FINDING THE RIGHT FREQUENCY: 5G DEPLOYMENT AND AVIATION SAFETY

(117–40)

REMOTE HEARING

BEFORE THE

SUBCOMMITTEE ON
AVIATION

OF THE

COMMITTEE ON
TRANSPORTATION AND
INFRASTRUCTURE
HOUSE OF REPRESENTATIVES

ONE HUNDRED SEVENTEENTH CONGRESS

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U.S. House of Representatives
Washington, DC 20515

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FEBRUARY 1, 2022

SUMMARY OF SUBJECT MATTER

TO: Members, Subcommittee on Aviation
FROM: Staff, Subcommittee on Aviation
RE: Subcommittee Hearing on "Finding the Right Frequency: 5G Deployment and Aviation Safety"

PURPOSE

The Subcommittee on Aviation will meet on Thursday, February 3, 2022, at 11 a.m. EST in 2167 Rayburn House Office Building and virtually via Zoom for a hearing titled, "Finding the Right Frequency: 5G Deployment and Aviation Safety." The hearing will examine how the C-band spectrum was reallocated for 5G wireless services, the aviation industry's safety concerns with the recent 5G deployment, and the effects of the recent deployment on the U.S. aviation industry and national airspace system (NAS). The Subcommittee will hear testimony from two panels. The first panel will feature the government witness from the Federal Aviation Administration (FAA). The second panel will include witnesses from: Aerospace Industries Association (AIA), Airlines for America (A4A), Air Line Pilots Association (ALPA), American Association of Airport Executives (AAAE), CTIA, Helicopter Association International (HAI), Regional Airline Association (RAA), and a telecommunications consultant.

BACKGROUND

I. FCC AUCTION OF C-BAND FOR 5G

On November 18, 2019, Federal Communications Commission (FCC) Chair Ajit Pai informed Congress of the FCC's intention to hold a public auction of mid-band wireless spectrum from 3.7–3.98 GHz, also known as the C-band, to fuel the deployment of 5G.[1] At the time, many aviation stakeholders expressed concerns about potentially harmful radio frequency interference with certain aviation safety equipment, including radio altimeters,[2] which operate in the adjacent 4.2–4.4 GHz band (aviation band).[3]

In response to the FCC's announcement, the FAA sent a letter on September 30, 2019, to the Interdepartment Radio Advisory Committee (IRAC), which is responsible for advising the National Telecommunications and Information Administration (NTIA) on spectrum decisions within the federal government, expressing reserva-

[1] Marguerite Reardon, "FCC to auction C-band spectrum for 5G", CNET (November 18, 2019), *available at* https://www.cnet.com/tech/mobile/fcc-to-auction-c-band-spectrum-for-5g/.

[2] Radio altimeters are also known as radar altimeters or RADALT.

[3] Letter of Edward Yorkgitus, Aviation Spectrum Resources to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 12–122 (filed Oct. 25, 2019) *available at*: https://ecfsapi.fcc.gov/file/10620182163379/19062019%20Aviation%20Associations%20Joint%20Ex%20Parte%20Filing%20Dkt%20No%2018-122.pdf.

tions about the auction of the spectrum adjacent to the aviation band. In this letter, the FAA also notified the IRAC of testing that was being conducted by the Aerospace Vehicle Systems Institute on the resilience of a variety of altimeters against 5G interference.[4] Additionally, on December 1, 2020, the General Counsel (and future Acting Secretary) of the Department of Transportation (DOT), Steven Bradbury, and FAA Administrator Steve Dickson sent a letter to the NTIA urging the agency to delay the FCC's upcoming auction due to concerns over the impact it could have on aviation safety.[5] However, the NTIA did not enter the letter into the FCC docket for consideration.[6]

Following the FAA and DOT letters, the House Committee on Transportation and Infrastructure Chair Peter DeFazio sent a letter to FCC Chair Pai urging the FCC to postpone its scheduled C-band auction due to other federal agencies' concerns surrounding the potential harmful 5G interference with radio altimeters.[7] Nonetheless, on December 8, 2020, the FCC began its public auction of the C-band, which yielded 21 winning bids and $81 billion in revenue.[8]

II. RADIO ALTIMETERS

Radio altimeters are fundamental flight instruments found on most commercial aircraft and many general aviation aircraft that enhance safety and flight operations by providing measurements of an aircraft's clearance height above the ground terrain and any obstacles.[9] On approach during flight within 2,500 feet of the ground terrain, the radio altimeter serves as a pilot's primary altitude-measuring instrument and is used for all-weather approaches and landing procedures; radio altimeter(s) enable a pilot to verify descent progress and distance to the ground on an approach, detecting unsafe situations.[10] Use of a radio altimeter is critical in enabling safe arrivals, particularly during inclement weather, low cloud layers, or other instances of low visibility.

According to the FAA, the "receiver on the radio altimeter is typically highly accurate, however it may deliver erroneous results in the presence of out-of-band radio-frequency emissions from other frequency bands." [11] Such interference from adjacent bands, or out-of-band radio frequency emissions, could pose a hazard to aircraft in flight by causing faulty or erroneous radio altimeter readings.[12] Erroneous altimeter readings are a cause for concern at all phases of flight, particularly in automated flight deck systems that rely on accurate altimeter readings for a variety of systems and functions. For example, in 2009 a Turkish Airlines aircraft landing at Amsterdam-Schiphol Airport experienced a faulty radio altimeter reading that was fed into the automated flight deck system while on approach, contributing to the aircraft's fatal crash and resulting in nine deaths.[13]

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[4] Letter of Michael Richmond, FAA Interdepartment Radio Advisory Committee Representative to Peter Tenhula, Chairman, Interdepartment Radio Advisory Committee (filed Sept. 30, 2019).

