AIRSPACE INTEGRATION OF NEW AIRCRAFT

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HEARING

BEFORE THE

SUBCOMMITTEE ON
AVIATION

OF THE

COMMITTEE ON
TRANSPORTATION AND
INFRASTRUCTURE
HOUSE OF REPRESENTATIVES

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August 31, 2018

SUMMARY OF SUBJECT MATTER

TO:	Members, Subcommittee on Aviation
FROM:	Staff, Subcommittee on Aviation
RE:	Subcommittee Hearing on "Airspace Integration of New Aircraft"

PURPOSE

The Subcommittee on Aviation will meet on Thursday, September 6, 2018, at 10:00 a.m. in 2167 Rayburn House Office Building to explore issues related to the integration of new aircraft into the National Airspace System (NAS). The Subcommittee will receive testimony from representatives of the government and industry.

BACKGROUND

The United States has the largest and busiest airspace in the world. The NAS is used by a diverse fleet of aircraft ranging from gliders, balloons, and single engine piston aircraft to very large turbine-powered transport airplanes and high-performance military jets. With notable exceptions, most conventional aircraft operate at altitudes between 500 feet above ground level up to 40,000 feet above sea level.

In fiscal year 2016, the Federal Aviation Administration (FAA) estimated that over 70,000 flights were operated in U.S.-controlled airspace each day.[1] Approximately 5,000 aircraft were aloft under instrument flight rules at any given time during peak periods.[2] On

[1] "Air Traffic by the Numbers.", Federal Aviation Administration., pp.7. (The figure reflects aggregated total instrument flight rules and visual rules operations). Available at: https://www.faa.gov/air_traffic/by_the_numbers/media/Air_Traffic_by_the_Numbers_2017_Final.pdf (last accessed on Aug. 15, 2018)

[2] *Id.* at 9. Instrument flight rules are "[r]ules and regulations established by the Federal Aviation Administration to govern flight under conditions in which flight by outside visual reference is not safe. IFR flight depends upon flying by reference to instruments in the flight deck, and navigation is accomplished by reference to electronic signals." *Pilot's Handbook of Aeronautical Knowledge*, Federal Aviation Administration, FAA-H-8083B-25, pp. G-16. Available at: https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/pilot_handbook.pdf (last accessed on Aug. 27, 2018)

average, over 2.5 million passengers flew to and from U.S. airports each day.[3] That same year, aviation contributed 5.1 percent to the gross domestic product.[4]

Recent technological advances have led to the emergence of new types of aircraft that are expected to fundamentally transform aviation and the use of airspace, while also impacting numerous sectors of the economy.[5]

Emerging Aircraft Technologies

Unmanned Aircraft Systems

Unmanned aircraft systems (UAS) have been in military use for decades.[6] However, new and technically advanced UAS are increasingly used in a number of applications including agriculture, infrastructure inspection, photography, and public safety. Many civil UAS are relatively inexpensive and are widely available. The FAA estimates that the number of commercially operated UAS will grow from 110,604 aircraft in 2017 up to over 700,000 aircraft by 2022.[7] In addition, the number of model or "hobbyist" UAS is forecast to grow from approximately 1.1 million aircraft up to potentially 3 million aircraft by 2022.[8] UAS operate at altitudes up to 400 feet above ground level, [9] but in many cases, UAS are capable of flying at significantly higher altitudes.[10] As technology improves, industry observers anticipate greater numbers of UAS to be flown "beyond visual line of sight" (BVLOS) of operators which will enable additional applications in various economic sectors.[11]

"Flying Cars"

Several firms have announced plans for passenger-carrying, electrically propelled aircraft. These aircraft, commonly described as "flying cars", will typically carry five or fewer passengers as a new form of primarily local transportation. The firms announcing such plans

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[3] https://www.faa.gov/air_traffic/by_the_numbers/ (last accessed on Aug. 15, 2018)

[4] *Id.* (last accessed on August 15, 2018)

[5] While commercial space transportation vehicles will also transform the use of the airspace and greatly impact the United States economy, this hearing will focus on unmanned aircraft systems and flying cars. For a discussion of commercial space transportation and airspace integration challenges, please see the Subcommittee's June 26, 2018 hearing entitled, "Commercial Space Transportation Regulatory Reform: Stakeholder Perspectives" (https://transportation.house.gov/calendar/eventsingle.aspx?EventID=402613).

[6] John David Blom, Unmanned Aerial Systems: A Historical Perspective, Occasional Paper 37, pp 46. Combat Studies Institute Press, US Army Combined Arms Center Available at: https://www.armyupress.army.mil/Portals/7/combat-studies-institute/csi-books/OP37.pdf (last accessed on August 20, 2018)

[7] FAA Aerospace Forecast FY2018-38, pp. 43

[8] *Id.* at 43.

[9] Bart Elias. *Flying Cars and Drones Pose Policy Challenges for Managing and Regulating Low-Altitude Airspace*, Congressional Research Service. Jul. 23, 2018.

[10] Jay Bennett, "Drone Breaks Record (And the Law) By Allegedly Flying to 11,000 Feet", *Popular Mechanics*, Mar. 9, 2016. Available at: https://www.popularmechanics.com/flight/drones/a19854/drone-flown-11000-feet/ (last accessed on Aug. 17, 2018)

[11] See e.g., Alan Perlman, "Inside BVLOS, the Drone Industry's Next Game Changer", *UAV Coach*, Feb. 16, 2017. Available at: https://uavcoach.com/inside-bvlos/ (last accessed on Aug. 20, 2018)

include start-up technology companies, traditional aerospace firms, and automobile manufacturers.[12] These aircraft are expected to operate up to altitudes of 2,000 feet above ground level.[13] Like UAS, these aircraft will rely more extensively on automated flight controls, will be electrically propelled, and have relatively short ranges compared to conventional aircraft. Some companies have announced plans to commence services with these aircraft early in the next decade.

Airspace Integration Efforts

Role of the Federal Aviation Administration

The FAA regulates the use of the NAS. The agency also provides air traffic control services in United States airspace and also international airspace assigned to the United States.[14] The FAA's regulation of airspace encompasses operating rules, equipage requirements, and communication procedures, among other things, in different regions of airspace.[15] The FAA also determines the boundaries of various classes of airspace, separation standards, and flight paths.[16]

The introduction of UAS and flying cars on a large scale will require integration into the NAS. At a minimum, such integration efforts will entail measures to safely separate aircraft, clear obstacles, and protect persons and property on the ground. Airspace integration will also require addressing any gaps in operating rules and any required interoperability of existing and forthcoming air traffic control systems.

Low Altitude Authorization and Notification Capability

The FAA has commenced certain airspace integration efforts already. For instance, the Low Altitude Authorization and Notification Capability (LAANC) will provide near real-time processing of airspace authorization for certain UAS operations. These authorizations will enable airspace access for UAS in proximity to airports.[17] To date, the FAA has authorized five private firms to actually provide the service. LAANC is expected to be in the "beta" phase throughout 2018 and is being introduced in six "waves" throughout the United States.[18]

UAS Traffic Management (UTM)

The National Aeronautics and Space Administration (NASA), in partnership with the FAA, has been conducting research on a UAS traffic management (UTM) system.[19] UTM is

[12] Manuel Carrillo III, "Automakers, aerospace and startups are baking on a 'flying car' future.", Jul. 26, 2018. https://www.cnet.com/roadshow/news/flying-car-vtol-roundup/ (last accessed on Aug. 20, 2018)
[13] Elias, *supra.*
[14] https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/air_traffic_services/ (last accessed on Aug. 20, 2018).
[15] See e.g., 14 C.F.R. §§ 91.126-91.135 & 14 C.F.R. Part 93
[16] See e.g., "Amendment of Class E Airspace; New Castle, IN", 83 *Fed. Reg.* 42,022 (Aug. 20, 2018)
[17] https://www.faa.gov/uas/programs_partnerships/uas_data_exchange/ (last accessed on Aug. 20, 2018)
[18] *Id.* ; "Beta" testing is the second phase of software testing that precedes commercial release, *Merriam Webster Dictionary.*
[19] https://www.nasa.gov/ames/utm & https://utm.arc.nasa.gov/index.shtml (last accessed on Aug. 24, 2018)

expected to enable more advanced UAS operations by providing conflict avoidance, congestion management, and communications among other capabilities. The results from NASA research are expected to be transferred to the FAA in 2019 for additional testing.[20] A number of private firms are also working on UTM-related activities.[21] H.R. 4, the *FAA Reauthorization Act of 2018*, contains provisions intended to accelerate the development, licensing, and use of UTM.[22] The *FAA Extension, Safety, and Security Act of 2016* (P.L. 114-190) also contained a provision related to UTM research and a pilot program. [23]

Counter-UAS Technologies

Along with efforts to detect and regulate UAS operations in the NAS, the development of authorities and processes to counter unlawfully operated UAS for security or safety reasons are also underway. Technologies to counter UAS can have impacts on the airspace, including the operation of air traffic control, functioning of aircraft avionics, and other users of the NAS. The use of counter-UAS technologies will require careful consideration and application.

WITNESS LIST

Ms. Shelley Yak
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FAA Technical Center
(*Accompanied by:* Mr. Jay Merkle
Deputy Vice President, Program Management
FAA Air Traffic Organization)

Tom Prevot
Director of Engineering, Airspace Systems
UberElevate

JoeBen Bevirt
Founder and Chief Executive Officer
Joby Aviation

Mariah Scott
President
Skyward

[20] *Id.*
[21] See *e.g.*, https://gutma.org/full-members/ (last accessed on Aug. 20, 2018)
[22] H.R. 4 (115TH Cong.) §§ 45506 & 45507
[23] P.L. 114-190, § 2208, Jul. 15, 2016

AIRSPACE INTEGRATION OF NEW AIRCRAFT

THURSDAY, SEPTEMBER 6, 2018

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

The subcommittee met, pursuant to call, at 10:02 a.m., in room 2167, Rayburn House Office Building, Hon. Frank A. LoBiondo (Chairman of the subcommittee) presiding.

Mr. LOBIONDO. Good morning. The subcommittee will come to order.

Without objection, the Chair is authorized to declare a recess at any time.

We are in the early days of a technological revolution that will transform the aviation industry and our national airspace. In recent years, we have witnessed the growing use of unmanned aerial aircraft, or drones, to improve many different sectors of our economy, including infrastructure, energy, emergency response, and agriculture.

This committee has met a number of times to discuss the opportunities and challenges, including regulatory and safety issues, that will come with drones. More recently, we have heard from developers of new "flying car" aircraft. These aircraft may soon fly commuters and across-town travelers above congested highways, bridges, and roads in our cities.

It was not long ago that flying cars only existed in science fiction. These aircraft will carry three or four people short distances, fly a couple of thousand feet up, and share similar flight technology to drones. It is an exciting time for the aviation industry in the United States.

Other countries see this potential as well. For example, at the end of August, the Japanese Government convened a meeting in Tokyo that included 21 private companies to develop a plan for introducing flying cars there in the next decade. This meeting included American and European companies, in addition to Japanese firms. Companies participating range from tech companies and airlines to airspace and automobile giants that we all know.

And Japan is not the only country embracing this new transportation initiative. Firms in China are also looking to establish themselves as leaders. The United States must be active in order to maintain its global leadership in aviation. That means that the Federal Aviation Administration needs to stay ahead of these new technological advancements.

One thing that remains unchanged in the face of these developments is that our number one priority has been, is, and will be safety. To both ensure safety and maintain our leadership in aviation, we must systematically address a number of issues. Today we begin with how we safely and efficiently integrate new users into the National Airspace System.

Each day, thousands of conventional aircraft fly at altitudes that can often be measured in miles and fly between airports located in many of our communities. UAS and flying cars will fly at altitudes much closer to the ground and more often than not operate from places other than airports.

These differences raised at least a couple of initial questions of how UAS and flying cars integrate into the airspace. First, how will these aircraft physically fit and operate within the three-dimensional airspace and be kept at safe distances from other aircraft, buildings, and people on the ground in urban and other environments?

The second big question relates to air traffic control systems. Air traffic control and conventional aircraft rely on a number of procedures, including extensive voice communications between pilots and controllers over the radio. Flying cars and UAS will be far different. The concept is that highly automated systems on these aircraft will communicate with other highly automated systems on the ground, such as UAS traffic management, with less human intervention.

So the question here is, how will the new aircraft and systems incorporate with existing ones and also with each other? While those are big questions around airspace integration, there are others. In recent months, we have seen growing interest in more use of counter-UAS systems in the face of an emerging risk posed by unlawfully operated drones. There are many unknowns about the use of counter-UAS systems, which could impact avionics and air traffic control. Flying cars and lawfully operated UAS could also be impacted.

Fortunately for us, there are bright and creative people applying their talents to realize the benefits of UAS and flying cars in both the private and public sectors. These include efforts being undertaken in my district by the FAA's premier flagship technical facility in Egg Harbor Township, New Jersey, to advance airspace integration. We appreciate all the work that the industry and the FAA are doing at the FAA Tech Center to make safe integration of new aviation technologies a reality.

As this subcommittee continues to look ahead, it is important that industry engage with the members of this panel. There are exciting issues, and I look forward to hearing from our distinguished panel of witnesses.

Now, I would like to recognize Mr. Larsen for any opening statement.

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

This morning we are discussing issues related to the integration of new and emerging users into the U.S. airspace. The chairman and I have ensured this precise topic be a focus of the subcommit-

tee's oversight work in recent years and with the particular emphasis on unmanned aircraft, which we are here to discuss today.

And I am pleased that we will also explore the next new thing that may soon take the skies: passenger drones. Two of the panelists today will describe how the previously unthinkable and only imagined in shows that I watched growing up, like "The Jetsons," is pressing forward at a rapid pace and will soon change how the national airspace is used.

According to a recent industry scorecard, U.S. drivers spend, on average, more than 40 hours each year in traffic during peak hours. Traffic congestion not only costs U.S. drivers more than $300 billion each year but results in wasted hours and lost productivity. It takes a toll on air quality and the environment as well. This is something with which my constituents are all too familiar.

A 2017 industry study found commuters around the city of Everett in the district I represent spent more time stuck in traffic gridlocks than anyone else in the country. So, yes, we are better than Washington, DC, but barely.

But with recent advances in design and technology happening in places like Washington State, more than 50 passenger drone concepts are reportedly in development and testing. Such concepts have the potential to reduce traffic congestion and the demand on roads and bridges nationwide by carrying commuters through the air at low altitudes.

Some of the new concepts aimed to fly in U.S. airspace by 2020, but before that occurs, several issues need to be explored. For instance, how and where will they operate? How will Congress ensure operations are safe for those in the aircraft and for people and property on the ground? We are already seeing the risks unauthorized use of small UAS pose to the aviation system. So in considering passenger drones, safety must be paramount.

Another important question is how and when will the FAA develop a comprehensive regulatory framework to integrate these operations in the U.S. airspace? Is the FAA on track to accommodate this fast-paced industry so the U.S. remains globally competitive? There may be lessons learned from the FAA's efforts to integrate drones.

Initially, when the FAA was not keeping pace with the global stage, U.S. drone companies threatened to go abroad for testing, development, and deployment. What can be done here to prevent that from happening with this new technology? Is there a role for Congress? And, finally, how will the passenger drone concepts we explore today become accessible and realistic options for all once deployed in cities across the Nation?

So I look forward to exploring these topics today with the panelists and, of course, look forward to discussing continued integration issues associated with unmanned aircraft.

With that, Mr. Chairman, I will submit the rest of my comments for the record, and look forward to the panelists.

[Mr. Larsen's prepared statement follows:]

Prepared Statement of Hon. Rick Larsen of Washington

Thank you, Chairman LoBiondo, for calling today's hearing on "Airspace Integration of New Aircraft."

This morning, we are discussing issues related to the integration of new and emerging users into U.S. airspace.

Chairman LoBiondo and I have ensured this precise topic be a focus of this subcommittee's oversight work in recent years, and with a particular emphasis on unmanned aircraft, which we are here to discuss today.

I am pleased we will also explore the next "new thing" that may soon take to the skies: passenger drones.

Two of the panelists today will describe how the previously unthinkable, only imagined in shows like "The Jetsons," is pressing forward at a rapid pace and will soon change how the national airspace is used.

According to a recent industry scorecard,[1] U.S. drivers spend, on average, more than 40 hours each year in traffic during peak hours.

This traffic congestion not only costs U.S. drivers more than $300 billion each year, but results in wasted hours and lost productivity. It takes a toll on air quality and the environment as well.

This is something with which my constituents are all too familiar.

A 2017 industry study found commuters around the city of Everett, in the district I represent, spent more time stuck in traffic gridlocks than anyone else in the country.[2]

But with recent advances in design and technology, happening in places like Washington State, more than 50 passenger drone concepts are reportedly in development and testing.

Such concepts have the potential to reduce traffic congestion and the demand on roads and bridges nationwide by carrying commuters through the air, at low altitudes.

Some of the new concepts aim to fly in U.S. airspace by 2020, but before that occurs, several issues need to be explored.

For instance, how and where will passenger drones operate? How will Congress ensure operations are safe for those in the aircraft and for people and property on the ground?

We are already seeing the risks unauthorized use of small UAS pose to the aviation system.

When considering passenger drones, safety must be paramount.

Another important question is how and when will the Federal Aviation Administration (FAA) develop a comprehensive regulatory framework to integrate these operations into U.S. airspace?

Is the FAA on track to accommodate this fast-paced industry so the U.S. remains globally competitive?

There may be lessons learned from the FAA's efforts to integrate drones.

Initially, when the FAA was not keeping pace with the global stage, U.S. drone companies threatened to go abroad for testing, development and deployment. What can be done to prevent that from happening here? Is there a role for Congress?

And finally, how will the passenger drone concepts we explore today become accessible and realistic options for all once deployed in cities across the nation?

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

And of course, I look forward to discussing continued integration issues associated with unmanned aircraft.

There is no denying the extensive public and commercial benefits of unmanned aircraft and their applications continue to grow. For example, unmanned aircraft have been used to perform inspections of critical infrastructure, including bridges and railroads, and to assist in recovery efforts following recent natural disasters and wildfires.

In 2012, Congress directed the FAA to safely and efficiently integrate unmanned aircraft into the National Airspace System. While integration efforts and collaboration between the FAA and industry are ongoing, we are still far from full integration.

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[1] INRIX, *INRIX 2017 Global Traffic Scorecard*, http://inrix.com/scorecard/ (last visited Aug. 29, 2018).

