of the things I am trying to get done in Boston. We designed our airport and laid out our runways back in the 1920s, and we were trying to—we had very weak aircraft, very limited thrust, and we were

just trying to maximize the wind direction. And now we have got very powerful aircraft that could easily take off over the water. But we have left our runways where they are.

Is there anything that you see might help us move in that direction of, when possible, like it is in Boston, to maximize the use of over-the-water flights?

Mr. DOURADO. Certainly with Overture, we will have a lot of excess thrust available on takeoff and landing. And so we are planning to use that to minimize exposure to communities, and to design airport-specific procedures into the flight computer, so that the pilot can fly very easily a procedure that reduces the exposure to the community.

Mr. LYNCH. Thank you for your indulgence, Mr. Chairman. I yield back.

Mr. LARSEN. Thank you, Representative Lynch, I appreciate that.

Any further questions from members of the subcommittee?

Seeing none, I want to thank the witnesses today for your testimony. Your contribution to today's discussion has been informative, and it has been helpful. I think we moved at least 10 years into the next 30 years. As a result, I think we have established a good record for this subcommittee about what the future of aviation and aerospace is for us to build upon in the future, as well.

I want to, for the record, remind that Members will be going to the FAA Technical Center at the end of the month to look at some of this technology that has even been mentioned here today. And this hearing has given us much to think about.

I ask unanimous consent the record of today's hearing remain open until such time as our witnesses have provided answers to any questions that may have been submitted to them in writing, and unanimous consent the record remain open for 15 days for any additional comments and information submitted by Members or witnesses to be included in the record of today's hearing.

Without objection, so ordered.

If no other Members have anything to add, the subcommittee stands adjourned.

[Whereupon, at 12:19 p.m., the subcommittee was adjourned.]

SUBMISSIONS FOR THE RECORD

Statement of Hon. Sam Graves, a Representative in Congress from the State of Missouri, and Ranking Member, Committee on Transportation and Infrastructure

Thank you Chairman Larsen and Ranking Member Graves for holding this hearing.

I would also like to express my condolences to the friends and families of those who perished as a result of the aviation accident in Ethiopia over the weekend.

While things are quickly developing in aerospace and aviation, we must never stop working to ensure the safest system possible. As a pilot, I appreciate both the importance of safety, as well as the opportunities that lie ahead for aviation businesses, consumers, and aviators.

The air transportation system of the future promises great advances in the way we move people and goods across town, around the globe, and into space. It will also allow us to better connect small and rural communities with the rest of the country and world.

But it is essential that safety be at the forefront of everyone's mind. We can allow for innovation while maintaining a safe and efficient air transportation system. That is the balance that must be struck in order to be successful.

Fostering innovation and incorporating advancements in technology into our infrastructure network is one of my top priorities.

Advances in aircraft and launch vehicle technologies will change the way we live. In 2050, air travel could be a completely different experience. Imagine working in D.C., but going home to Missouri, Louisiana, Oregon, or Washington every night.

Focusing on what the system will look like in 30 years, and how to allow for new developments will ensure the United States remains the world's leader in air transportation. Just as important, it will create the environment for American ingenuity and job creation.

I am excited to hear about some of the newest users of the airspace, including drone operators, and commercial space transportation providers. I also look forward to hearing about how air taxis and the reemergence of supersonic flights will change air travel. As I said in the beginning, these are exciting times; the possibilities are limited only by our imagination.

Statement of Mark Baker, President and CEO, Aircraft Owners and Pilots Association, Submitted for the Record by Hon. Larsen

Chairman Larsen, Ranking Member Graves, Members of the Subcommittee, thank you for the opportunity to provide the Aircraft Owners and Pilots Association's (AOPA) perspectives on our future air transportation system. AOPA represents more than 300,000 of America's pilots and aviation enthusiasts. We were founded in 1939 with the simple mission: to give a united voice to what was then called "miscellaneous aviation". Through the decades, we have been faithful to our core missions—promoting safety, preserving the freedom to fly, and building the next generation of pilots.

Since AOPA was founded 80 years ago, aviation has gone through many changes and the advent of unmanned aircraft has been among the most dramatic. In 2017, AOPA stayed true to its values when we launched a new line of membership options created for unmanned aircraft pilots for the common purpose of safe integration of all users of the National Airspace System (NAS). Our members collectively operate over 85% of all general aviation (GA) aircraft in the United States and represent two-thirds of all pilots, making AOPA the largest civil aviation organization in the world.

Our testimony is focused on the safe integration of unmanned aircraft into the NAS, while maintaining our excellent safety record. Over the last several decades, the general aviation total accident rate has decreased by more than 85%. Preliminary National Transportation Safety Board (NTSB) statistics show that in 2017 (the most recent data available), for the fourth straight year, the overall GA fatal accident rate has declined to below one fatal event per 100,000 flight hours.

While technology, education, and training will lower this number even further, the stellar safety record reflects the productive oversight by this Committee and the constant work by the Federal Aviation Administration (FAA) and industry by putting safety first and producing results.