[2] INRIX, *Los Angeles Tops INRIX Global Congestion Ranking*, http://inrix.com/press-releases/scorecard-2017/ (last visited Sep. 4, 2018).

For example, just over 2 years ago, the FAA released the long-awaited final rule on small commercial UAS operations (part 107), which significantly expanded and standardized the ability to conduct commercial UAS activities in the United States.

While this was a great first step toward integration, part 107 falls short in several ways.

For example, part 107 includes a waiver process that UAS operators must follow in order to fly more advanced and complex operations.

An industry group released analysis last week finding that since the FAA released part 107, the agency has granted more than 1,800 waivers, with only 23 waivers issued for beyond visual line of sight operations and only 13 for flights over people.[3]

A case-by-case waiver process is not sustainable to keep pace with an industry rapidly growing.

While the FAA moves forward with UAS integration efforts, it remains imperative that both commercial and recreational users operate these aircraft safely.

This is one of the reasons the FAA's UAS Integration Pilot Program (IPP) is important. It provides an opportunity for the agency, as well as State and local governments, to partner with the private sector to ensure safe UAS integration and help better craft regulations.

Further, I remain concerned about the increasing risks of UAS collisions with manned aircraft, as well as incursions with critical infrastructure and other mishaps.

I hope to hear from the FAA today about what Congress can do to resolve these safety concerns and ensure the agency has what it needs to help advance further integration efforts.

Whether it is UAS or passenger drones, this type of innovation is why the United States remains the world leader in aviation.

I welcome our panelists' perspectives on how this subcommittee can help ensure the aviation industry continues to innovate and thrive.

Again, thank you Chairman LoBiondo for calling today's hearing. I look forward to this discussion.

Mr. LOBIONDO. Thank you, Rick.

We are pleased to have Ranking Member Peter DeFazio with us.

Peter, do you have any opening remarks?

Mr. DEFAZIO. Thank you, Mr. Chairman. Yes, I do, briefly.

First, I want to congratulate you on holding this hearing, and perhaps it will be the last hearing over which you preside on this subcommittee. And I want to thank you for your great work, and I have enjoyed working with you, and I am sure you won't be a stranger. So thanks.

Mr. LOBIONDO. Thank you.

Mr. GRAVES OF MISSOURI. You didn't say that to me yesterday.

Mr. DEFAZIO. What is that?

Mr. GRAVES OF MISSOURI. You didn't say that to me yesterday.

Mr. DEFAZIO. Well, you are not leaving, so far as I know, Sam, unless we come up with a candidate in your district. Oh, presiding, yeah, OK, I could have said that, but I am just not—I am not measuring the drapes yet.

So anyway, this is a really important hearing. I mean, it is mind-boggling to read about, you know, what Uber is anticipating, what Joby is far along in developing in terms of new forms of transport which could help solve congestion.

Yesterday we held a hearing on technology, and there are things which can mitigate ground congestion, but they aren't ultimately going to resolve it. And as we continue to grow in population and density, we will be back at this point 10 or 15 years from now, even if the technology can mitigate the ground congestion. So new solu-

[3] Association for Unmanned Vehicle Systems International (AUVSI, *Waivers Under Part 107: Interactive Report*, https://www.auvsi.org/our-impact/waivers-under-part-107-interactive-report (last visited Aug. 29, 2018).

tions are warranted, and there is certainly a lot of potential in what we will hear today.

The key thing will be the safe integration into the existing controlled and uncontrolled airspace. You know, we are making progress on UTM and LAANC, and, you know, we will hear from Skyward today, who is working on those issues, which is absolutely critical.

It is kind of interesting that Oregon, which isn't—although Portland is getting to be kind of a mess, but one of the most congested places in the country has pioneered in some of these technologies. The first demonstration I ever saw of ADS–B was a company in Salem, Oregon, and now we have Skyward in Portland working on this extraordinary new integration for less traditional operations commercially.

And I can't help but to again make a point that the key thing—and we will hear from the FAA today here—is that we need to be able to regulate so-called model aircraft. Now, the model aircrafters, who are a responsible, longstanding group of people—you know, I started out with the little balsa wood planes with the little engines that wouldn't work, and I know what they are doing.

But at some point they became petrified that the FAA, which wasn't considering regulating them, was going to regulate them in ways that were detrimental, and they got my Republican colleagues to put a very broadly worded provision in an FAA bill which prohibits any regulation of model aircraft, which includes over 1 million drones that have been sold in the United States of America.

What is the problem there? Well, just last week when I was home, we had to ground all the aircraft fighting the Terwilliger fire about 25 miles from my house because some jerk flew his toy drone into the controlled and prohibited airspace. The sheriff said, we don't know who the person is or where it came from. We can't do anything about it. So even though we have upped the fines, doesn't matter.

And I got a provision in the FAA bill that came out of the House that would allow reasonable regulation and operator identification of these drones. It is critical that we take that step. There is a competing amendment that won't get the job done put in by the Chinese toy manufacturers.

So I would hope that Congress in its wisdom decides that we are going to go down the path of sanity here and allow real regulation, real identification, and not have to wait until we go back 20, 25 years ago when we used to call the FAA the—they said they had a tombstone mentality. They investigated and fixed things after we lost a passenger aircraft. We don't want to go back to those days, but that is going to happen with one of these drones being illegally and improperly operated, whether it is maliciously or someone who is just a jerk.

So anyway, I just thought I would take the opportunity to raise that point again since we are sort of having a conference with the Senate which sort of almost kind of did an FAA bill but now says they had 90 amendments that would have been adopted if they had taken it up, so therefore we have to deal with all their 90 amend-

ments that never were adopted and were never taken up on the floor of the Senate. So I am not sure we get to resolution.

Anyway, with that, thanks for being here.

Mr. LOBIONDO. OK. Thank you, Peter.

I would like to now welcome our distinguished panel of witnesses. First on the list is Ms. Shelley Yak, who is Director of the Federal Aviation Administration Technical Center. I am going to take a moment of personal privilege because those of you who have attended any of these hearings or meetings know that whenever I get the chance.

The FAA Technical Center that Shelley is the Director of is the premier facility in the world for safety, security, research, and development. There are somewhere between 3,500 and 4,000 incredible people who dedicate themselves each and every day to keeping America first. Shelley has done an excellent job, and we welcome you, Shelley, today.

Jay Merkle, Deputy Vice President of the Program Management Organization for FAA's Air Traffic Organization; Mr. Tom Prevot, director of engineering, airspace systems for Uber Elevate; JoeBen Bevirt, founder and chief executive officer of Joby Aviation; and Mariah Scott, president of Skyward.

Thank you all for being here. Your full statements will be submitted into the record. We ask you to do your best to keep your opening statement to about 5 minutes, and we will proceed.

Shelley, you are up first.

TESTIMONY OF SHELLEY J. YAK, DIRECTOR, WILLIAM J. HUGHES TECHNICAL CENTER, FEDERAL AVIATION ADMINISTRATION, ACCOMPANIED BY JAY MERKLE, DEPUTY VICE PRESIDENT, PROGRAM MANAGEMENT ORGANIZATION, AIR TRAFFIC ORGANIZATION, FEDERAL AVIATION ADMINISTRATION; THOMAS PREVOT, DIRECTOR OF ENGINEERING, AIRSPACE SYSTEMS, UBER TECHNOLOGIES, INC.; JOEBEN BEVIRT, FOUNDER AND CHIEF EXECUTIVE OFFICER, JOBY AVIATION; AND MARIAH SCOTT, PRESIDENT, SKYWARD, A VERIZON COMPANY

Ms. YAK. Thank you for your kind words.

Good morning, everyone. Good morning, Chairman Shuster, Chairman LoBiondo, Ranking Member DeFazio, Ranking Member Larsen, and the members of the subcommittee. Thank you for the opportunity to appear before you today to discuss the FAA William J. Hughes Technical Center and the work that our 3,000 employees and contractors do to facilitate new entrants, new users, new technologies into the National Airspace System, or the NAS.

My name is Shelley Yak. I am the Director of the technical center and the FAA's Director of Research. Accompanying me today is Jay Merkle. He is the Deputy Vice President of the Program Management Organization within the Air Traffic Organization. His organization is responsible for implementing next generation air transportation system programs and sustaining the NAS system.

From 1958 to the present, many of the complex technologies and systems in the NAS were researched, developed, tested, and began their nationwide deployment at the technical center through its

unique research, engineering, testing, evaluation, and deployment platforms.

We are able to accomplish these tasks because we are responsible for managing and operating a one-of-a-kind Federal laboratory. Our workforce is composed of world-class and world-renowned engineers, scientists, mathematicians, and technical experts. We do our work through partnerships with industry, academia, and other Government agencies.

The technical center has two primary missions: to support the advancement of the next generation air transportation system and to sustain the operation of our NAS. In other words, we keep the NAS operating and running while we are also building our future.

The technical center is the place where we turn ideas into value and problems into solutions. The work we do at the center ensures that the United States continues to lead the world in embracing, implementing, and integrating new technology such as unmanned aircraft systems into the NAS.

Unmanned aircraft systems, or the UAS, are at the forefront of change in the aviation industry. The need for us to fully integrate this technology into the NAS continues to be a national priority. In the past few years, we have witnessed the exponential growth of UAS technologies and market applications. And we know that the research must keep pace in supporting their full integration.

FAA's research portfolio in total contains six research domain areas, which support and align with our UAS integration roadmap. For example, the FAA's airport infrastructure and technologies research traditionally includes pavement and terminal area research, now includes research on the potential uses of UAS in an airport environment.

Our aircraft safety assurance research area focuses on aircraft systems and materials, propulsions, and fuels, including fire safety, which also addresses lithium batteries. And our digital systems and technologies domain research researches communication links, electronic systems, and cybersecurity, all topics relevant to UAS and urban air mobility.

Also applicable is our environment and weather impact mitigation research on weather, icing, noise, and emissions, and our human aeromedical factors research on operator training and digital interface requirements.

The sixth domain, aviation performance and planning, brings it all together. This domain performs research on improvements in air traffic management and integrating new entrants into the NAS.

In addition to the work in these areas, the UAS integration pilot program has been busy accelerating drone technology. This past May, Secretary Chao selected 10 State, local, and Tribal governments, each partnering with private sector entities, to participate in the program. This month, awardees across four different States successfully flew drones demonstrating the innovative ways drones may assist their communities. These areas include long-distance drone delivery, agriculture, and infrastructure inspections, and even wildlife management.

Throughout our history, FAA has adapted to changes in technology and has successfully integrated new operations and equipment into the NAS. Working together with you, Congress, and our

stakeholders, we are confident we can balance safety and security with innovation.

Finally, before I conclude, I would like to take a moment to acknowledge the support of Chairman Shuster and subcommittee chairman, Mr. LoBiondo. You have both been instrumental in providing the FAA with the direction and necessary resources to maintain our position as a global leader in aviation. On behalf of the 3,000 employees at the center and all FAA employees, I thank you both for your leadership, and wish you well as you retire from Congress.

This concludes my statement. Jay and I will be happy to answer your questions at this time.

[Ms. Yak's prepared statement follows:]

Prepared Statement of Shelley J. Yak, Director of the William J. Hughes Technical Center, Federal Aviation Administration

Chairman LoBiondo, Ranking Member Larsen, Members of the Subcommittee:

Thank you for the opportunity to speak with you today about the role of the Federal Aviation Administration's (FAA) William J. Hughes Technical Center in facilitating new entrants, new users, and new technologies into the National Airspace System (NAS). Accompanying me today is Peter "Jay" Merkle, the Deputy Vice President of the Program Management Organization (PMO) within the Air Traffic Organization (ATO). The PMO is responsible for implementation of all Next Generation Air Transportation System (NextGen) program activity; all NAS communications; navigation, weather, surveillance and automation modernization programs; and all service life extensions to legacy NAS sensors, communications and navigation aids.

WILLIAM J. HUGHES TECHNICAL CENTER

The Technical Center has served as one of the core facilities for sustaining and modernizing the air traffic management system, and for advancing programs to enhance aviation safety, efficiency, and capacity since 1958. It is the Nation's premier air transportation system Federal laboratory. The Technical Center's highly technical and diverse workforce carries out activities to support the full system/service development lifecycle—from conducting research and development, testing and evaluation, verification and validation, to operational sustainment and decommissioning.

The Technical Center's staff develops scientific solutions to current and future air transportation safety, efficiency, and capacity challenges. Our engineers, scientists, mathematicians, and technical experts utilize a robust, one-of-a-kind, world-class laboratory environment to identify integrated system solutions for the modernization and sustainment of the NAS. Automatic Dependent Surveillance Broadcast (ADS-B), En Route Automation Modernization (ERAM) and Data Communications (Data Comm) were all developed, tested and began their nationwide deployment at the Technical Center through its engineering, testing, evaluation, and deployment platforms.

The Technical Center replicates the entire NAS, with the capability to support not only NextGen, but all aviation systems. The Technical Center's areas of focus include air traffic management, communications, navigation, surveillance, aeronautical information, weather, human factors, airports, and aircraft safety. More recently, the Technical Center has been instrumental in the FAA's efforts to facilitate new entrants and users to the NAS; particularly, unmanned aircraft systems (UAS or drones).

FAA'S VISION FOR UAS INTEGRATION

Future aviation operations must accommodate the increasing demand for airspace access by traditional civil aviation users as well as new entrants. UAS are at the forefront of change in the aviation industry. They are being used today to inspect infrastructure, provide emergency response support, survey agriculture, and to go places that are otherwise dangerous for people or other vehicles. Entrepreneurs around the world are exploring innovative ways to use drones in their commercial activities. To date, we have processed over 1.1 million UAS registrations, over 230,000 of which are for unmanned aircraft that can be flown commercially. For per-

spective, as of July 2018, there are just under 300,000 manned aircraft listed on the U.S. registry. The need for us to fully integrate this technology into the NAS continues to be a national priority.

The Department of Transportation and FAA's vision for integration is ambitious. We intend to fully integrate UAS into the most complex airspace system in the world, enabling UAS to operate harmoniously with manned aircraft, occupying the same airspace and using many of the same standards and procedures. Two years ago, we established the regulatory framework— and set the global standard—for small UAS integration. Our roadmap for full UAS integration is intended to enable increasingly more complex UAS operations over time: (1) operations over people; (2) operations beyond the visual-line-of-sight of the operator; (3) small UAS package delivery operations; (4) routine/scheduled operations; (5) large carrier cargo operations; and, finally, (6) passenger transport operations.

RESEARCH AND DEVELOPMENT

As the FAA's Director of Research, I oversee the FAA's aviation research and development (R&D) activities. Effective research enables the FAA's mission to provide the safest, most efficient aerospace system in the world. As new technologies change the aviation industry, our approach to research must evolve as well. Emerging innovations, such as UAS, require an agile research and development strategy focused on change driven by technology and collaborative, data-driven partnerships across government and with industry and academia. Through this collaboration, we will continue building on our unparalleled safety record, while increasing the efficiency of our system and more fully integrating new users.

With the exponential growth of UAS technologies and market applications we have witnessed in just a few years, we know that research must keep pace to support full integration. We are aligning our UAS research activities with our integration roadmap. Safety is and will always be the FAA's first priority, and continued support for UAS research initiatives will ensure that UAS are integrated into the NAS in a safe, secure, and efficient manner.

UAS research activities are coordinated across many different types of entities, including internal FAA organizations, different U.S. Government agencies, and nongovernmental entities that perform collaborative research to support the FAA's overall integration objectives. Coordination with each type of entity includes the identification of research needs and current research, governance for continuous cooperation, and mechanisms for managing progress and results. Issues and considerations being addressed include detect and avoid standards and technologies, collision avoidance standards, command and control standards and technologies, human factors, severity thresholds (for example, impact effects), automation/autonomy, and wake turbulence effects. One example of this coordination is the UAS Standardization Collaborative (UASSC), co-chaired by the FAA and the Association for Unmanned Vehicle Systems International (AUVSI) and managed by the American National Standards Institute (ANSI). UASSC brings together over 230 members from the user applications, manufacturer, safety and emergency response, academic and government communities to accelerate development of standards and conformity assessment programs to facilitate the safe integration of UAS into the NAS.[1]

The FAA's NextGen organization also has appointed a UAS portfolio manager to unify and manage all UAS R&D execution. The UAS R&D portfolio includes UAS research conducted at the Technical Center, the Center of Excellence for UAS, interagency UAS partnerships, UAS flight demonstrations and test sites, and all aviation safety research defined by the Office of Aviation Safety through the FAA's UAS Integration Office. Additionally, the FAA's ATO is developing concepts and requirements to address FAA challenges associated with the provision of air traffic services to UAS airspace users.

The FAA is also gathering operational data and experience that will inform future rulemaking to enable UAS operations over people and beyond line-of-sight. While the small UAS rule—14 C.F.R. part 107—has been largely successful by enabling operations such as crop monitoring/inspection; research and development; educational/academic uses; power-line/pipeline inspection; antenna inspections; emergency response; bridge inspections; aerial photography; and wildlife nesting area evaluations, it does not permit several potential uses for UAS that are highly valued by industry, such as operating beyond line-of-sight or at night. To accommodate these operations, the rule allows operators to apply for waivers from its provisions. As of August 2018, the FAA has reviewed almost 12,000 operational waiver applica-

[1] https://www.ansi.org/standards__activities/standards__boards__panels/uassc/overview#UASSC%20Overview

tions and has issued approvals for over 1,800 waivers, significantly reducing the processing time from almost 90 days to approximately 20 days.

While most of these approved waivers (more than 90 percent) have been for night flying, others have been granted for more complex activities, such as for flying over people or beyond line-of-sight. The commercial activities that typically receive waivers for UAS operations are for filmmaking, photography, and infrastructure inspections.

The newly launched UAS Integration Pilot Program (IPP) sets the stage to move even closer to expanded operations through enhanced partnerships among industry and State, local and tribal authorities. On May 9, 2018, the Secretary of Transportation announced that 10 State, local, and tribal governments were selected to participate in the IPP. Each of the participants is partnering with private sector entities to evaluate operational concepts and provide DOT and FAA with actionable information that will accelerate safe and secure UAS integration. The goals of the program are to: identify ways to balance local and national interests; improve communications with local, State, and tribal jurisdictions; address security and privacy risks; accelerate the approval of operations that currently require special authorizations; and collect data to support the development of regulatory actions necessary to allow more complex, routine low-altitude operations. A list of the participants and each of their proposed operational concepts may be found at: https://www.faa.gov/uas/programs__partnerships/uas__integration__pilot__program/awardees/.

AIRSPACE MANAGEMENT

The FAA's primary mission is to provide the safest, most efficient airspace system in the world. We are responsible for providing air traffic control and other air navigation services 24 hours a day, 365 days a year, for 29.4 million square miles of airspace. In addition to this critical operational role, the FAA uses its statutory authority to carry out this mission by issuing and enforcing regulations and standards for the safe operation of aircraft—manned and unmanned—and by developing procedures to ensure the safe movement of aircraft through the nation's skies.

Automated Airspace Authorization

The basic rules for small UAS operations—14 C.F.R. part 107—set the global standard for integration and provided small drone operators with unprecedented access to the NAS. Part 107 creates airspace rules specific to small UAS operations. It allows line-of-sight, daytime operations in uncontrolled Class G airspace without the need for approval from the FAA. Operations in controlled airspace—Class B, C, D, and surface area E—require prior approval from air traffic control.

Compliance with basic airspace requirements—the "rules of the road"—is essential to maintaining safety and efficiency in the NAS and ultimately will make it easier for our national security and law enforcement partners to identify a drone that is being operated in an unsafe or suspicious manner. To facilitate airspace approvals for small UAS operators, last November, we deployed the prototype Low Altitude Authorization and Notification Capability (LAANC) at several air traffic facilities to evaluate the feasibility of a fully automated solution enabled by public/private data sharing. Based on the prototype's success, we began the first phase of a nationwide beta test of LAANC on April 30, 2018, enabling LAANC services at about 80 airports. This rollout will continue incrementally to nearly 300 air traffic facilities covering approximately 500 airports. We recently completed the fifth wave of this nationwide rollout, which now covers 82 percent of air traffic facilities, and we are on track to complete nationwide deployment in September 2018.

LAANC uses airspace data based on the FAA's UAS facility maps, which show the maximum altitudes in one square mile parcels around airports where UAS may operate safely under part 107. It gives drone operators the ability to request and receive real-time authorization from the FAA, allowing them to quickly plan and execute their flights. LAANC also makes air traffic controllers aware of the locations where planned drone operations will take place, and it can provide information on aircraft that have requested access to a defined airspace.

UAS Traffic Management

LAANC is an important foundational step toward implementing UAS Traffic Management (UTM). UTM is a "traffic management" ecosystem for UAS operations not under FAA air traffic control (ATC), and is separate but complementary to the FAA's air traffic management system. UTM development will ultimately identify services, roles/responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements for enabling the management of low-altitude UAS operations where ATC does not typically provide services.

We view UTM as a suite of capabilities that will incorporate components from the FAA, industry, and our government partners to create a comprehensive system of low-altitude airspace management for UAS. Our plan for future UTM capabilities includes a number of components—LAANC, remote identification, and dynamic airspace management—that will support the needs of industry, FAA, and our security partners. The eventual full deployment of UTM services will create an environment in which the entire spectrum of unmanned aircraft can be safely realized, including the transportation of people and property.

UAS in Controlled Airspace

We are also making headway with an Aviation Rulemaking Committee (ARC) to address UAS in controlled airspace, which will provide recommendations on UAS integration in, and transit to, high altitude airspace. The ARC will develop scenarios that will encompass the most desired operations, identify gaps in research and development needed to successfully integrate larger UAS into controlled airspace, and recommend up to five prioritized changes to policies and procedures that will spur integration and economic growth. The ARC held its fifth meeting in May 2018 and will continue to meet through the expiration of the ARC's charter in June 2019.

IMPEDIMENTS TO FULL UAS INTEGRATION

The FAA has made significant progress in integrating UAS into the NAS and, through our ongoing research activities, we are well-positioned to continue to build on our accomplishments. We know, however, that there is much more work to do. The FAA's commitment to the safe, secure, and efficient integration of UAS and the expansion of routine UAS operations also requires resolving specific challenges to enable this emerging technology to achieve its full potential.

Statutory Exemption for Model Aircraft

The most significant challenge the FAA continues to encounter is the perception by many recreational UAS operators that they are not required to follow the basic rules of UAS operation because they erroneously believe they fit under the statutory exemption for model aircraft operated under the programming of a community-based organization. These unknowing operators present risks to both manned and unmanned compliant operators. The current exemption for model aircraft—Section 336 of the FAA Modernization and Reform Act of 2012—makes it difficult for the FAA to develop new regulatory approaches that will help expand and facilitate more advanced uses of UAS in the NAS. A set of basic requirements for all UAS operators are essential to allow both the FAA and our security and law enforcement partners to discern between the clueless, the careless, and the criminal—including serious threats to national security—and to ensure all operators conduct compliant operations or face the consequences of introducing a safety or security risk into the NAS.

Remote Identification

As Congress has recognized, remote identification of UAS is another critical step on the path to full integration of UAS technology. In order to support beyond visual line-of-sight operations, UAS operators need to know where their aircraft is and where other aircraft are along their flight path. Remote identification is also essential to enable our law enforcement and national security partners to identify and respond to security risks. Effective integration and threat discrimination will continue to be a challenge until all aircraft in the NAS—manned and unmanned—can be identified. Anonymous operations are inconsistent with safe and secure integration.

Last December, we published the report and recommendations prepared by the summer 2017 UAS Identification and Tracking ARC [2]. The ARC's 74 members represented a diverse array of stakeholders, including the aviation community and industry member organizations, law enforcement agencies and public safety organizations, manufacturers, researchers, and standards developing organizations involved with UAS. The ARC's recommendations cover issues related to existing and emerging technologies, law enforcement and national security requirements, and how to implement remote identification. Although some recommendations were not unanimous, the group reached general agreement on most issues. The FAA is reviewing the technical data and recommendations in the ARC report to support the development of the FAA's remote identification requirements. We are currently working on a proposed rule to implement these requirements as quickly as possible.

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[2] See https://www.faa.gov/news/updates/?newsId=89404&omniRss=news_updatesAoc&cid=101_N_U

CONCLUSION

Throughout our history, the FAA has adapted to changes in technology and has successfully integrated new operators and equipment into the NAS. Our progress in accommodating new technologies and operations demonstrates that the agency is well positioned to maintain its status as the global leader in UAS integration. We are committed to working with Congress and all of our stakeholders to find solutions to our common challenges. Working together, we are confident we can balance safety and security with innovation. With the support of this Committee and the robust engagement of our stakeholders, we will continue to safely, securely, and efficiently integrate UAS into the NAS and solidify America's role as the global leader in aviation.

Finally, before I conclude I would like to take a moment to acknowledge the support of Chairman Shuster and Subcommittee Chairman LoBiondo. You have been instrumental in providing the FAA with the direction and necessary resources to maintain our position as a global leader in aviation. I thank you both for your leadership and wish you well as you retire from Congress.

This concludes my statement. I will be happy to answer your questions at this time.

Mr. LOBIONDO. OK. Thank you, Shelley.

Jay, do you have an opening statement?

Mr. MERKLE. Thank you, Chairman. I do not. Shelley has our only statement for the FAA.

Mr. LOBIONDO. OK. Dr. Prevot, you are up.

Mr. PREVOT. Good morning. Chairman LoBiondo, Ranking Member Larsen, Ranking Member DeFazio, and members of the subcommittee, it is a privilege to be here before you today to discuss Uber's perspective on airspace integration of new aircraft. My name is Tom Prevot, and I am excited to lead Uber's airspace systems engineering.

Uber is developing aviation products because we believe aerial ride-sharing and drone deliveries have the potential to radically improve urban life. As a multimodal transportation company, Uber believes solving the problems of congested urban environments is core to our mission of making transportation safe, reliable, and affordable.

Just as skyscrapers allowed cities to use limited land more efficiently, urban air transportation will use three-dimensional airspace to alleviate transportation congestion on the ground. One of the primary challenges in enabling urban air transportation is airspace integration and air traffic management. In order to operate at affordable prices and serve customers well, we intend to fly thousands of aircraft in each metropolitan area that we serve.

The traditional human-centered air traffic system, however, is not designed to manage air traffic at this scale. Therefore, we applaud NASA and the FAA for developing the novel concepts and technologies for unmanned aircraft systems traffic management, commonly abbreviated as UTM. We encourage NASA and the FAA to place the highest priority on extending these concepts towards other forms of urban air mobility, including small passenger carrying aircraft such as electric vertical takeoff and landing vehicles.

These concepts are paving the way for Uber and other companies to drive innovation and develop airspace services that manage the vehicles on our network safely and efficiently without putting an undue burden on existing air traffic operations.

Our vision is to operate 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.

Our systems will constantly monitor each flight with several safety layers handling outlying situations. In developing these systems, Uber will take a systematic approach to integration and validation in simulations and field testing to ensure interoperability and safety.

Uber has signed two Space Act Agreements with NASA, one for the development of UTM concepts and technologies, and another to explore urban air mobility, or UAM. Under the agreement focused on UTM, we are actively collaborating with NASA and a number of other companies to develop and test the information exchange protocols between the FAA systems and the industry-based UAS service supplier systems.

Under our UAM agreement with NASA, we are focused on assessing the impact of new urban air entrants on traditional air traffic operations with the goal of developing procedures and technologies that allow urban air traffic to integrate and scale into the existing operations. To kick-start this area of collaboration, a simulation study will be conducted at NASA and its research center in the Silicon Valley in just 2 weeks.

Uber is participating in the UAS integration pilot program administered by the Department of Transportation and the FAA. We are proud to be a part of the team led by the city of San Diego that was recently selected to conduct flight tests as part of the pilot program.

We work with many partners in the industry on overcoming the technological barriers to conducting safe and acceptable drone deliveries and are pleased with the exceptional collaboration between industry and the FAA to work through the regulatory barriers associated with operating multiple unmanned vehicles safely over people and beyond the line of sight.

Beyond the UAS IPP, Uber is excited about the work the FAA is conducting through its Low Altitude Authorization and Notification Capability initiative, more commonly referred to as LAANC. Uber believes LAANC sets the groundwork for the future of drone traffic management and is supportive of its ongoing expansion. We encourage the FAA to extend the approach of coordinating airspace access through digital data exchanged beyond the static facility maps.

We commend the Department of Transportation on these innovative, future-facing projects, and look forward to working with the Department on these and other exciting initiatives, including establishing Federal rules on remote identification requirements for all drone aircraft.

Uber is investing in urban air transportation because it has the potential to deliver time savings at affordable prices to consumers across the world. We see exceptional demand across all markets for safe, reliable, fast transportation services, and our network can be an excellent supplement to public and private transit options.

The converging forces of improving battery technology, massive utilization, and the outset of reliable autonomous aviation will transform how people and things move around cities across the world. Working with leaders in both the public and private sector,

we are confident Uber will make a sizable impact on this challenge and bring about a lasting positive change for the world.

Thank you for your time, attention, and invitation. I look forward to answering your questions.

[Mr. Prevot's prepared statement follows:]

Prepared Statement of Thomas Prevot, Director of Engineering, Airspace Systems, Uber Technologies, Inc.

Chairman LoBiondo, Ranking Member Larsen, and Members of the Subcommittee, it is a privilege to be here before you today to discuss Uber's perspective on the future of air traffic and airspace integration of new aircraft.

My name is Thomas Prevot, and I am excited to lead Uber's airspace systems engineering. Our airspace systems will manage both Uber's Elevate initiative, our future uberAIR product that aims to allow anyone to push a button and get an urban air flight, as well as our drone delivery initiative for Uber Eats.

Uber is developing aviation products because we believe aerial ridesharing and drone deliveries have the potential to radically improve urban life. Every year, millions of hours are wasted in traffic on roads globally. In early 2018, INRIX, a Kirkland, Wash.-based traffic technology and data firm, ranked Seattle ninth among cities in the United States for time spent stuck in traffic at 55 hours per year due to congestion. And the *Los Angeles Times* reports L.A., one of our Elevate pilot markets, is the most congested city in the world. For residents of those cities and for the rest of us, moments stuck on the road represent less time with family, fewer hours growing our economies, and more congestion polluting our world.

As a multi-modal transportation company, Uber believes solving these problems is core to our mission of making transportation safe, reliable, and affordable to everyone, everywhere. Just as skyscrapers allowed cities to use limited land more efficiently, urban air transportation will use three-dimensional airspace to alleviate transportation congestion on the ground. We started this journey 2 years ago, publishing our *Elevate White Paper* to answer the questions: why don't people fly in cities today, and what barriers must be overcome to make such a service possible at scale?

And from our extensive research, we have found that one of the primary challenges in enabling urban air transportation is airspace integration and air traffic management. In order to operate at affordable prices and serve all our potential customers well, we intend to fly thousands of aircraft in each metropolitan area that we serve. The traditional safe, human-centered air traffic system, however, is not designed to manage air traffic at this scale. Therefore, we applaud the National Aeronautics and Space Administration (NASA) and the Federal Aviation Administration (FAA) for developing the novel concepts and technologies for Unmanned Aircraft Systems Traffic Management, commonly abbreviated as UTM.

We further encourage NASA and the FAA to place the highest priority on extending these concepts toward other forms of urban air mobility including small passenger carrying aircraft such as our electric Vertical Take-off and Landing (VTOL) vehicles.

UTM is paving the way for Uber and other companies to drive innovation and develop airspace services that manage the vehicles on our network safely and efficiently without putting an undue burden on existing air traffic operations or air traffic controllers. Our vision 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. Our network systems will also constantly monitor each flight with several safety layers handling outlying situations. In developing these systems, we will take 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.

We have signed two Space Act Agreements with NASA, one for the development of UTM concepts and technologies, and another to explore Urban Air Mobility or UAM. Under the agreement focused on UTM, we are actively collaborating with NASA and a number of other companies to develop and test the information exchange protocols between the FAA's systems and the industry-based UAS service supplier systems. These tests are coordinated by NASA as part of the UTM Technical Capability Level 4 preparations, and utilize simulations to bring the stake-

holders together in achieving interoperability before testing these capabilities in the field under the UTM pilot program.

Under our UAM agreement with NASA, we are focused on assessing the impact of new urban air entrants on traditional air traffic operations with the goal of developing procedures and technologies that allow urban air traffic to integrate and scale into the existing operations. To kickstart this area of collaboration, a simulation study will be conducted at NASA Ames Research center in the Silicon Valley in just 2 weeks. We view this simulation, as well as both our partnerships with NASA, as critical for devising the path for safely sharing the airspace amongst all airspace users.

Additionally, Uber is participating in the UAS Integration Pilot Program (UAS IPP) administered by the Department of Transportation and the FAA. We are proud to be a part of the team, led by the city of San Diego, that was recently selected as one of ten State, local, and tribal governments able to conduct flight tests as part of the pilot program.

We work with many partners in the industry on overcoming the technological barriers to conducting safe and acceptable drone deliveries and are pleased with the exceptional collaboration between industry and the FAA to work through the regulatory barriers associated with operating unmanned vehicles safely over people, with beyond the line of sight operations, and with fewer than one pilot per vehicle.

Beyond the UAS IPP, Uber is excited about the work the FAA is conducting through its Low Altitude Authorization and Notification Capability initiative, more commonly referred to as LAANC. LAANC is an automated application and approval process for airspace authorizations that uses airspace data, including UAS facility maps, to dramatically decrease response times on flight requests from weeks or months to near real-time. We believe the initiative sets the groundwork for the future of drone traffic management and are supportive of its ongoing expansion to 300 air traffic facilities and 500 airports across the country. We encourage the FAA to extend the approach of coordinating airspace access through digital data exchange beyond the static facility maps.

We commend the Department of Transportation on these innovative, future-facing projects and look forward to working with the department on these and other exciting initiatives, including establishing Federal rules on remote identification requirements for all drone aircraft.

At Uber, we are investing in urban air transportation because it has the potential to deliver time savings at affordable prices to consumers across the world. We see exceptional demand across all large markets for safe, reliable, fast transportation services, and our network can be an excellent supplement to public and private transit options. The converging forces of improving battery technology, massive utilization, and the outset of reliable autonomous aviation will transform how people and things move around cities across the world. Working with leaders in both the public and private sector we are confident Uber will make a sizable impact on this challenge and bring about a lasting positive change for the world.

Thank you for your time, attention and invitation. I look forward to answering your questions about Uber's vision and approach to air traffic and UAS integration.

Mr. LOBIONDO. Thank you, Doctor, for your testimony.

Mr. Bevirt.

Mr. BEVIRT. Thank you very much, Chairman LoBiondo, Ranking Member Larsen, Ranking Member DeFazio, and distinguished members of this committee. Thank you for your work in creating the safest and most efficient transportation system in the world.

It is a great honor to be here today to tell you about the progress towards my childhood dream of a civilization unfettered and free to fly. Our small team of dedicated and driven visionaries has fused a series of technological advancements into an extraordinary and unprecedented aircraft, safe and quiet, nimble and fast, accessible and affordable.

We will operate a fleet of these electric aircraft as air taxis flying from building to building. My mission is to provide a service so compelling and affordable that everyone will fly every day. I believe that unbounded aerial mobility will drive gains in productivity, quality of life, and bring about renaissance as we turn streets into parks.

We are rapidly growing our team of engineers and technicians and are venture backed by prominent investors. We plan to create thousands of high-quality domestic jobs as we scale from certification into vehicle manufacturing and service operations.

As a Nation, we spend hundreds of billions of dollars each year building and maintaining our roads, and yet congestion is more acute than ever before. The limitations of the automobile and our ground infrastructure constrain where we can work and where we can live. On average, we spend nearly an hour a day in the car locked to one-dimensional trajectories.

Aerial mobility will save us billions of hours per year and increase access to high-quality jobs. Managing airspace will be one of the key challenges in delivering this safe, efficient, and reliable means of air travel to our end customers.

We will begin our operations within the existing airspace framework with a pilot on board who can coordinate and de-conflict our flights using a traditional radio-based system to maintain real-time communication with the FAA flight control staff. Our initial flights will be very much like helicopter operations today, following established, safe, part 135 regulations.

However, as the size of our operations scale, we will need to move to an increasingly automated air traffic control system that allows for digital de-confliction of airspace in realtime. We support the ongoing development of unmanned traffic management at NASA and the FAA.

Given the incredible foresight and hard work over the past decade by my colleagues at the FAA and your committee, the certification path for vehicles like ours has been dramatically improved. Thank you.