ECONOMIC IMPACT OF MANNED AND UNMANNED AVIATION

The general aviation industry has a large economic impact in the United States. It has a total annual economic output of over $219 billion and contributes more than $109 billion each year to the US GDP. The industry is made up of aircraft manufacturers, avionics and parts providers, fueling and service providers, maintenance shops and many more diverse businesses. There are over 1.1 million jobs directly or indirectly attributed to the general aviation industry.

The economic impact of unmanned aircraft integration is significant. According to the Alliance for Drone Innovation, the economic impact of unmanned aircraft into the NAS will total more than $13.6 billion in the first three years of integration and will grow sustainably for the foreseeable future, cumulating to more than $82.1 billion and more than 103,000 jobs by 2025.

AOPA ENGAGING WITH UNMANNED INDUSTRY

As an organization representing the freedom to fly for all users, AOPA believes that safely integrating unmanned aircraft can be achieved by engaging collaboratively with the entire aviation community, ensuring all users have an appropriate level of aeronautical knowledge, and using technology to minimize safety risks. Our long-term vision for unmanned aircraft is for routine operations to take place in harmony with other NAS users including general aviation.

To facilitate this vision, AOPA serves on a multitude of government and industry committees dedicated to the safe integration of unmanned systems. As AOPA President, I represent AOPA on the FAA's Drone Advisory Committee (DAC). The DAC is a broad based, long term advisory committee that provides the FAA with recommendations on key unmanned aircraft integration issues by helping to identify challenges, prioritize improvements, and create broad support for an integration strategy. Additionally, AOPA actively supports safe integration by participating in numerous FAA sponsored Aviation Rulemaking Committees (ARC), including UAS in Controlled Airspace ARC, Micro UAS ARC, Commercial Space ARC, Airspace Access Priorities ARC, and others. AOPA is also active on the ASTM International committees that are developing standards for detect and avoid, remote ID and Unmanned Traffic Management (UTM).

Additionally, AOPA has submitted a letter of interest in response to the National Aeronautics and Space Administration (NASA) Aeronautics Research Mission Directorate (ARMD) Urban Air Mobility (UAM) Grand Challenge Request for Information. AOPA shares ARMD's UAM vision for a "safe, efficient, convenient, affordable, environmentally friendly, and accessible air transport system".

AOPA also supports the FAA's formation of an Unmanned Aircraft Safety Team (UAST), modeled after the very successful Commercial Aviation Safety Team (CAST). The group's mission is to collect and use UAS operational data to identify safety risks, and then develop and voluntarily implement mitigation strategies to address those risks.

Through the work of the above committees and other activities, the FAA and industry have demonstrated that by working collaboratively, we can make significant progress toward integrating unmanned aircraft into the NAS. Efforts to date have produced results. In 2016, a rule for Registration and Marking Requirements for small UAS was published, which applies to UAS weighting more than 0.55 pounds and less than 55 pounds. In June 2016, the FAA Part 107 small UAS rule was published, becoming effective in August 2016. This rule enables routine small UAS operations conducted within visual line-of-sight (VLOS). Prior to the finalization of the small UAS rule, the FAA only authorized commercial unmanned aircraft flights on a case by case basis for operation in the NAS.

UNMANNED AIRCRAFT IMPLEMENTATION PRIORITIES

AOPA believes there are a handful of key implementation priorities that must be addressed to facilitate the safe integration of unmanned aircraft into the NAS: Be-

yond Visual Line of Sight (BVLOS) operations, airspace and air traffic management, airport infrastructure, and growing the pilot population.

Beyond Visual Line of Sight (BVLOS) Operations

This effort will require Detect and Avoid (DAA) and Command and Control (C2) technical solutions for unmanned aircraft. These two capabilities must be implemented to keep unmanned aircraft at a safe distance from other aircraft and ensure the pilot can control the unmanned aircraft.

While manned aircraft accomplish see and avoid through visual means, unmanned aircraft operating BVLOS are unable to rely on the vision of the pilot. To support BVLOS, minimum DAA performance standards must be developed. The C2 link between an unmanned aircraft and its pilot is critical to ensuring that the pilot can safely control the unmanned aircraft during normal and emergency situations. The C2 link enables the pilot to maintain control, comply with air traffic control (ATC) instructions and avoid other aircraft. Because the C2 link is critical to safety, minimum performance standards are necessary to ensure the link performs safely and reliably.

Airspace and Air Traffic Management (ATM)

Air Traffic Management requires the FAA to work collaboratively with industry in developing operational ATM concepts for unmanned aircraft in the NAS. In low altitude airspace, typically below 400 feet AGL, where FAA air traffic services are not provided, the FAA must work with industry to develop operational requirements that enable routine small UAS operations at low altitudes.

The FAA currently envisions a low altitude Unmanned Traffic Management (UTM) concept for unmanned operations as not under the control of the FAA, but as a separate but complementary component to the FAA's Air Traffic Management system. This concept must integrate small unmanned aircraft at low altitude with manned aircraft that also operate in this airspace. UTM development will ultimately identify services, roles and responsibilities, infrastructure, and performance requirements for enabling the management of low-altitude unmanned operations where the FAA does not typically provide separation services. AOPA supports the development of a phased approach building from rural to urban and from low-density to high-density airspace.