We believe part 23, amendment 64, plus special conditions can provide a basis for our vehicle certification. We have been working closely with the FAA to establish our means of compliance. We encourage Congress to provide the FAA with the resources that they need to support their rapidly increasing workload as they usher in this new era of mobility.

Alongside airspace management and vehicle certification, the development of landing sites within both urban, suburban, and rural airspaces is necessary for the successful deployment of this service across our Nation. The provisioning of these locations requires careful consideration of updated standards relating to landing zone requirements, site, and passenger security. It is important that standards for these sites are more uniform rather than less so.

To that end, a patchwork of disparate regionalized regulation is not in the public interest. We have already begun working with select municipalities to help define standards and best practices for takeoff and landing sites and for operations. We encourage close coordination and cooperation between Federal, State, and local governments, and regulatory agencies to synthesize these best practices in formal standards that can provide a clear, nationwide path to compliance and authorization.

If I could leave you with one takeaway from today's hearing it would be that this technology is very real and it is here now. I want to thank the leadership of this committee and its members for your time today. We believe this new mode of transportation

will bring about profound, positive impact on our daily lives and on the productivity of our Nation.

Thank you again, and I look forward to your questions.

[Mr. Bevirt's prepared statement follows:]

Prepared Statement of JoeBen Bevirt, Founder and Chief Executive Officer, Joby Aviation

INTRODUCTION

Chairman LoBiondo, Ranking Member Larsen, and distinguished members of the Subcommittee, thank you for the opportunity to appear before you today on behalf of Joby Aviation to discuss electric air taxis, the promise of next-generation air mobility, and how these aircraft can be integrated into our nation's airspace.

For more than 10 years, Joby Aviation has been at the forefront of next-generation air vehicles built around economical and sustainable fully electric powertrains. In pioneering efforts both with NASA and the US Department of Defense, we have helped push the boundaries of the possible in flight through the careful application of distributed electric motors and large-format lithium-ion batteries to air vehicle design. Distributed electric propulsion is the efficient use of a large number of smaller electric motors to distribute sources of thrust to create redundancy. This increases safety, improves aerodynamic efficiency for greater range and speed, and lowers the noise profile of air vehicles for greater community acceptance. One example of our early work is the X–57 Maxwell—the first all-electric "X-plane"—developed in conjunction with NASA and other private industry partners.

More recently, Joby Aviation has been 100 percent focused on the development of a piloted, five-seat, all-electric, vertical takeoff and landing passenger aircraft optimized for the delivery of on-demand air travel. Our design goals for the vehicle were threefold: first, unparalleled safety through layered redundancy across both the vehicle design and design of the subsystems therein; second, an extremely low noise profile via an all-electric powertrain and the careful design of our propellers; and third, highly efficient operations to maximize passenger seat-miles per unit of time and drive to increasingly low cost with higher utilization.

We are a development-stage company venture-backed by prominent angel, institutional and strategic investors. Currently we are a team of 180 engineers and technicians and expect to continue to grow rapidly, creating thousands of jobs in engineering and manufacturing over the next 5 years. This job growth is in part fueled by our philosophy of vertical integration where we achieve tight integration, rapid development, and efficient production by designing and manufacturing the majority of our aircraft, systems, and components in house.

THE PROBLEM + SOLUTION

The transportation systems in many of our nation's cities are at a breaking point. Over the past 20 years, we have seen increasing numbers of people moving into and around large metropolitan areas. Existing ground infrastructure—whether bridges, roads, tunnels or mass transit—is struggling to serve this increasingly concentrated population. It is still not easy, cheap nor fast to build new ground infrastructure to match increased demand. The result in many cities throughout the US is longer commute times, wasted productivity with an increasing percentage of people's days in cars, and a lower quality of life for many of your constituents.

We designed our aircraft to help solve this problem.

Our aircraft will have a professional pilot onboard and will transport four passengers to their destinations more than five times faster than existing ground transportation at greater safety and, in time, at equivalent cost without the need for extensive, new, fixed ground infrastructure. Our vehicles can take off and land from almost anywhere—including rooftops, parking structures and existing heliports. They are more than one hundred times quieter than current helicopters, meaning they can get people closer to their final destinations without disturbing surrounding communities. They are significantly more cost-effective, due to lower energy costs and simplified maintenance. At increasing utilization, we can drive to a cost per passenger-mile that is on par with the costs of ground transportation today. We aim to make this a mode of transportation that is affordable and accessible to everyone.

When deployed as an on-demand fleet with high-volume and high-frequency operations, we believe these vehicles can have a significant positive impact on lowering commute times, increasing productivity and quality of life, and reducing carbon

emissions in and around prominent cities such as Los Angeles, Dallas, Philadelphia and Washington, D.C.

However, we also believe that the transportation problem we can address is not limited to cities. Today's hearing is on "Urban Air Mobility", but we believe the problem and our solution is not just for large metropolitan areas. We aim to deliver fast, efficient and cost-effective air travel to suburban and rural communities too.

Traditional car-based ride-sharing networks like Uber or Lyft that rely on ground vehicles require significant population density to work. Their low prices are predicated on a high volume of passengers in a small area and a high number of drivers in a geography to service them. Only with those two ingredients can they drive value—whether that's low prices or prompt service.

That is not the case for aircraft like ours. Because our aircraft can travel point-to-point at high speeds, we can deliver highly utilized cost-effective service for more sparsely populated rural and suburban communities as well.

Many companies here are rightly focused on large metropolitan areas where existing transportation networks are overwhelmed. However, rural and suburban communities often face a different problem—namely, limited or non-existent transportation infrastructure. Our vehicles and our service can help people in these places as well: expanding economic opportunity by opening up new job markets, increasing quality of life with better access to health and human services, and strengthening personal relationships with far-flung friends, family and colleagues.

CHALLENGES + OPPORTUNITIES

If I could leave you with one takeaway from today's hearing, it would be that this technology is very real, very possible, and it is here now. We are optimistic about the promise of Joby Aviation in part because our FAA partners—who have for 60 years managed the safest transportation system in the world—are progressive and forward-thinking about the future of air travel. They share and continue to support our mission and timeline. Congress has and should continue to support these efforts by ensuring that the FAA has the resources it needs to support the development and integration of this technology.

America is a recognized leader in aerospace technology—a sector that delivers $143 billion in export sales and supports more than 700,000 high-paying jobs across the country. It is imperative that the US maintains its position as a leader in the development of the next-generation of air vehicles.

There are three areas that are worth discussing in greater detail here: airspace, regulation and infrastructure.

AIRSPACE

Managing airspace will be one of the key challenges for us and others in delivering safe, efficient and reliable air-transportation-as-a-service to end consumers. Unlike other companies, we made an early decision to design our vehicle and begin our operations wholly within the existing airspace management framework. We will have a pilot onboard from day one who can coordinate and deconflict our flights using the traditional, radio-based system to maintain real-time communication with FAA flight control staff. Our initial operations will be very much like helicopter operations today—coordinated along current flight paths and following established and provably safe methods of operation.

However, as the size of our operations scale—whether the volume of vehicles in continuous operation in and around a given geography or the frequency of those operations—we will need to move to an increasingly automated air traffic control system that allows for the digital deconfliction of airspace in real-time with limited input from either our pilots in the air or FAA staff on the ground. Some of this work has already begun with the ongoing development of the Unmanned Aircraft System Traffic Management (UTM) system led by NASA and the FAA.

We support the ongoing work to develop and implement a UTM system for drones operating in uncontrolled airspace at low altitudes and appreciate Congress's continued support for these efforts. We also believe that UTM should be scalable for operations of larger passenger-carrying vehicles at higher altitudes. Today, airspace integration efforts should focus on the communication between users who transition from a UTM to ATC—uncontrolled to controlled airspace—and vice versa. We support NASA's work on both UTM and urban air mobility and ask the Committee to encourage the FAA to make this NASA-FAA partnership a priority.

REGULATION

The path to certify for vehicles like ours has already been dramatically improved by the FAA's adoption of Amendment 64 of the Part 23 Airworthiness Standards.

We believe Part 23 plus special conditions can provide a reasonable basis for our vehicle certification. With Amendment 64, many of the overly prescriptive means of compliance were migrated toward consensus-based industry standards that preserve the safety objectives embedded within the Part 23 requirements while also allowing for novel means-of-compliance to meet these goals. We firmly believe that this approach allows for a more adaptive framework to define and accept new means-of-compliance associated with novel underlying technologies and vehicle configurations.

At Joby, we have already been working closely with FAA for more than 18 months to help adapt these new Part 23 and related guidelines to the certification of our aircraft. We encourage Congress to continue to support this important work. As in many areas of governance that have come before your committee—like the development of autonomous ground vehicles—we believe the most expedient way to safely introduce new technology is through private and public partnership around clear, shared goals.

INFRASTRUCTURE

Alongside the airspace management and vehicle certification, landing sites within urban, suburban, and rural airspaces are a necessary component of the successful delivery of this service. The provisioning of these locations requires careful consideration of updated standards related to landing zone requirements as well as site security and passenger security. Different locations will have some unique needs due the local zoning, population density and physical geography.

Despite the differences in geographies, however, it is important that standards for these sites are more uniform rather than less so—both within the US and, ideally, internationally. To that end, it is important that Federal preemption for the FAA in the area of aviation is respected both legislatively and judicially. A patchwork of disparate, regionalized regulation is not in the public interest.

We have already begun working with select municipalities to help define standards and best practices for takeoff and landing sites and for operations. We encourage close coordination and cooperation between the Federal, State, and Local governments and regulatory agencies to synthesize these best practices in formal standards that can provide a clear, nationwide path to compliance and authorization.

Furthermore, the FAA, EASA, and other regulators should work together to develop globally coordinated safety system expectations through agreed upon consensus standards that ensure the viability of reciprocal airworthiness acceptance. The relatively recent General Aviation Manufacturers Association Electric Propulsion Innovation Committee (GAMA EPIC) has brought both American and European voices into the conversation together. We encourage both agencies to continue to seek opportunities for collaboration and joint rulemaking.

CLOSING

Joby Aviation is committed to delivering on a new mode of on-demand air transportation that offers unprecedented freedom to get from one place to another for your constituencies—whether in cities, suburbs, or rural areas.

We are on the cusp of an exciting development for consumers, travelers, technology and America's global leadership in aviation. It's not hyperbole to suggest that the introduction of our aircraft and other electric vertical takeoff and landing (eVTOL) aircraft like it have the opportunity to transform the way people travel, where they live, and how they spend their time. It's a transportation revolution on par with the introduction of the railroad, the car, and jet travel. Just as each of these transportation modes had incredible, positive impacts on economic opportunity and quality of life, so too can on-demand air-travel with eVTOL usher in a new set of gains.

I thank this committee for this timely hearing and want to emphasize that the next generation of transportation and technology at Joby Aviation is closer than you might think. With Congress' support, we can begin to improve mobility, safety, and quality of life in the very near future. I look forward to your questions.

Mr. LOBIONDO. Thank you very much.

Ms. Scott, you are recognized.

Ms. SCOTT. Chairman LoBiondo, Ranking Member Larsen, Ranking Member DeFazio, members of the subcommittee, thank you for the opportunity to participate in this hearing on airspace integration.

At Skyward, we provide software, aviation expertise, and consulting services to help companies use drones safely, efficiently,

and legally. I have spent my career bringing new technology to market in highly regulated environments, not only in drones, but also in healthcare and secure online transactions. I understand the tremendous opportunity and responsibility that comes with the integration of UAS in the national airspace.

In order to maximize the value that drones can provide we need three things: one, continued public-private partnership as we work towards universal traffic management; two, regulatory innovation from the FAA and adequate enforcement of laws; and, three, freedom to compete for the best solutions in the market. There are already a number of effective public-private partnerships encouraging innovation and reducing barriers for business, including the UAS integration pilot program and LAANC.

Last winter, our customer, PBS Engineering, received a contract with Portland Public Schools to perform roof inspections for which drones are, hands down, the best tool. However, many Portland schools are in controlled airspace, so they were forced to delay and evaluate other methods.

This spring, LAANC went live in the Northwest, and PBS Engineering was able to quickly get the authorization they needed for drone use, saving public funds and minimizing safety risks for employees. Our customers love LAANC because they can fly more jobs. We love LAANC because it is the first step towards a universal traffic management system that will allow manned aircraft drones and eventually flying cars to safely share the airspace.

Historically, UTM has stood for UAS traffic management, but universal traffic management includes every vehicle that operates in the airspace. This is a decentralized network, like a wireless network or the internet, for coordinating all types of aircraft efficiently, safely, and scalably.

UTM will require public-private partnerships among aircraft manufacturers, sensor engineers, software developers, network providers, and regulators to implement standards and manage an interoperable worldwide ecosystem.

Google's new InterUSS project, in which we are a founding member, is an open-source decentralized platform to put standards into action. The platform will enable any UAS service supplier, like Skyward, to share standardized minimal sets of data that protect operator and customer privacy, but provide flight de-confliction and safe access.

We have the technical know-how, but we have work to do on the regulatory front. For competition to flourish, current Federal regulations must be enforced and new regulations must support industry growth. This is an opportunity for leadership to enable commerce and safety. We are encouraged by the latest version of the FAA Reauthorization Act, especially fewer restrictions for R&D and transporting payloads beyond line of sight.

We agree that enforcement authority should be given to the FAA, which has the expertise to regulate both commercial and recreational vehicles in the airspace. Moving forward, we would like to see the FAA continue to collaborate with industry on standards, especially remote identification of all aircraft, which we believe will directly enhance safety and spur economic growth. Remote IDs are essential for both hobbyists and commercial aircraft and are a crit-

ical foundational element for a universal traffic management network.

We continue R&D on networked fleet deployments and UTM. We believe that operating drones on Verizon's LTE network will be important to safely and securely deliver functionality like remote ID, airspace access, flying beyond line of sight, and remote air fleet deployments.

Verizon is investing billions of dollars in 5G infrastructure, which will enable secure aviation grade routing. 5G's latency and reliability, combined with the high density of micro cell sites, make it a good candidate to support autonomous air taxis. And virtual network slicing in 5G protects pieces of the network for safety critical applications, such as search and rescue.

The technical and regulatory project of integrating the airspace is enormous, yet small steps are already having a tremendous impact. Now we need to make bigger strides.

I appreciate the opportunity to appear before the subcommittee, and thank you for the support you have shown to the aviation industry as a whole.

[Ms. Scott's prepared statement follows:]

Prepared Statement of Mariah Scott, President, Skyward, a Verizon Company

Chairman LoBiondo, Ranking Member Larsen, and members of the subcommittee, thank you for the opportunity to participate in this hearing on airspace integration. My name is Mariah Scott and I am president of Skyward, a Verizon company. Our aviation expertise, consulting services, and aviation mapping and UAS fleet management software help companies use drones safely, efficiently, and legally. Drones present an enormous opportunity for innovation and our economy, but the potential can only be safely realized if Congress and the Federal Aviation Administration lean in with industry.

I've spent my career guiding new technology to market in highly regulated environments, not only in drones but also in healthcare and secure online transactions. Nowhere have we had the opportunity to shape the future—and to get it right the first time—as we do today with the integration of the national airspace. The drone industry has come a long way in the past 5 years, but we have only begun to scratch the surface in terms of the value that drones can provide. In order for businesses to realize that potential, we need three things:

1. Continued public-private partnership as we work toward Universal Traffic Management;
2. Regulatory innovation from the FAA and adequate enforcement of laws; and
3. Freedom to compete for the best solutions in the market.

PUBLIC-PRIVATE PARTNERSHIPS FOR UNIVERSAL TRAFFIC MANAGEMENT

Historically, UTM has stood for UAS Traffic Management. But we believe that a more inclusive concept—Universal Traffic Management—will better enable airspace to be shared safely among all types of aircraft. We see UTM as a system of systems, a decentralized network like a wireless network or the Internet, for coordinating all types of aircraft. We believe this will be the most efficient, cost effective, scalable, and safest method for managing the national airspace. This will require aircraft manufacturers, sensor engineers, software developers, network providers, and regulators to agree upon standards to create and regulate an interoperable worldwide ecosystem.

This sounds ambitious but there are already a number of effective public-private partnerships that are encouraging innovation and reducing barriers for businesses on a smaller scale. One example is the U.S. Department of Transportation and FAA's UAS Integration Pilot Program, which is enabling State, local, and tribal governments to partner with the private sector to develop new systems and use cases. In another example, the New Jersey Cape May County Airport, in Chairman LoBiondo's district, received $3 million for a 20,000-square-foot building to serve as

a center for drone businesses to conduct UAS testing and development. As a result of Cape May's innovative drone programs, in April 2018, Verizon chose the county to test a 200-pound drone that serves as a 4G portable hotspot in cooperation with local emergency responders. Verizon plans to use drones like these as a way to provide cellular connectivity when natural disasters damage existing cellular infrastructure.

Perhaps the most compelling example for this venue, last fall, the FAA partnered with 12 companies, including Skyward, on its Low Altitude Authorization and Notification Capability (LAANC). Previously, the FAA required companies to apply for authorization to fly in controlled airspace—which blankets vast swaths of the U.S. population—a process that took up to 90 days. Now, companies can use Skyward's software to request flights in specific volumes of controlled airspace and receive approval in seconds. This partnership—still in its early stages— is already an enormous success. Last winter, our customer PBS Engineering received a contract with Portland Oregon Public Schools to perform roof inspections and create district-wide roof access plans, a project for which drones are the safest, fastest, and most cost-effective tool. But because many of the schools lie within controlled airspace, the firm was forced to evaluate other methods. This spring, when LAANC went live in the Northwest, PBS Engineering was able to obtain authorization to use drones to inspect and map school roofs, saving public funds and minimizing employee exposure to hazards and fall risks.

The success of LAANC is the direct result of the FAA partnering with industry to create safe, sensible regulatory processes that have been automated and delivered by software providers like Skyward. This is just the beginning. For all its popularity, LAANC is a point solution that mitigates a specific logistical burden. A system of Universal Traffic Management that enables safe sharing of the airspace, from commercial airliners to small drones as well as the "flying cars" of the near future, is what the industry needs to truly flourish.

In practice, the future of Universal Traffic Management means that protocols will be baked into every aircraft, ground control station, and piece of software to ensure safety and reduce human error. Any drone will be able to work on any aviation-grade communications network, such as Verizon's LTE network, through any number of applications, following standard protocols. An operator will be able to deploy multiple drones at once, autonomously and from a remote location. Any aircraft will be able to safely navigate among dozens or hundreds of other aircraft of all sizes that are all going about their business. By sharing minimal amounts of essential, standardized information, we can achieve a global Universal Traffic Management system that will safeguard the integrity of the airspace and allow for seamless, equitable sharing of airplanes, helicopters, drones, and other airborne vehicles.

REGULATORY INNOVATION AND ENFORCEMENT

In the past 2 years, the FAA has been both forward-thinking and realistic with its approach to commercial drone use, as shown by its implementation of Part 107 of the Federal Airspace Regulations, the Part 107 waiver process, and LAANC. Similarly, we are encouraged by congressional efforts around the pending FAA Reauthorization Act and are especially excited about provisions that would reduce barriers for drone R&D as well as those that will permit transportation of payloads beyond visual line of sight. But more needs to be done to enforce current laws, especially among recreational drone users. A small number of bad actors within the recreational pilot community have threatened the safety of the airspace and damaged the reputation of all drone users by operating with disregard for regulations and basic common sense. This can't continue, and we appreciate that the Reauthorization Bill offers potential solutions. We agree that enforcement authority should be given to the FAA, which has the expertise to regulate and enforce activities in the airspace, whether commercial or recreational. Whether I drive a car down the highway for business or fun, I am still obligated to follow the rules of the road. The same should be true for any vehicle operating in the airspace.

In order to maintain its leadership in the worldwide drone industry, the FAA must also promulgate a remote identification rule that applies to all vehicles in the air. Remote identification will directly enhance safety and spur economic growth. But without legislation requiring remote identification, Universal Traffic Management will never become a reality, the potential for drones won't be maximized, and commerce will be restricted, slowing an important source of economic growth for the country.

Moving forward, we would like to see additional funding for the FAA that would allow it to continue to develop sensible regulations and a more efficient waiver process, as well as specific direction to collaborate with industry and implement stand-

ards toward this Universal Traffic Management system. Congress should also give the FAA the tools to better enforce the regulations and laws that we currently have as well as allow it to adapt with industry to meet the safety and security requirements of future airspace integration. It is imperative that the industry be safe, and without penalty and enforcement of the rules, we are likely to see more careless, clueless, and criminal pilots endanger the national airspace.

ENCOURAGING MARKET COMPETITION

There are so many different aviation vehicles, customers, regulators, and service providers that a centralized UTM system or single UTM provider wouldn't be able to manage all aspects of aviation traffic, which is why we continue to seek out partnerships with government and other businesses. Skyward's head of innovation, Jonathan Evans, serves as president of the Global UTM Association, an international body of industry leaders, including GE, Sony, and Alphabet's Project Wing, working to develop consistent standards for remote identification, deconfliction, and communication that will allow aircraft, software, and regulators all over the world to understand what an aircraft is, where it's flying, and the responsible party. Google's new InterUSS Project, in which we are a founding member, is an open-source, decentralized solution putting those standards into action. The platform will enable any UAS service supplier (USS), including Skyward, to share standardized, minimal sets of data in a consistent way that protects operator and consumer privacy (no operational data is stored on the platform). Multiple open-source data nodes can be hosted by any USS, resulting in a scalable, distributed, auditable, and flexible way to share airspace and deconflict flights. Flight information is acquired at the time of need, sharing just the right amount of information to safely deconflict and inform the other network nodes.

In the meantime, we continue R&D on the future of networked fleet deployments and Universal Traffic Management. We believe that operating drones on Verizon's LTE Network will be critical for creating a distributed Universal Traffic Management network—for remote identification, flying beyond line of sight, and remote networked fleet deployments. Looking toward the near future, Verizon is investing billions of dollars in 5G infrastructure, which will enable secure aviation-grade routing and beyond line of sight flights. 5G's latency and reliability, combined with the high density of micro cell sites, make it good candidate to support autonomous air taxis. And virtual network slicing in 5G protects pieces of the network for safety-critical applications such as search and rescue.

Each of these investments could be jeopardized if the FAA decides to purchase or prioritize one system over another. Rather than stifling innovation by declaring one UTM provider a "winner," the FAA should let the providers deliver those services that best meet the needs of the end users. After all, a networked deployment for urban package delivery in New Jersey has different requirements than a search and rescue operation in rural Oregon.

CONCLUSION

The technical and regulatory project of integrating the airspace is enormous, and small steps are already having a tremendous impact—but now we need to make bigger strides. It would be nearly impossible for a single developer to create a "perfect" end system up front, which is why industry-government partnerships and open-source development are so important. LAANC represents a successful technological-regulatory first step toward airspace integration, but in the near future we'll need highly sophisticated, dynamic, and secure technical networks to ensure safety and competition.

I appreciate the opportunity to appear before this Subcommittee and thank you for the support that you have shown to the aviation industry as a whole.

Mr. LOBIONDO. Thank you very much.

We will now start with questions from Mr. Larsen.

Rick, you are up.

Mr. LARSEN. Thanks.

For Ms. Yak, do you have any updates on results that might be informative or helpful to the FAA or the industry with regards to the drone integration pilot program?

Ms. YAK. Yes. That is the program I mentioned in my opening remarks. That is a program that we put in place that allows us to collaborate with State, local, and Tribal governments.

Mr. LARSEN. Right.

Ms. YAK. And the purpose is to advance UAS technology. So they have been very successful in testing and evaluating UAS in different use models. In fact, I mentioned the four that just successfully flew this month.

FAA's role in this program is that we are a facilitator with these programs, and one of the benefits we receive from the tech center's perspective is the receipt of data. So that data allows us to do more modeling, simulation, and understanding.

But to really get to the point of your question, they have been working in the areas of detect and avoid, command and control, navigation, weather. And examples of their use that they have been approved for is beyond visual line of sight; package delivery; which we had a successful flight this month, I believe it was, for a long-range flight of package delivery, I think it was medical supplies; inspection of infrastructure; as well as patrol and surveillance.

Mr. LARSEN. Yeah, OK.

And then for—is it—I am sorry. We met yesterday, but is it pronounced Preevoe or Previt?

Mr. PREVOT. Preevoe.

Mr. LARSEN. And is it pronounced Beevurt or Bevurt?

Mr. BEVIRT. Bevurt.

Mr. LARSEN. OK. It is Larsen, so it is all clear.

Dr. Prevot and Mr. Bevirt, given what you heard about the progress on IPP, are you able to utilize that information? Is that information helpful to you as you are thinking ahead about conceptually? Let's start here.

Mr. PREVOT. Yeah. So Uber is actively participating in the IPP with our drone delivery efforts for Uber Eats, and we anticipate that we can carry the learnings that we get from the IPP also into our area ride-sharing initiative as well. So we think it is extremely helpful.

We are very pleased with the support that we are getting from the FAA and the collaboration that we are getting in the IPP so far. So, yes, I would say that is an extremely useful initiative.

Mr. LARSEN. Yeah. Mr. Bevirt.

Mr. BEVIRT. We agree that it is a very useful initiative, and we look forward to carrying the learnings into our work on aerial mobility. Thank you.

Mr. LARSEN. Great.

So also for both of you, and actually for Ms. Scott as well, has the newly written part 23 regulations for GA [general aviation] aircraft, has that been helpful to you, and how are you using it, if you are using it at all?

Mr. BEVIRT. Yes, absolutely. The part 23, amendment 64 has been transformative in our ability to move forward expediently with the FAA. The FAA has been incredibly supportive, and they are really leaning in and very proactive and forward thinking on embracing these new modes of technology, which will really fundamentally revolutionize how we move as a society.

Mr. LARSEN. Yeah.

Mr. PREVOT. Yeah, the same. We are working with manufacturers who build aircraft for us, five manufacturers:Embraer, Bell,

Pipistrel, Aurora Flight Sciences, and Karem, and we expect all five of them certainly to benefit from the part 23 regulations.

Mr. LARSEN. Yeah. Yeah.

Ms. Scott.

Ms. SCOTT. We haven't been involved with part 23.

Mr. LARSEN. OK. All right. Thanks.

And maybe for—this is a somewhat sarcastic question, but it gets to a point. So if you are going to have thousands of these air taxis flying around, will you take the complaint—the noise complaint calls so I don't have to?

OK. In other words, how are you going to address—it is not just numbers. It is, you know, noise. It could be, potentially. So how are you addressing—thinking about that?

Mr. BEVIRT. Yeah. So second to safety, noise is our very high priority, and we have considered it both in the overall vehicle architecture and also the design of every one of the subcomponents on the aircraft. And we are incredibly pleased with the progress. Our aircraft is now more than 100 times quieter than a helicopter. It is really, really spectacular. When it is flying over, you can barely hear it. It is——

Mr. LARSEN. At what altitude?

Mr. BEVIRT. At 1,000 feet.

Mr. LARSEN. 1,000 feet, OK.

Mr. BEVIRT. In a city you can't hear it at all. It is only if you are in the countryside. I care very passionately about noise. I grew up out in the mountains where it was just absolutely pristine quiet, and I love the quiet. And so as an engineer developing these tools, this was my childhood dream to build VTOL aircraft.

And when I started working on this more than 25 years ago, I realized that VTOL aircraft were incredibly noisy when they were powered by combustion engines. And so I wanted to build an electric VTOL, but battery-specific energy wasn't what it needed to be, and I needed to wait for the batteries to get to the point where we could build a really quiet vertical takeoff landing aircraft that allows us to really transform transportation as we know it.

Mr. LARSEN. Yeah. I am sorry I am out of time, but other Members will have similar questions, I am sure. Thank you.

Mr. BEVIRT. Thank you very much.

Mr. LARSEN. Thanks.

Mr. LOBIONDO. OK. Thank you, Rick.

Sam? No.

Bob?

Mr. GIBBS. Thank you, Chairman.

I think when I was 5 years old, my favorite TV show was "The Jetsons." I don't know if this is what is going to happen or not.

Ms. Yak, in your testimony, you discuss a roadmap for full unmanned aircraft integration into the National Airspace System, including operation beyond the visual line of sight for the operator. Can you provide us an update on the progress of the integration in that?

Ms. YAK. From a research perspective, because that is pretty much what we do, the UAS integration path for research is pretty much a step path, but it is not linear. We can do that in parallel. So you are absolutely right. We are looking at research for oper-

ations over people, beyond visual line of sight, package delivery. And then that brings us to the next stage which is on expanded operations, large cargo delivery of packages, and then ultimately to passenger transportation.

So that is our guideline, and we are doing a lot of research in different areas. For instance, research that we are doing that is going to enable UAS integration as well as support urban air mobility is research in the command-and-control area.

So command and control is the data link between the pilot and the aircraft. So we are doing research from that perspective of frequency levels, the minimum operational performance requirements necessary for that data link to ensure the integrity of that link to allow us to integrate these aircraft into the system.

Mr. GIBBS. I guess for anybody on the panel, just to further, is technology there where we have collision avoidance technology that the equipment, the aircraft itself could take action on its own? What is the technology for that, for all these things flying around, like "The Jetsons," I guess, you know? If anybody in the room can remember "The Jetsons," you know what I am talking about.

Mr. BEVIRT. Congressman Gibbs, thank you for your question. So as we talked about, initially we will deploy these as piloted aircraft, but from day one, they have a sensor suite that is embedded on those aircraft that is unprecedented. We have cameras, infrared sensors, LiDAR, radar, and so they can sense the environment around the aircraft in really an unprecedented and exciting way.

And over time, as we prove to ourselves and to the FAA that these technologies will make those aircraft and the operation of those aircraft safer than with the pilot, we will begin to add in protections similar to what you see in maybe a level 3 car where it is a safety net around the aircraft, and it will help the pilot in the case that maybe there is a small drone and you don't see it, but the aircraft can see it and can avoid it. So we see incredible technological progress as we move forward.

Mr. GIBBS. What do you see the cost? You know, as this moves on, the costs will come down. But what do you think you are looking at here when this starts to become more readily available?

Mr. BEVIRT. Yeah. So, again, cost and accessibility to everyone is the core of our mission. When we first launch this service, we are targeting the price of a taxi, and so the price for the trip will be on par with the price of a taxi trip. And over time, we believe that we can get the cost down below the cost of personal car ownership. And at that point, this is transformational and everybody will ride it every day.

Mr. GIBBS. That is pretty exciting. I just was curious on a timetable. How far do you think we are looking out? Is this 5, 10 years, 15 years, or what do you think, that we will really see the integration of this?

Mr. BEVIRT. Yeah. So we are—I mean, we are currently working through certification, and we have an incredible collaboration with the FAA, and that is moving very rapidly. And once we have a clear path to finalize the certification, we will ramp production and begin to roll out in cities across the country.

Mr. GIBBS. So right now, it is really the Government regulations, bureaucracy, whatever you want to say, that is the limiting factor, or is it technology, or is it cost, or what?

Mr. BEVIRT. It is really about my company doing the rigorous work, my team doing the rigorous work to ensure that we have tested every single component and every corner case to make sure that this is the safest aircraft we can possibly put into production. We are fielding in levels of redundancy which are really unprecedented in small aircraft to make this incredibly safe. Safety is our number one priority.

Mr. GIBBS. OK. I appreciate it. Thank you.

I yield back.

Mr. BEVIRT. Thank you.

Mr. LOBIONDO. Peter.

Mr. DEFAZIO. Thank you, Mr. Chairman.

To Ms. Yak or Mr. Merkle, I mentioned section 336 at the outset. I mean, we have had an average of 100 monthly reports of drones in controlled airspace, and I just talked about the suspension—most recent suspension in my district of firefighting because of—so remote ID will fix that. But are there other issues with drone operations other than remote ID that need addressing by the FAA?

Mr. MERKLE. Yes. Thank you for your question, Ranking Member DeFazio. Fundamentally we have two barriers. The first is the airspace rules need to apply to everyone equally in the airspace. And as you mentioned, section 336 does limit the FAA's authority in that area. We believe that repeal of section 336 is vital to being able to consistently apply all the airspace rules to all operators in the area. And that in turn will allow remote identification, our next step in integration of drones or urban air mobility or any of these other exciting technologies to be truly fully functional and useful, because then every aircraft will be able to see every other aircraft in the area which will be fundamental to safety.

Mr. DEFAZIO. And, I mean, my amendment does both remote ID, and it does say to the extent necessary to ensure safety and security of U.S. airspace. I mean, I think we have heard now from four agencies that want to be able to shoot down drones on their own. Have you been in communication with them at the DHS, DoD, DOE, and——

Mr. MERKLE. We have been. The FAA does not want the authority to interdict or provide counter-UAS measures. We support Department of Defense and Department of Energy having those capabilities now. We also support the administration's proposal to have the Department of Homeland Security and the Department of Justice have that same authority.

Mr. DEFAZIO. Uh-huh. But there are also concerns with what technologies they might use and how that might affect legitimate nearby commercial operations or general aviation aircraft?

Mr. MERKLE. Yes. We work closely with our security partners to ensure that whenever they are employing counter-UAS measures, that they coordinate with us and ensure that we do not introduce a hazard into the airspace.

Mr. DEFAZIO. OK. Want to be certain of that.

I have a provision regarding section 336 in the House bill. Would that fix the problems as far as the FAA is concerned?

Mr. MERKLE. I am generally familiar with that, and, yes, that does give the FAA the authority that we believe we need.

Mr. DEFAZIO. OK. Any of the other panelists want to express any concerns about the current state of sort of where we are totally unregulated for all drones?

Ms. SCOTT. Yes. I would just add support for Mr. Merkle's position in that we also agree with that position that all aircraft need to be regulated and registered and we need the remote identification capability. It is a critical foundational element for any sort of universal traffic management system for providing safe integration and for allowing our commercial operators the comfort and feeling that they are following the laws and everyone else in the airspace will as well.

Mr. DEFAZIO. OK.

Mr. BEVIRT. We also believe that it is important to have Federal preemption, and we—although we are putting sensors on the aircraft that can help to mitigate unregistered drones, it would definitely be preferable if all aircraft flying in the NAS were part of the NAS.

Mr. DEFAZIO. OK. Doctor.

Mr. PREVOT. I can only second that remote identification to me is key for us to being able to de-conflict our flight paths from everybody out there. First we need to be able to see them to avoid them.

Mr. DEFAZIO. OK. Thank you.

And, again, just have one quick question, Ms. Yak, or Mr. Merkle. The FAA has been working on the conflicts, and when I asked a couple years ago what happens when you ingest a drone into a jet engine, the answer was, well, gee, we really don't know. I mean, since then, we have done the airframe testing. When are we going to do the engine ingestion test?

Ms. YAK. Thank you. I will answer that.

We have partnered with ASSURE, our Center of Excellence, to do that work. They have completed phase 1, which was basically an analysis of drone versus birds, and we have a lot of data on the birds. So the conclusion of that phase 1 was, well, they are different than birds, and that from the batteries, the cameras, the motor itself, what effect would that have.

So starting this fall, we are moving into phase 2, and we will then be live testing by ingesting those components as well as full drones into a fan assembly. We will be gathering data from that experience and then we will be putting it into modeling and simulation.

Better yet, we are using simulations from the manufacturers on their fan assemblies to be processing that data so that we can better analyze and understand the effects those components have or full UAS have on fan assemblies and be able to produce the results of this research in about a 12-month, 18-month timeframe.

Mr. DEFAZIO. OK. Thank you.

Thank you, Mr. Chairman.

Mr. LOBIONDO. OK. Thank you, Peter.

Bruce, do you have questions?

Mr. WESTERMAN. Thank you, Mr. Chairman.

This is kind of a general question. As we have this debate, I can't help but think about "The Jetsons" and George Jetson commuting

to work. But how does this physically work? Are there lanes in the sky, or how do you manage traffic flow? How do you avoid obstacles, birds, drones, all those things that might be there? How does this technically work?

Mr. PREVOT. Well, I can start. This is a very good question, and I don't think there is a real simple answer to this. But we are working with NASA and with the FAA to evaluate different concepts. And in one of the concepts that we are excited about is what we call Dynamic Skylane Networks, since you mentioned lanes. You can think of it as a virtual network of lanes, overpasses, on-ramps, and off-ramps, essentially, that can be adjusted to where the traffic needs are, to where safety and security concerns might be, where noise requirements exist, and also where the demand needs to go. So in a sense, you can think of it as a three-dimensional road system in the sky that you can utilize for your traffic. That is one of the concepts that we are pursuing.

Mr. WESTERMAN. OK.

Mr. BEVIRT. We are also doing extensive work on dynamic flocking and simulations for high-density operations in and around takeoff and landing locations. We are very optimistic about the capacity of the airspace to handle large amounts of traffic.