Airport Infrastructure

Our nation's airport ecosystem must continue to support all sectors of aviation, including potential new entrant urban mobility aircraft and the challenges faced by high volume, low-altitude operations.

With new advances in electric and electric-hybrid vertical takeoff and landing (eVTOL) technology, aviation will be more accessible than ever before, and airports will be a cornerstone of the infrastructure these new aircraft will need.

Airports are already economic engines for the communities they serve and those who live around existing airports will be far more likely to realize the benefits that will come with eVTOL aircraft. Uber understands that existing airports are important parts of the coming eVTOL ecosystem. According to their whitepaper on "Uber Elevate", the numerous airports located in and around metropolitan areas will serve as maintenance and support locations for eVTOL aircraft.

General aviation airports are already populated with aviation maintenance facilities and personnel. They have space available to host a substantial number of eVTOL aircraft. AOPA expects eVTOL operators to plug into this existing infrastructure as their market develops.

Please take a moment to watch our video of what eVTOL technology and local airports means for transportation and the economy. https://www.youtube.com/watch?v=OtpCldGVSSg&feature=youtu.be. It is now more important than ever for Congress to ensure a strong and vibrant airport ecosystem for today's aviators and for the future.

ADDRESSING THE FUTURE OF AVIATION

Growing the Pilot Population

Getting the next generation of Americans interested in aviation and aerospace is a key component of the aviation industry's future. The FAA estimates that 1.3 million unmanned aircraft pilots will need to be certified for commercial operation by 2020.

Safe integration of unmanned aircraft requires an investment in training, certification and ongoing safety education of unmanned pilots. For example, Uber has published "Uber Elevate", a detailed vision of small, electric air vehicles capable of vertical takeoff and landing and distributed across urban centers in huge numbers.

While the long-term vision includes autonomous operation, the authors of the Uber paper expect that building the system will require pilots, and many of them. Autonomous flight is likely to be years, if not decades down the line.

High School Aviation STEM Program

AOPA is a leader in developing our future workforce. We are already working to rebuild the pilot population and the aviation industry from the ground up through AOPA's High School initiative to get young people interested in aviation careers.

By providing high-quality STEM-based aviation education to high school students nationwide, AOPA is opening the door to aviation careers for thousands of teens. The courses are designed to capture the imagination and give students from diverse backgrounds the tools to pursue advanced education and careers in aviation fields.

Working with professional instructional designers, AOPA is offering a four-year high school aviation STEM program that falls along two tracks—pilot and unmanned aircraft systems or drones.

The program conforms to math and science standards and, in keeping with career and technical education best practices, will lead to a certification or industry-accepted test, such as the FAA Private Pilot knowledge test or a Part 107 drone pilot certification.

As of February 2019, the curriculum is being used by an estimated 2,190 ninth-grade students at 80 schools in 26 states. There are another 402 students at 25 schools testing the tenth-grade curriculum with additional grade-level curriculums to be introduced in the coming years.

We are already seeing a dramatic improvement in diversity demographics when comparing students using the 9th curriculum compared to today's aviation workforce. Below is a chart comparing AOPA 9th grade students to employed pilots and flight engineers.

AOPA 9th Grade Students	Employed Pilots and Flight Engineers*
25% Female	6.2% Female
22% African American	1.8% African American
26% Hispanic	8% Hispanic
3% Asian	1.5% Asian

*US Department of Labor, Bureau of Labor Statistics, 2017

Congress, and this Committee specifically, has also recognized the need to support aviation workforce development programs by authorizing two new grant programs to recruit and train the next generation of pilots and aerospace workers as part of the Federal Aviation Administration Reauthorization Act of 2018 (Public Law 115–254).

The pilot education grant program would support the creation and delivery of curriculum designed to provide high school students with meaningful science, technology, engineering, math and aviation education and encouraging our nation's youth to become the next generation of commercial, general aviation, drone or military pilots. The aviation technical workforce grant program includes scholarships, apprenticeships, establishing new training programs, purchasing equipment for schools and supporting career transition for members of the armed forces.

While these two programs are authorized for $10 million per year over the next five years, it is imperative that Congress provide full funding in FY20 to help ensure the future of our nation's aviation industry will have the pilots and aviation technical workforce needed to meet the growing demand for a well-trained aviation workforce.

Each sector of aviation, civil, commercial, and military face significant challenges in preparing for the future. There are hundreds of programs and projects being undertaken today to address these challenges whether they be workforce, technology, environmental, commercial space, air redesign, unmanned aircraft, and several others. More coordination and knowledge sharing are seriously warranted in these areas.

Private and governmental organizations working together to address the development and sustainability of the aviation workforce, conducting and coordinating re-

search activities and developing new aviation materials, training programs, and procedures, and leveraging the knowledge of organizations and federal agencies are all vital to protect and grow the aviation industry.

CONCLUSION

AOPA and its members are committed to serve and grow general aviation, including the unmanned aircraft community, as they safely integrate into our Nation's airspace. We will continue to serve as the chief advocate and support of all pilots and continue our work to ensure our skies are safe and accessible to everyone who dreams of flying.

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