Mr. WESTERMAN. But it would be some kind of dedicated path that you would be on in your flying vehicle?

Mr. BEVIRT. Yes. But with the virtue of being able to be dynamically allocated and adjusted. You think, you know, in some bridges they will move the center line, depending upon the traffic patterns in the morning versus the evening.

Mr. WESTERMAN. Right.

Mr. BEVIRT. In the sky, the road can go wherever we need it to go whenever we need it to go, right. And there are many constraints, weather constraints and demand constraints, that can allow this to be very flexible, and that is the real virtue of this.

I think there is also a massive opportunity because air traffic doesn't require the ground infrastructure and the hundreds of billions of dollars we spend maintaining ground infrastructure. That is one of the things that makes it such a cost-effective mode of transportation, both for the individual customers but also for us as a Nation. So we are——

Mr. WESTERMAN. Do you envision some kind of a master control program that each individual has equipment on it so that it keeps vehicles out of the path of other vehicles?

Mr. BEVIRT. We believe that it is a network of interconnected systems similar to what Ms. Scott spoke about.

Ms. SCOTT. I think—we think of this concept of universal traffic management as a system of systems or more of a distributed network, like the internet or like a wireless network, where no one company or entity is controlling the internet.

But we have a set of technical standards that allow for interoperability. We have a lot of connectivity options. It could be LTE. It could be Wi-Fi. It could be satellite, ADS–B, depending on the type of routing that you need. So you have connectivity and you have dynamic routing. And then we are relying on the regulator to provide the performance-based criteria for how we need the aircraft to operate safely and integrate with each other. But we are bringing

the technical standards and that know-how to provide interoperability.

Mr. WESTERMAN. And just briefly, Ms. Yak, on the part 77 process, how will the integration of drones and flying cars affect the part 77 process, and any idea on how this might affect land development?

Mr. MERKLE. I think the integrated pilot program is going to be instrumental in helping us understand that because that is really a collaboration between your local communities and the airspace users. And the IPP is really the point where we get to work with companies like Uber and Joby and the local communities and determine what is the best balance between airspace utilization and issues like privacy, land use, and local concerns, such as noise. And we expect the IPP to be very informative in those areas.

Mr. WESTERMAN. I yield back, Mr. Chairman.

Mr. LOBIONDO. Ms. Brownley, questions?

Ms. BROWNLEY. Thank you, Mr. Chairman.

Ms. Yak, I wanted to ask you a question. Can you tell us about what research the FAA Technical Center is doing to test the safety of these new technologies that we are learning about today? And can you comment also if there are similarities or if there are differences for testing the safety of unmanned versus manned aircraft?

Ms. YAK. Yes, thank you. Very good question.

Before I start talking, I would like to put the assumptions out there, and you have heard a few of them. Urban air mobility, vertical takeoff and landing, that is the technology that it will be using. It is also going to be using electric or battery propulsion. And we are talking about initially being manned flight but eventually being autonomous.

The research FAA does and the reason behind the research that we do is to collect the information, the data, and provide the scientific analysis to be utilized for future regulations, guidelines, or procedures. So that sets the foundation.

Now, I mentioned in my opening remarks, some of the research that we are doing on large aircraft also apply to these aircraft, like the materials, lightweight materials, composites, propulsion, electric and battery. So the research question in support of this technology is, what are the performance measurements or requirements for these technologies and materials and batteries?

Another good example is the research that we do from a weather perspective. So we do a lot of research around what is the weather information pilots need to operate. And we are doing a gap analysis for UAS.

But the research question for somebody is, what is the effect of weather in an urban environment? What about wind gusts? What effect will that have on this new type of aircraft, let alone cold on the longevity of batteries? So these are the type of what-ifs.

Now, in regards to the second part, what are we working on, again, it is a lot about the digital interface, the links between the pilot and the aircraft, the sensor technology between the aircrafts, ground, eventually satellite. That allows us to know where the aircrafts are so that we can stay well clear and provide that information for the pilot. We are focusing in those areas.

Ms. BROWNLEY. Thank you.

And to the panel, in terms of what Ms. Yak said about the what-ifs, do the what-ifs have impacts on what you are doing today in terms of moving forward with your innovations?

Mr. BEVIRT. Yeah, as we have spoken about, safety is really our number one priority and ensuring both the safety of the individual aircraft and also the operation of the service as a whole.

And the work that the FAA Tech Center has done and the collective aviation industry over the past 100 years has created the safest transportation system in the world. So not only is air travel the fastest and the lowest cost but also the safest, our safest mode of transportation. It is really stunning.

And incredibly grateful to the work of this committee and the FAA over a long period of time which has steadily improved safety. And I think it is incredibly commendable and really spectacular, the achievement.

Ms. BROWNLEY. Is there anything that the FAA is not doing that is impeding your progress, with regards to the tech center?

Mr. BEVIRT. I think the FAA has been incredibly supportive, very forward-looking, very innovative in embracing these new technologies and looking how to make them as safe as we possibly can.

Ms. BROWNLEY. Very good.

Any comments, Mr. Prevot?

Mr. PREVOT. I just want to back up to the weather problem. I do think there is research that has to be done that is not tech center research, but I don't think we have enough of an understanding about the microclimates in urban areas. And so there is certainly a gap that needs to be filled.

Ms. BROWNLEY. Thank you for that.

And I just have a few more seconds, but, Ms. Yak, I noticed that the Drone Advisory Committee has changed somewhat in terms of membership. And so I just wanted to know, given those changes, what can we expect the DAC to focus on in the near term?

Mr. MERKLE. Yes, thank you for that question.

The Drone Advisory Committee is being somewhat reconstituted. But I was at the last meeting, and it is still very active, and it is very much focused on how can industry help the FAA with the integration of these exciting technologies. So I believe they are at the stage right now of identifying how industry can help.

Ms. BROWNLEY. Thank you, Mr. Chairman.

Mr. LOBIONDO. Doug?

Mr. LAMALFA. Thank you, Mr. Chairman.

For Ms. Yak and Mr. Merkle, I represent a very, very rural district in northern California, most of which is on fire right now. A new one last night just turned into 15,000 acres in about 10 hours. So the use of drones and aircraft that can remotely do the type of work needing to be done, expecting power lines, especially with that interface with forestry, or dams, anything that is very remote, very tough terrain, you know, sending them in for helping to spot fires where visibility is not good for normal aircraft, it is a great tool for many, many areas in remote and, again, rugged terrain.

But what is the current status of allowing more beyond-the-line-of-sight technology with drones being approved by FAA and being able to be more widely used, you know, other than what you have

in the military and other limited uses, something that could be used more privately with proper certification, et cetera?

Mr. MERKLE. Thank you for the question.

We are currently operating—or our partners are operating flights that are beyond visual line of flight. Working with BNSF, the railroad, they are doing linear inspection under a COA. So we are seeing progress there.

We also——

Mr. LAMALFA. Is that more of a pilot situation, or is it becoming more mainstream, widespread, et cetera?

Mr. MERKLE. It is setting the foundation for spreading that technology and those procedures to other operations.

Likewise, we recently had a flight at NASA, a No Chase COA, which was operating in the airspace with other manned aircraft. So it is really a major step towards full integration into the airspace.

But, again, this is why remote ID and repeal of section 336 is so important, especially in these rural areas where you would likely see general aviation or crop dusters or other things operating at the same altitudes with these type of aircraft. It is very important that all the operators in the airspace see each other.

Mr. LAMALFA. With the ID that you were talking about and, I think, Mr. DeFazio brought up initially too, how far and wide can that aircraft ID? I mean, to every, you know, toy-store drone? Or, I mean, how far can we go with this stuff in order to have it not be impractical but also be helpful with, you know, people with these vehicles?

You mentioned the one that somebody flew around near a fire zone up there in Oregon that completely shut down the operation. It could have been as simple as just a toy-store drone or something like that somebody was fooling around with. How far down can we regulate or track every single vehicle like this?

Mr. MERKLE. We would certainly like to track it, at a minimum, down to the same requirements that we have in part 107, the 0.55 pounds. Potentially, there may be some different performance characteristics that come in as people develop new aircraft. We might have to revisit that.

But we are currently in the process of—we are post the Aviation Rule Committee on the remote ID, and we are in the process of developing a rule on that. And I expect that some of these details will come out in the notice of proposed rulemaking.

Mr. LAMALFA. Do you anticipate, then, some type of a device on every possible drone, putting out a signal of some sort that——

Mr. MERKLE. We do. Much like every car has a vehicle identification number and all of us who drive them have registration and license plates, we believe, based on the recommendations from the Aviation Rule Committee, every drone should have an identification.

Mr. LAMALFA. A transmitting signature.

Mr. MERKLE. Transmitting the signal and available via network to all the other operators in the airspace.

Mr. LAMALFA. OK. With all this flying-car business being talked about, every prototype ever seen is neither good at being a car or at being an aircraft. They are very low-performing as a car and low-performing as an airplane.

So how is this integration with, you know, a purpose aircraft, you know, the modern, private-pilot-type planes with the integrating and the lanes we are talking about, with an aircraft that cannot perform nearly at that level? As well as, when you put it on the street, I mean, you know, you have wings and everything. What is the practicality of trying to do both in one vehicle?

Mr. MERKLE. We have a——

Mr. LAMALFA. And up in the airspace with other higher speed, you know, more normal aircraft.

Mr. MERKLE. Right. That is a challenge, the integration of these vehicles. But much like we integrate helicopters in busy metropolitan areas or general aviation, which have very different performance characteristics from a passenger jetliner, we believe that the concepts like under UTM and the dynamic routes will provide us with the structure that will allow us to safely manage these aircraft in the airspace.

Fundamentally, the routing addresses the structure and procedures portion and allows safe integration. And the automation behind UTM allows that solution to scale to the number of drones.

Mr. LAMALFA. OK. Thank you.

Thank you, Mr. Chairman.

Mr. LOBIONDO. André, questions?

Mr. CARSON. Thank you, Chairman. Yes, sir.

When we talk about operating drones beyond the operator's line of sight, that means pretty much relying on some high-tech computer software and other technology.

After we have all seen the staggering number of flight delays or even cancellations in the past few years during very high-profile computer outages, particularly with Southwest and even Delta, I wonder what risks there are or there may be for drone and even UAS systems as it relates to similar outages.

And, secondly, what are the lessons learned from the airline outages, from our subcommittee perspective and your perspective? And what can be done to prevent these outages and future sloppy housekeeping?

And are drones subject to mass outages?

Mr. MERKLE. We are in the very early stages of UAS traffic management. We are really moving from the NASA research in the concepts into operationalizing that. So the specifics on how we design the availability really aren't there yet.

However, we do know that the concepts behind UTM, such as a distributed network and many actors, are much more resilient than, say, a single data center. So we believe that the concepts have the kind of resiliency built into them. And as we partner with companies like Uber and Joby and Skyward, I believe that their innovation and what they bring to the table will provide the solutions that bring that resiliency.

Mr. CARSON. OK.

Mr. PREVOT. Yeah, I think it is also key for us to design our systems for exactly these cases so that even if outages were to occur and the drones were disconnected from the network, that we could be sure that we can still safely land them in safe locations.

Mr. CARSON. OK. Thank you.

Anything from the engineering mind?

Mr. BEVIRT. I wholly agree that a distributed network with diverse communications and then additionally with the aircraft able to fly and land themselves safely and de-conflict safely without the centralized control system is critical, so multilayered redundancy is really, really important.

Mr. CARSON. OK.

Gentleladies, nothing?

All right. I yield back, Chairman. Thank you.

Mr. LOBIONDO. Scott, you are up.

Mr. PERRY. Thank you, Mr. Chairman.

Mr. Merkle, Pennsylvania has faced a series of disruptive weather events this year, resulting in a lot of power outages. One utility in the district I'm privileged to represent, PPL, has used UAVs effectively in the recent storms and flooding events to assess dangerous situations and reduce response times. They did this without the benefit of beyond-visual-line-of-sight, a capability, as you know, that improves safety and response time for power restoration.

And, of course, I urge the FAA to continue to work, as directed by Congress, to give utilities the ability to employ the beyond-the-visual-line-of-sight operations to respond in emergency situations as well as routine maintenance, inspection efforts, et cetera.

But short of beyond-the-visual-line-of-sight, hurdles remain for utilities' use of UAVs even within a line of sight in Class C airspace. And I am just wondering—I certainly understand—I am a helicopter guy, so I understand the sensitivity in Class C airspace. Is there some way utilities can be granted a blanket approval to fly the UAS below the energized utility? So we are talking power lines. I don't know that any commercial or otherwise, quite honestly, other than the military, is flying below the utility even in, you know, Class C or other towered airspace.

Mr. MERKLE. So we are working towards that goal. As I said, the BNSF partnership has identified the kind of underlying technologies that will make that capability possible throughout the airspace. And really it comes down to the specific utilities and companies coming in and applying to the FAA and working through.

These cases tend to have unique characteristics around them, and so it does take some human judgment and collaboration with the applicant to figure out the safest way to integrate. But we are actively integrating aircraft like this in Class B, Class C, Class D airspace all throughout the NAS.

Mr. PERRY. So is that something that they can apply for now?

Mr. MERKLE. Yes, it is.

Mr. PERRY. Is that right? OK.

Mr. MERKLE. It is. And we have companies doing similar things now.

Mr. PERRY. All right. Thank you.

Mr. Bevirt and Ms. Scott, I am just curious, regarding the remote ID and tracking, are we talking about current transponder technology with a Mode C, or are we talking about something completely different for that?

Ms. SCOTT. Most current technology is not going to be suitable for the smaller drones. But the Remote ID Aviation Rulemaking Committee that Mr. Merkle referenced, we also participated on that committee and made recommendations for technical imple-

mentations that can meet the performance criteria that the FAA would like. And there are a number of different ways that that can be done.

There are also a couple of different technical standards bodies—ASTM, 3GPP, CTA—that are also working on technically how can we adapt existing technology for these different form factors.

Mr. PERRY. So just, you know, the guy that is curious—and I think probably other people are too—are we talking, like, cellular technology?

I am picturing, like, a transponder head, right? And then the radio itself is either right there in the console or it is in the back, and it is heavy, you know, and so on and so forth. Are we talking cellular technology or something other than that? What are we talking about?

Ms. SCOTT. Certainly cellular technology and cellular connectivity is an option for providing that kind of connectivity.

Mr. BEVIRT. And then there is also, in the near term, ADS–B. Of course, ADS–B has its limitations, but it is getting deployed rapidly, currently, on the existing aviation fleet, and it provides an important first step.

Mr. PERRY. And just out of curiosity, you know, this is a commercial enterprise, and I think it is a fascinating concept to just ponder and to see happening. And I am assuming that you are planning on all-weather capability, right? It sounds like it, right?

So I am picturing myself, like, wanting to get in this machine, right, that doesn't have a pilot in it. And there is a thunderstorm; you can see it coming, right? I mean, you have been in the aircraft when the—you know, it is one thing, maybe, sitting in the back, but when the rain is pounding on the windscreen at a buck-20 or whatever you are at, it is unnerving.

And what is the—I mean, do you do, like, customer surveys or studies? You know, I would think this would be somewhat fearful for a lot of people.

Mr. BEVIRT. Yeah, I think the weather research and the sensing—there are a lot of really exciting sensing methodologies—airborne LiDAR—that give the aircraft the ability to see vertical windshear and see thunderstorms that the human eye can't see.

But I think before you are getting into an autonomous aircraft in a severe weather situation, there is a huge amount of work that has to be done on the artificial intelligence algorithms to prove that they can make decisions around weather that are better than a human pilot. And I think that that will be many years to come.

Mr. PERRY. My time has expired. I thank you.

Mr. LOBIONDO. Steve?

Mr. COHEN. Thank you, Mr. Chairman. I appreciate you—I appreciate you for many of your votes. One time, one of these magazines paired the Democrat who voted most with the Republican, and I was with you. So you are going to have to run for reelection, so I can make it more public now.

Mr. LOBIONDO. I will have to work on that.

Mr. COHEN. Yeah. Thank you. I was honored, though.

But thank you and Mr. Larsen for holding this hearing. The emergent drone industry is gonna make a big difference in our country, and it is imperative we set the framework right.

We also have to pass the FAA authorization before the September 30th deadline. That is the big work of our committee. As a matter of health and safety, I urge the Senate to adopt the SEAT Act provision included in the House bill that was passed, H.R. 4. The U.S. Court of Appeals found that the FAA's justification to not review the safety risks of more cramped passengers as "vaporous."

And now the inspector general is auditing the FAA for its failure to take the issue seriously. There is a safety and a health problem with the size of seats, the pitch of seats, and all of that. And the FAA needs to do its duty and make sure people can evacuate airplanes in the required time.

We need to pass a longtime FAA authorization and include the SEAT Act that was passed unanimously by this committee and overwhelmingly by the full House.

In May of this year, Memphis was 1 of 10 areas selected out of 150 applicants to participate in the Department of Transportation's drone integration pilot program, and I was honored to be at the announcement. According to the Department of Transportation, the potential economic benefit of drone integration into the national airspace will be upwards of $82 billion and create up to 100,000 new jobs. Big news for Memphis and the Nation.

In Memphis, some of these airspace integration demonstrations include airport, runway, and aircraft inspections; perimeter surveillance and geofencing; medical device and consumer package delivery; and environmental protection efforts, such as coastline erosion detection. The airport authority is partnering with industry giants like FedEx, General Electric, Intel, and others.

Just this past Thursday, 901Drones, FedEx, the Memphis Fire Department, and others, including officials visiting Memphis from the FAA, successfully completed a demonstration of important perimeter geofencing safety measures to keep drones from flying into the designated zones and critical safety redundancies to keep the public safety and airport operations unaffected.

Drones have boundless real-world applications, and Memphis is now at the center of this rapidly growing industry. It is important we get the policy framework right. It has to be absolutely, positively right, as FedEx would say.

First question is for Director Yak. The University of Memphis is a close partner in the Memphis drone program and brought to light an insightful concern: The role of local municipalities is not mentioned in the hearing summary of subject matter. It seems clear that local municipalities will play a large role in future airspace integration efforts.

While programs such as the FAA's integration pilot program go a long way toward helping that develop, does the FAA have any plans to work with Congress or request Congress to help communities develop the necessary infrastructure that will allow the potential benefit of drones to be realized?

Ms. YAK. I was checking with Jay because I thought that actually fell into his arena.

I think the DOT and FAA, as you can see by the establishment of the Integration Pilot Project, is understanding and seeing that there is a wild world out there—"wide," not "wild." And what I mean by that is, whenever you take technology regulation, particu-

larly from a safety perspective, you need to look at it from a societal perspective too. What is the impact on society? What is allowed? And what should the rules be?

We are progressing in a number of partnerships with industry as well as with the local governments and that to be able to understand this world that we are entering in. From a research perspective, we got the technology down. We are looking in that—we are looking at that with our partners. We are looking at that and how to better regulate. But it is the IPPs and the working with the local governments and the Tribal communities to understand the use and then what are the ways to enable this technology in their area.

Mr. MERKLE. I would just add to that, just as we do with manned aviation today, we actively work with our local communities when we are planning new airspace utilization projects, and so we would expect that to continue.

And, as you pointed out, the IPP is critical to opening those relationships with the local communities around drones and identifying the issues that are of concern to them and working with them. And we fully expect the research and the actions coming out of the IPP to inform how we adapt and evolve to the future for the drones.

Mr. COHEN. Thank you.

And I think my time is about up. And I came late, so maybe I am taking a little risk, but, Dr. Prevot, I understand you talked about Uber doing Uber Eats by drone?

Mr. PREVOT. That is correct.

Mr. COHEN. You know, about 30 years ago, I was in the State senate, and somebody showed me a phone. Of course, it was like this, it was gigantic. And he said, we are going to have—like Dick Tracy, we are all going to have phones. And I said, you are crazy. Well, I was wrong.

Mr. PREVOT. Yep.

Mr. COHEN. So Uber Eats by drone, is this—I mean, does the drone go to the restaurant and then kind of knock on the door? How does it get in? I mean, The Rendezvous is downstairs. How does the drone get downstairs to get my ribs?

A VOICE FROM HOUSE DAIS. To your balcony.

Mr. PREVOT. We were experimenting with different concepts there that can involve couriers, as well, in the process. Because we already have a food delivery business, and so the drone may also only take the food from our courier to another courier, potentially, on the other side. Or we can have fixed infrastructure.

Part of our integration pilot program is experimenting with different concepts and seeing what works best. But the main idea is, yes, you push a button, and you get your burger or sandwich a little bit faster.

Mr. COHEN. I am all for it. I use Uber Eats, and it is great. I just can't imagine some drone going into a—the future.

Thank you. I yield back.

Mr. LOBIONDO. The gentleman from Georgia.

Mr. WOODALL. Thank you, Mr. Chairman.

I may have missed it at the beginning, but all this talk about moving people and places, I hadn't heard any mention of part 135 and what the impact is there.

Can someone help to lay out for me, from an expert perspective, what the evolution is going to be, from the part 135 requirements we have today for charter aircraft to the fact that I can climb in an Uber with absolutely anybody today and get to where I need to be?

Mr. BEVIRT. Yeah. So one of the things we are planning is to launch our service as a fully piloted aircraft and with a professional pilot on board from day one. And over time, our sensing systems and our software systems will provide that pilot increasing levels of automation. And one day, we may end up flying these fully autonomous.

But we are really focused on operating fully within the existing part 135 standards. And we expect that those—in our conversations with the FAA, it has been confirmed that we have a path forward to launching this service and this operation.

Mr. WOODALL. Now, I understand that within the current bandwidth of regulation. Though, there was a time I had to find somebody with a taxi medallion in order to do ride-sharing, and now we trust a much broader pool of people.

Do we expect, as we are training autonomous—not autonomous—as we are training remote pilots, as we are training more and more ordinary, everyday drivers to be in the sky, do we expect an evolution in a regulatory framework? Or are we expecting part 135 to remain with us for a generation to come?

Mr. MERKLE. We believe our current regulatory framework can address these challenges and can be adapted to provide operating certificates for—operators-type certificates for aircraft and pilot licenses as well. It is really a matter of understanding what was intended by a regulation like part 135 and working with the applicant to ensure that their implementation meets the intent.

Mr. WOODALL. And as you all are looking regulatorily and through the lens of technology, do you expect me to be flying in an autonomous aircraft or in a remotely piloted aircraft first?

Mr. MERKLE. I will let my colleagues answer that.

Mr. PREVOT. Uber is also intending to fly with pilots first. But the model is probably going to be more remotely piloted than—not necessarily with a single pilot per aircraft. Kind of as another transition period, actually, we will manage our fleet very precisely, because it has to integrate into a multimodal trip. We have the first mile, we have the last mile that we need to connect into. So there is really not as much flexibility for the aircraft to do anything themselves, at least in our model. We believe it is going to be very highly remotely piloted, but it might be remotely piloted by a largely automated system.

Mr. WOODALL. And in order to get the broad adoption that we would all like to see, is the expectation that we are always going to be talking about electric aircraft, that we concede there is no place for combustion aircraft in airspace close to our homes?

Mr. BEVIRT. That is certainly our view, that both from an emissions standpoint and, even more importantly, from an acoustics standpoint, that fully electric is necessary to make this technology ubiquitous.

Mr. WOODALL. And given those range challenges as they exist today, a remotely piloted aircraft certainly seems to speak to ROI,

if I could put two people in an airplane to get to where they need to go instead of just one.

As you are looking for capital, as capital is being attracted to these ideas, where is that capital flocking today? Is it on the autonomous side? Is it on the remotely piloted side? Is it all going to piloted proof-of-concept projects?

Mr. BEVIRT. So our particular aircraft is a five-seat, so it has a single pilot and four passengers. And we are fully electric, and, as you mentioned, that reduces our range capabilities. Today we can only fly about 150 miles, plus an FAA reserve, a 30-minute reserve for safety. And so that limits our operations to—this is not something you are going to take cross-country.

But we do have ambitions to be able to fly from DC to New York or from New York to Boston in the not-too-distant future. So we see huge improvements coming on the battery front that will extend that range and make this not just, you know, for one geographic area, but be able to network different geographic areas together, which we believe will have a really profound effect on the economy and the ability for people in geographically disparate locations to communicate and work together more effectively.

Mr. WOODALL. Thank you all for your pioneering work and your expertise today.

Mr. BEVIRT. Thank you.

Mr. WOODALL. I yield back, Mr. Chairman.

Mr. LOBIONDO. Donald?

Mr. PAYNE. Thank you, Mr. Chairman and to the ranking member. I appreciate this opportunity to be here.

And, Ms. Yak, it is nice to see you again. I had the pleasure of touring the Hughes Technical Center in Chairman LoBiondo's district a year ago and was very impressed with the work being done there.

As you know, I represent a densely populated urban district. Noise from trucks, buses, Newark International Airport, and helicopters are a constant concern for my constituents. I would like to hear more about the FAA's work on noise-mitigation research, specifically with regard to UAS and flying cars.

I know we are getting in the future with George Jetson and his boy, Elroy. And so, you know, obviously, it is not very far off. So, you know, I know it is really not a big issue now, but as this technology becomes more common, we should not be adding to the seemingly intractable problem of aircraft noise in urban areas.

Can you——

Ms. YAK. Absolutely. Thank you for the question.

As I mentioned earlier, balancing technology with community concerns is a very important part of the process. Our UAS implementation plan does include in it obtaining and researching noise information, noise data. In fact, the integration pilot program is also providing us the data regarding noise so that we can start using that noise information to start analyzing it and determining how to use that information for certification requirements and affecting the aircraft performance of the future.

With that, I will hand it over to—oh, Jay said I hit all the points, so I must have done good. But my peers, I think——

Mr. PAYNE. Yeah, if anyone else could elaborate, I would appreciate it.

Mr. BEVIRT. Yeah. So noise is near and dear to my heart, and specifically for operations in and around urban areas, we expect it to be significantly below the background levels, such that the aircraft operations will be inaudible. In suburban and rural areas, the noise levels are very low, but you will be able to hear the aircraft in a very quiet environment.

But for your constituents, we have done a huge amount of work, again, making these aircraft more than 100 times quieter than a helicopter.

Mr. PAYNE. Yeah, because, I mean, you know, if you have bad weather in Newark Airport, they shift the runways, and it comes right over the South Ward, where I live. And, I mean, you would think the wheels are going to hit the top of some of these homes, you know, on the trajectory that they are coming in.

And believe me, we really get hammered, you know, about this and the helicopter issue. In Jersey City, it has become a big problem. These tourist helicopters are flying closer and closer into areas across from New York to get the view, so they straddle the river in New Jersey. And, you know, these constituents are just going crazy. So it is something that is very important, and, you know, I need to continue to stress the need to continue to work on this.

So I see the potential for flying cars to reduce the stress on our roads, infrastructure, and help mitigate congestion issues facing districts like mine. But I am concerned on how the law enforcement and homeland security experts will deal with this emerging technology in the hands of bad actors.

If you walk around Capitol Hill, you will see the curbs and streets are lined with barricades, in part to prevent cars driven, you know, by bad actors from accessing this critical space.

How do we engineer our cities to deal with cars that can't be blocked by ordinary barricades? What discussions is the industry having around that aspect?

Mr. BEVIRT. So we can put up—just like with cars you can put up a physical barricade, because of the control systems in these aircraft, you can actually put up digital barricades. And so we can constrain these aircraft so that the control system physically can't create a trajectory that can go where we don't want it to go. So the aircraft can, whether it is the pilot or one of the passengers in the aircraft, if they try to——

Mr. PAYNE. Deviate from the——

Mr. BEVIRT [continuing]. Deviate from the trajectory, it just physically won't go. So these are digital barricades.

Mr. PAYNE. What happens to it? It just stops?

Mr. BEVIRT. Let's say this is the barricade, you know, this is the no-fly zone. It will just find a trajectory around——

Mr. PAYNE. Oh, it will force it away from—oh, OK. All right. Well, that's pretty interesting, pretty neat.

Well, with that, I will yield back. Thank you very much.

Mr. BEVIRT. Thank you.

Mr. LOBIONDO. Lloyd, you are up.

Mr. SMUCKER. Thank you, Mr. Chairman.

Ms. Yak, over here. I may have missed earlier testimony along the lines of my question. I have been back and forth between two hearings. But I wanted to specifically follow up to your written testimony in regards to UAS, small drones.

Just as you mentioned, there are a lot of commercial application entrepreneurs who are finding more and more ways to use drones to make their operations more efficient. Two particular areas in my community: agriculture for crop assessment and then inspecting infrastructure like power lines, for instance.

And, you know, what I hear from them is line of sight has been an issue, the ability to operate beyond line of sight. And I read in your testimony that there is an ability to get waivers today. And I guess I wanted to understand a little bit more about that.

Generally, who is receiving those waivers, and for what purpose? How easy is it to get a waiver? And do you think we will be changing the regulations to make that easier?

And I certainly understand the security concerns as well. We are seeing, you know, potential use of drones by terrorists or in other activities that we obviously don't want to see.

But I would just like to hear your response to that.

Ms. YAK. Mr. Merkle will respond to that.

Mr. SMUCKER. OK. Great.

Mr. MERKLE. Thank you for the question.

Let me first address the evolution. Last month, the FAA published an updated version to our UAS roadmap that plots the evolution towards beyond visual line of sight, package delivery, urban air mobility, passengers, that sort of thing.

But the fundamental next step and necessary next step is remote identification and the repeal of section 336, because that allows us to identify every aircraft in the airspace. And then that will make it much easier to move towards beyond visual line of sight.

We also have had recent success with flights, such as our partner, BNSF, the railroad, which is now doing linear inspection beyond visual line of sight, a No Chase COA. So we are seeing that emerge. It really isn't tomorrow; it is today.

And you are correct, it is done by a waiver process. And, yes, anyone can apply. And depending on whether you need a waiver for the aircraft or for airspace, you apply, actually, to the same website. It is on the UAS website for the FAA you apply.

Mr. SMUCKER. So it is a website application, and what is——

Mr. MERKLE. It is a website application, yes, and then humans get the email.

Mr. SMUCKER. What is the criteria for receiving a waiver?

Mr. MERKLE. The criteria for receiving a waiver—it depends on what you are asking for. So it really does take a case-by-case analysis for each waiver. Because it may have implications for the specific airspace you are in or other hazards or other things going on around there or the particular aircraft. So it really does take human analysis at this point.

But as we move down the path towards UAS integration and we get things like remote ID and beyond-visual-line-of-sight, then the waivers will no longer be required.

Mr. SMUCKER. Yeah. All right. Thank you.

And a second question. Mr. Prevot, in regards to the airline industry, there is today a severe shortage of pilots. And I know that you had mentioned in your testimony one of your key business challenges is pilot training.

And I am just curious, with the introduction of aerial ride-sharing, do you think that will increase the demand for pilots? And how will you address the issue of a limited workforce?

Mr. PREVOT. Yeah, it will definitely increase the demand for pilots, as we want to operate for quite a while with pilots. And, initially, we will only utilize pilots that are certified by the FAA, starting with certified helicopter pilots most likely.

We would like to get the vehicles simpler to be operated so we might be able to extend this to fixed-wing pilots as well. And there might also be an opportunity to basically create a new training program and train up new possible pilots for this job.

Mr. SMUCKER. This is a common issue that we hear about here in Congress. Do you have any suggestions for what we can be doing here to better address a labor force issue like this?

Mr. PREVOT. I am supportive of some of the simplified vehicle operation type things.

Mr. SMUCKER. Thank you.

Mr. BEVIRT. Can I——

Mr. SMUCKER. Sure.

Mr. BEVIRT [continuing]. Add something to that?

So one of our investors is JetBlue. And we are actually looking at this as a huge opportunity, where we can provide a training ground for pilots that can then, after flying with us for several thousand hours, transition and begin flying commercial operation, similar to the partnerships that part 135 operators have had with part 121 operators historically.

And so there is really a fantastic opportunity to drive a huge amount of interest into becoming pilots and then for those pilots to have long careers in the part 121 operation. So we think this is a huge feeding ground and a really spectacular opportunity, which we are very excited to be working on.

Mr. SMUCKER. Good. Thank you.

Mr. BEVIRT. Thank you.

Mr. LOBIONDO. Are you yielding back?

Mr. SMUCKER. Yes.

Mr. LOBIONDO. OK.

Ms. Norton?

Ms. NORTON. Thank you, Mr. Chairman. I very much appreciate this hearing. Always excited to hear about the subcommittee thinking futuristically, because it is happening anyway. So I am very interested in autonomous cars and autonomous aircraft. This is a very controlled space in the Nation's Capital that I represent.

Recently—and I suppose this first question is for Mr. Bevirt or perhaps Dr. Prevot—we have seen how, with or without the Congress—and it looks like without—autonomous cars are moving, some of them being tested on the streets, and there has been an occasional mishap. That gets a huge—if we had the kind of publicity that gets to the daily accidents on the road, we would be reading nothing else in the paper. But what we do know is that these autonomous cars are far safer than you or me at the wheel.

Given the fact that the public gets scared off, perhaps, by one single accident, as we have had in the recent months, how close are we to moving toward remote or pilotless aircraft? Is this still something that needs a lot of work, even though, to our credit, the subcommittee is thinking about what you are doing now? I mean, this is not anything that is going to happen within the next 10 years, or what is your best estimate on that?

Mr. PREVOT. I think there are many pieces in place. Aircraft basically today are flying highly automated already. But I believe we have to collect a huge amount of data, actually, with pilots on board to make sure that we can prove that these systems are ready to be autonomous, that we have covered all the cases. So that is kind of the approach that we are taking, having the pilots on board.

And then it may also not be a one-size-fits-all. It could be that we can prove that certain routes, certain circumstances have never had the need for a pilot to intervene and we have got everything covered there, so we can incrementally start removing the pilots from those vehicles.

But I do think it is certainly a number of years out.

Mr. BEVIRT. Yeah, I would wholeheartedly agree that the goal is to demonstrate, as you spoke about, Congresswoman, that these systems have the potential to be much safer than human-piloted aircraft.

But there are things like weather, for example, that we talked about, where humans and our cognitive abilities to make really complex decisions are really quite spectacular. And so we want to leverage the skills and the capabilities that the human pilot has as well as the skills that the autonomous and automated systems have. And so——

Ms. NORTON. Yeah. Well, I want you to help us think, for example, if there are autonomous cars and autonomous aircraft—remember, we have pretty close to autonomous planes and autonomous underground railroad. We just had a spectacular accident here, I don't know, about a dozen years ago with somebody at the wheel. But our underground subways basically drive themselves and have been doing so for a long time. And when a pilot gets in the air, you know, he is not sitting there driving the plane. That plane is on automatic pilot as well. So it is pretty clear we are already there.

But if we go to autonomous planes and everybody can have an autonomous plane—you don't even have to drive it, because now it is autonomous—we may be into—Mr. Prevot, perhaps, understands this—we may be into what we have here in the District of Columbia, and I would dare say perhaps my colleagues have the same as well. Now we have a lot of congestion on the roads because anybody can get an Uber or a Lyft. And those of us who ride them are very glad they are out there.

But, Mr. Prevot, what we have done here in the city is—or at least there is a proposal to put a tax on Uber and Lyft so that we can help fund our underground Metro, as we call it, our underground railroad, which is going broke, so that we would have a choice and not be left, as we are now, with one or the other.

And what Uber and autonomous cars and the like provide are choices. Yet there may need to be a whole new set of traffic rules, a new set of who gets to drive. Perhaps we in the Congress ought to be thinking about this or even more so at the local level. And I realize I am asking you to think in the future, but that is what we are trying to do here today.

So when you think about how we would have to deal with congestion—perhaps we would have less congestion, perhaps, in the air. Perhaps we would have more. Perhaps we would have fewer accidents, perhaps more. Who needs to be thinking about that, who is thinking about these kinds of issues, as we get excited about autonomous vehicles?

Do you want to begin, Dr. Prevot?

Mr. PREVOT. Yes. I believe that going to the air gives you more choices, just as you said. I mean, now you have another way of doing a multimodal trip. And we certainly have to think about the congestion that it might create in the air, that it also might create around the skyports.

As we optimize trips through our network, we see Uber, for example, as a platform, where we also want to integrate with public transportation and with all these other means.

Ms. NORTON. So you understand why the District thinks that Uber ought to help us pay for underground transportation even as we have had to make room for more Ubers on the road here.

Mr. PREVOT. Well, I would say that is not necessarily my area of expertise.

Ms. NORTON. I would like you to submit to the chairman what those whose expertise it is to know about this think about using some form of transportation to help fund another form of transportation.

But go ahead.

Mr. BEVIRT. So I think that there is an incredible opportunity. Just as Congress funded our National Highway System and then funded the construction of many of our airports, there is an incredible opportunity here, as Congress looks forward, to think about how to support this new and more efficient mode of transportation.

Ms. NORTON. Thank you, Mr. Chairman.

Mr. LOBIONDO. Jason?

Mr. LEWIS. Thank you, Mr. Chairman, and thank the ranking member as well for having this hearing. Very, very informative. We are, indeed, embarking on a brave new world here, which is really, really exciting.

But I do want to drill down a little bit as to, you know, what I describe, and for lack of a better term, as a common-law nuisance, to make certain as we embark on flying cars or package delivery or however we use the airspace, that people aren't using their property to the detriment of the enjoyment of other people's property. And, traditionally, that has been regulated at the local level, as you know. So whether we are talking about passenger technology, as you have, or package delivery or, in the case of public safety or public use, the concerns of privacy.

And I will just give you a quick example. In San Francisco, we thought we could relieve congestion by putting these shared and dockless bikes on every corner. We have them in Washington, DC,

now. In San Francisco, they are saying, get them off, they are a nuisance. So, you know, the law of unintended consequences may have a role to play here.

So I guess I would start with Ms. Scott on this. There is disagreement in the community on preemption, on who should control this so that we can maximize this brave new technology, as I say. There are some at the Uniform Law Commission that came out that do not agree with the position of Federal preemption on some of the regulations below the national airspace or below 300 or 400 feet. And there are others that say that is the only way to go.

You have been looking at traffic management, obviously. Do you see a solution for this?

Ms. SCOTT. Thank you for the question.

We believe the FAA is best suited to provide regulatory oversight for all aircraft in the airspace—hobbyists, commercial, manned, unmanned, passenger drones—and that there is also an important role for States and municipalities to play in that. But we believe that there should be common operating rules. And just as there are for manned aviation, you have the FAA setting a Federal regulatory framework, but you have an important role for States and locals to play in how they balance concerns around privacy——

Mr. LEWIS. But if someone next to an airport is tired of their dishes being rattled every time a plane lands, they usually go to the local authorities first.

Ms. SCOTT. And we agree that there is a role for State and local law enforcement with drones, which is why we are such proponents of the remote identification for all aircraft that would allow a local law enforcement to be able to look up and see and easily distinguish who is a participant in the system and who might be a bad actor.

Mr. LEWIS. You know, it cuts both ways too. It is not just, oh, gosh, we have to allow the locals to regulate your particular industry or your endeavors. It cuts both ways. As I understand it, the Low Altitude Authorization and Notification Capability right now allows for single drone use. There was a group in my home State that wanted to use multiple drones for some air show or something, and they had to wait 100 days.

So one common rule that has one jurisdiction across the country can actually operate to the detriment of what some of you are trying to do, as well, on the other side.

Dr. Prevot, let's get your input on all of this.

Mr. PREVOT. I do believe that it would be very difficult if we have very different regulations across the country, especially for people who want to operate pretty much everywhere.

You mentioned the Low Altitude Authorization and Notification Capability. I think it could be extended to handle these other cases as well. We are in the early stages of all this, so I believe we have to learn and see how the things work right now.

Mr. LEWIS. So, if somebody on Sunday morning at 5:30 is delivering a package to my next-door neighbor and buzzing around my window or buzzing around my backyard picnic later that day, I should call the FAA?

Ms. SCOTT. I think, just as we have common operating rules for helicopters but municipalities might set rules about operating

hours for when a helicopter can land downtown on the designated helipad, I can envision a similar balance between State and local implementation of those rules with a common Federal operating structure. I think the——

Mr. LEWIS. Let me just interject. I think we all agree that the common Federal operating structure is you can't allow a local rule to interfere with interstate commerce or the national airspace. So a municipality can't just come in and say, oh, let's just ban landings and takeoffs. That would obviously interfere. But below that, those rules and regulations, that is the question we are going to have to face, in my view.

Ms. SCOTT. And I would say that I think the UAS integration pilot program is a great project for us to figure out how best to balance those local community concerns with Federal operating rules and collect data and really, real-time, see how does it work when you try to implement——

Mr. LEWIS. I certainly agree with that.

Thank you, and I yield back.

Mr. LOBIONDO. Jimmy?

Mr. DUNCAN. Thank you, Mr. Chairman.

And maybe some of what I am asking about has already been answered. I was in another committee hearing for, I guess, the first hour or so.

What I am wondering about, though, is this tremendous explosion of drones in number. I understand that the official FAA prediction on registered drones, it is now somewhere over 1 million, and it is going to be 2½ million by 2022. The growth has been so fast over the last 3 or 4 years, I think that 2½ million may be a low estimate. And then I am told by staff that there are tens of millions of unregistered drones that hobbyists have and so forth.

Are we going to, at some point, see a day where there will have to be some sort of limitation on drones? I mean, they, so far, already exceed the number of fixed-wing aircraft. So, if we have a 100 million drones in this country in a few years—I mean, do you foresee a time when we are going to have to limit the number some way? Or is the number just unlimited?

Mr. MERKLE. Thank you for the question.

Just as in manned aviation we deal with capacity and efficiency all the time, there will eventually be some point where airspace capacity will be reached. We don't know where that is or when that will be. But until we actually evolve the concepts around UAS traffic management, we really won't know fully where those limits are.

One of the fundamental principles of UAS traffic management is it uses automation to scale to the number of drones that we are anticipating. So we think that we will get far more capacity for the airspace with concepts like UTM than is reachable with our traditional air traffic control or air traffic management techniques. So we think the number will be much, much higher.

But working with our partners as they evolve their concepts and they bring applications in, we will all together move forward in understanding how to manage capacity and efficiency safely.

Mr. DUNCAN. And I also have seen articles about concerns about privacy, and I am wondering, does the FAA—is the FAA set up—Mr. Lewis got into this a little bit—is it set up to accept complaints

now about drones? And are you getting very few complaints, many complaints?

I would imagine that most people would call some local official. I don't think their first thought would be to call a Federal agency, but are you getting complaints about drones now?

Mr. MERKLE. We do, yes. Thank you for the question. We do get complaints. We get concerns. Our advice to anyone, particularly in areas of privacy or where they feel that a law has been broken, is to contact their local law enforcement first. That really is the best way to deal with these instances, because, of course, the FAA's mission is civil aviation safety.

So we have no authority to enforce, you know, local privacy laws and that sort of thing. So always we refer them to local law enforcement, and we continue to try and educate the public that that is the correct way to deal with these concerns.

Mr. DUNCAN. And are the number of complaints, would you classify them as very few or very many, or are the numbers of complaints going up some or rapidly or——

Mr. MERKLE. Unfortunately, that is a little beyond my particular expertise, but I would be happy to work with you and your staff to get you the specific numbers.

Mr. DUNCAN. All right. Thank you very much, Mr. Chairman.

Mr. LOBIONDO. OK. Shelley, is there any work being done at the tech center to address and mitigate the possible security risks posed by UAS and other emerging aircraft technologies?

Ms. YAK. Yes, there is, particularly from a cybersecurity perspective. And the work that we are doing does not necessarily begin and end with the drones. It is also for aircraft in general. And what I am referring to is the establishment of a cybersecurity safety threat and risk assessment methodology.

You may ask, well, you know, what does a methodology do? Well, the methodology is the background that the procedures, the process that we use to be able to do risk assessments, measure what the risk is, what the vulnerability assessments are, what the threats are.

By understanding what the threats are, then we can identify the mitigations. That is important twofold: one, from an industry perspective by understanding what the threats and the vulnerabilities are and what the potential mitigations are, they can start remedying them early in the life cycle. And from the FAA perspective, we can use that data for any rulemaking, certification, or guidelines.

Now, that is the foundation for security and particularly cybersecurity. We are also looking at the technologies itself, again, with our industry partners, on security protocols to be used in data links, on data exchange rates, minimum operational performance on these systems that we have been talking about.

Cybersecurity is all about security and resiliency, the human aspect if something happens, what is the reaction, the data availability and accessibility. So that is the type of research work that we are doing in regards to the cybersecurity and security of drones as well as urban air mobility aircraft.

Mr. LOBIONDO. So, Shelley, for you, and really for anyone else on the panel, what technological developments must be imple-

mented before these new aircraft technologies can be safely introduced or integrated into the NAS?

Ms. YAK. So you have heard a lot about remote ID, and I would say that every panel member here subscribed to the need for remote ID. We need to know where the aircraft is so that our pilot can stay well clear.

We need the technology understood and in place for sensors and frequency management, a communication between the aircraft, the pilot, the pilot in controlled space with the controller. Those are essential.

I am intrigued. I learned a lot from this panel. I enjoyed it as to the technologies that our colleagues are working on in the aircraft makeup itself, and we will be working with them closely on the performance requirements for those aircraft from the material they use as well as the propulsion method.

So there is a lot of work to do. I think the UAS traffic management arena is blossoming well. We have a demo coming up in the 2019 timeframe, where the technical center will be working very closely with NASA on—and industry will be flying drones through our test sights, and we will be simulating drones out of our laboratory, our NextGen Integration and Evaluation Capability Laboratory.

So that will be a lot of learning and a lot of data that we can use for future concept use and development.

Mr. LOBIONDO. Anyone else? No.

So a brief sort of statement and then a question, Ms. Scott, for you. A couple of years ago, we had a devastating superstorm by the name of Sandy, and we have also had some devastating hurricanes in Florida and Texas and Puerto Rico. And I was very impressed when Verizon undertook the initiative to understand that in these devastating storms our ability to communicate is basically wiped out and witnessed in my district the—sort of the test of the flying cell tower on a drone, which was absolutely remarkable. So I want to commend you all for taking that initiative.

But listening this morning to some weather forecasts from back home, there is a storm that is possibly moving up the east coast next week that has the potential to be a hurricane, not saying it is, which got me thinking, is that sort of drone cell tower operational now or limited basis, or where do we stand with that technology?

Ms. SCOTT. So I haven't been——

Mr. LOBIONDO. Microphone.

Ms. SCOTT. Excuse me. So the flying cell phone tower work I am familiar with is an R&D project, and I know that the ongoing research into characterizing how to do that, how the network performs, and what drones are suitable for that, that work is ongoing. I would be happy to refer you to some of the experts who are working on that project more closely.

Skyward is actually used by Verizon to manage hurricane response operations, so we used Skyward to manage the deployments and the drones that we used at Verizon to respond to Hurricane Irma and Harvey, but that was more in a response surveying and inspection capacity.

Mr. LOBIONDO. Obviously the next 2 months are critical for hurricane potential, and I would be curious as to a followup from your folks to know the capabilities, if, in fact, we are hit with one of these again.

Ms. SCOTT. I would be happy to follow up with you.

Mr. LOBIONDO. OK. Rick.

Mr. LARSEN. Thanks.

Ms. Scott, in your testimony, you said for all its popularity, LAANC is a point solution that mitigates a specific logistical burden. That being the case, what would be the top three steps needed then to expand that or to get to the universal traffic management idea that you believe needs to happen?

Ms. SCOTT. Great. Thank you for that question. We were the first service supplier to be approved to provide LAANC as a service, and it has had tremendous growth for the industry because it has opened up so many controlled airspaces to be possible for drone use, for safe drone access.

What we would like to see in terms of improvements for LAANC specifically, first, it is still in beta and the FAA has been tremendously innovative in rolling it out and rolling it out quickly. We would like to see it move into a full deployment with the robust and secure funding that it needs to maintain adequate performance. We would like to see the inclusion of DoD and Federal contract towers in the LAANC system so that we can offer safe authorization to those airspaces as well.

And we would like to see the ability to attach existing waivers to LAANC authorizations. So a number of our customers might have an existing waiver perhaps for night operations, and those authorizations currently can't be attached to a LAANC authorization. So that is just an additional system enhancement that would make it easier for our customers to get quick access to the places they need to fly.

Mr. LARSEN. Yeah. Great.

Mr. Prevot, do you have the top three things that need to happen to get to a traffic management system that you all can take advantage of?

Mr. PREVOT. I agree with the remote ID that was mentioned before. I also agree that we need to have a right communication and spectrum management infrastructure. And, again, we have to prove out that we can properly interoperate between all the systems where we are working on already.

Mr. LARSEN. And, Mr. Bevirt, the big three.

Mr. BEVIRT. I would concur with Dr. Prevot and that we—it—on UTM it is—we need to continue the funding for the work that the FAA and NASA are doing. And additionally, you know, for us to roll out this service, it is not predicated on UTM. We will be operating within the existing part 135 framework, but we do very much look forward to those tools becoming available so that we can scale to much denser operations.

Mr. LARSEN. Yeah. So just finally, I have been paying attention this whole time. You have probably seen me texting. I was texting my sophomore engineering student son in college and telling him about what this hearing is about. And he had a very interesting question that I wanted to pass on, because I think it is absolutely

relevant, about getting from point A to point B and how the drone, with people in it, communicates to get from point A to point B. And I said, it is probably satellite communications. So he goes, I don't like it. If it is communicating through a satellite, why not just hack the flight?

So the question really is kind of a fundamental one about not just the safety of will it fall out of the sky or is it safe to fly in, but the security—the secured communication to ensure that even a piloted drone or a pilotless drone has to get from point A to point B. And what—how are you thinking about the security of that communication of that flight so that flight gets from point A to point B?

Mr. BEVIRT. Yeah. I think that is incredibly important and including the—it needs to be redundant and diverse communication. So you have cellular connections. You could potentially have multiple carriers—cellular connections from multiple carriers and satellite communications. So that diversity in each of those links is secured such that the ability to have all of those communications simultaneously compromised is very, very low.

Mr. LARSEN. Yeah. Ms. Scott, have you—do you have some thoughts on this as a carrier or——

Ms. SCOTT. Certainly, designing for security and reliability should be a top concern for any UTM system development and for the technical standards that support those systems. We are excited about the potential of LTE networks to provide that secure communications link and have been doing a lot of R&D work on that in the context of UTM development, and look forward to collaborating closely with the FAA and other regulators to understand the performance-based criteria that we need to meet and then being able to design for that security and resiliency.

Mr. LARSEN. Yeah. That is fine. I will just make one note. Next year, about the time you are rolling out the pilot on maybe the simulators and so on, maybe it would be a good time for the subcommittee to get back up to the tech center in the later winter, early spring.

Ms. YAK. Great. That would be wonderful. And thank you again for coming out and seeing us about a year and a half, 2 years ago. The employees at the technical center really appreciated your attention and taking time to see the great work we do. So thank you.

Mr. LARSEN. Whatever Frank wants, Frank gets.

Mr. LOBIONDO. Next year or two?

Mr. LARSEN. You will have to talk to your spouse about that.

Mr. LOBIONDO. All right.

Mr. LARSEN. And your dog.

Mr. LOBIONDO. OK. I would like to ask unanimous consent that 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 that the record remain open for 15 days for additional comments and information submitted by Members or witnesses to be included in the record of today's hearing.

So I want to thank our entire panel. I think this was very interesting and informative. I thank you for your commitment and expertise to this particular issue.

But, Shelley, if you would pass on a particular thanks to the thousands of men and women at the tech center who are doing such incredible work each and every day to keep our air system the best and the safest in the entire Nation.

And with that, we stand adjourned.

[Whereupon, at 12:17 p.m., the subcommittee was adjourned.]

SUBMISSIONS FOR THE RECORD

PREPARED STATEMENT OF CHRIS RITTLER, CEO, CAPE PRODUCTIONS

Chairman LoBiondo, Ranking Member Larsen, and members of the Subcommittee, on behalf of Cape Productions, I appreciate the opportunity to provide a statement for the record for the Aviation Subcommittee hearing on the integration of new aircraft into the national airspace system.

Today, organizations across industries ranging from oil and gas and public safety to agriculture, telecom and construction rely on the Cape Aerial Telepresence platform, which removes the limitations of traditional commercial drone technology to unlock the full potential of drone integration into operational workflows. Our technology, which is deployed in the United States, Mexico, the Middle East, and Australia, saves lives, prevents incidents, and makes people and property safer.

Our technology allows remote users to manipulate a drone in real-time and with minimal latency (subject to the approval of Cape software and a remote pilot in command). While there are many applications for our platform, it is quickly becoming the preferred tool to help public safety professionals gain situational awareness and improve response times. For example, Cape recently worked with the police department in Ensenada, Mexico, to use drones for Aerial Intelligence-Led Emergency Response. When a call comes in to the police, a Cape drone is immediately dispatched to the scene, helping the commander put eyes on the situation and make informed decisions about whether and how to respond. The live feed is also available to the responding officers on their mobile devices, allowing them to monitor the situation in real time. After only four months of operation, the drone program has conducted more than 1,600 operations and is credited with reducing crime by more than 10 percent.

Police, fire departments, and other public safety organizations across the United States are interested in adopting similar programs, but the current Federal Aviation Administration (FAA) rules and guidelines prevent public safety professionals in the U.S. from taking full advantage of Cape's technology. The restrictions on flying over people, at night, and beyond visual line of sight (BVLOS) limit the use of drones to specialized operations (e.g., launching a drone from a fire truck on the scene of an event) rather than using drones as a complementary first responder on a scene. While Cape recognizes communities can apply to waive these requirements, the process is arduous—each community must submit its own application—and the FAA has yet to approve a waiver to fully enable this type of operation.

Cape applauds the Administration for launching the Unmanned Aerial System (UAS) Integration Pilot Program (IPP). The IPP is an opportunity for state, local, and tribal governments to work with the drone industry to accelerate safe UAS integration. The program is also designed to inform future FAA rulemakings to allow more complex drone operations. Cape is participating in the San Diego, California, IPP and is hopeful the FAA will provide the necessary waivers to fully deploy Cape's technology with public safety professionals in San Diego and surrounding communities.

As the Subcommittee looks at how to more rapidly integrate UAS into the national airspace system, we recommend prioritizing public safety uses and creating an expedited pathway for Federal, state, and local public safety organizations to conduct more complex operations. For example, similar to Part 107 for commercial operations, Cape recommends the FAA allow public safety organizations to conduct more complex UAS operations (i.e., flying over people, at night, and BVLOS) without receiving a waiver, as long as certain criteria are met (e.g., maintaining appropriate coordination with local air traffic control operations, limiting flights to predefined areas bound by a geofence, conducting appropriate community outreach, etc.).

We applaud the Aviation Subcommittee for examining the barriers to integrating drones into the existing airspace system and would welcome the opportunity to en-

gage in further dialogue about ways to unlock the full potential of drones for improving public safety.

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