[5] Secretary Steven Bradbury and Administrator Steve Dickson, *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, FAA & DOT (December 1, 2020), *available at*: https://www.faa.gov/sites/faa.gov/files/2021-10/DOT__Letter__to__NTIA__FCC3.7__GHz__Band__Auction.pdf.

[6] Fed Aviation Admin., FAA Statements on 5G (Jan. 2, 2022), *available at*: https://www.faa.gov/newsroom/faa-statements-5g.

[7] House Transportation and Infrastructure Committee, *Chair DeFazio Calls on FCC to Postpone Tomorrow's Scheduled Auction of a Portion of 3.7–4.2 GHz Radio Frequency Spectrum, Citing New Research That Amplifies the Safety Concerns of the Aviation Community* (December 07, 2020), *available at*: https://transportation.house.gov/news/press-releases/chair-defazio-calls-on-fcc-to-postpone-tomorrows-scheduled-auction-of-a-portion-of-37-42-ghz-radio-frequency-spectrum-citing-new-research-that-amplifies-the-safety-concerns-of-the-aviation-community.

[8] *See* FCC Public Notice, *Auction of Flexible-Use Service Licenses in the 3.7–3.98 GHz Band for Next-Generation Wireless Services*, AU Docket No. 20–25 (Aug. 7, 2020), *available at* https://docs.fcc.gov/public/attachments/FCC-20-110A1.pdf; FCC Announces Winning Bidders in C-band Auction, FCC (February 24, 2021), *available at*: https://www.fcc.gov/document/fcc-announces-winning-bidders-c-band-auction.

[9] RTCA Inc., *Assessment of C-Band Mobile Telecommunications Interference Impact on Low Range Radar Altimeter Operations* (October 7, 2020), *available at*: https://www.rtca.org/wp-content/uploads/2020/10/SC-239-5G-Interference-Assessment-Report__274-20-PMC-2073__accepted__changes.pdf.

[10] Jim Sparks, *Radio Altitude: The Instrument of Choice*, AviationPros (July 2003), *available at*: https://www.aviationpros.com/home/article/10387134/radio-altitude-the-instrument-of-choice.

[11] Fed. Aviation Admin., Safety Alert for Operators, Subject: Risk of Potential Adverse Effects on Radio Altimeters when Operating in the Presence of 5G C-Band Interference (Dec. 23, 2021), *available at*: https://www.faa.gov/other__visit/aviation__industry/airline__operators/airline__safety/safo/all__safos/media/2021/SAFO21007.pdf.

[12] Fed Aviation Admin., 5G and Aviation Safety (Jan. 2, 2022), *available at*: https://www.faa.gov/5g.

[13] Frances Fiorino, *Boeing Warns of Possible 737 Altimeter Fault*, Aviation Week (March 2009), *available at*: https://web.archive.org/web/20120322020140/http://www.aviationweek.com/

Radio altimeters also provide height-above-terrain information, which can serve as a critical component for other systems on an aircraft, such as the Terrain Awareness and Warning System (TAWS).[14] Terrain warning is required in the U.S. for all air carrier operations due to numerous fatal Controlled Flight Into Terrain (CFIT) accidents,[15] and has been the subject of several National Transportation Safety Board recommendations.[16] Fortunately, there has not been a single passenger fatality due to a CFIT accident on an U.S. Part 121 aircraft equipped with TAWS since the system deployed in the late 1990s.[17]*Prior to this time, CFIT accidents were the leading cause of fatalities in commercial aviation*.[18]

In the fall of 2020, the Radio Technical Commission for Aeronautics (RTCA), a non-profit organization, completed a six-month study of radio frequency interference from 5G network emissions with radio altimeter performance.[19] The RTCA study stated that, without appropriate mitigations and guardrails, deployment of 5G wireless services in the C-band could cause "catastrophic failures leading to multiple fatalities."[20] The RTCA study also concluded that the aviation industry cannot mitigate such a risk alone and suggested the FCC, FAA, and aviation and telecommunications (telecom) industries work together to ensure radio altimeters are safeguarded in the interest of public safety.[21] While the FCC offered the aviation sector a 220 MHz guardrail (3.98–4.2 GHz) between bands to help prevent harmful interference, many aviation stakeholders maintained that this mitigation measure alone was not enough.[22]

Since May 2021, the Department of Defense has been leading an interagency effort to test the potential effects of certain 5G technologies on radio altimeters, primarily on military aircraft, focusing on improving the performance of equipment to protect against harmful interference.[23] There have also been calls for developing performance standards for radio altimeters to ensure all altimeters are designed to filter out interference and are better performing given that no standards for radio altimeters currently exist. Although the RTCA is working on revising the minimum operational standards for altimeters, aviation stakeholders anticipate that the process of setting those standards and receiving approval from the FAA will take several years, after which more time will then need to be allotted for manufacturers to begin producing and installing these new altimeters.[24]

III. 5G Deployment and the FAA's Response

A. Special Airworthiness Information Bulletin and Initial 5G Deployment Delay

The current situation over 5G deployment escalated in November 2021 when the FAA issued a special airworthiness information bulletin alerting manufacturers, operators, and pilots that action may be needed to address potential interference with radio altimeters caused by 5G deployment.[25] Verizon and AT&T, which were ex-

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aw/generic/story_generic.jsp?channel=comm&id=news/ALT030509.xml&headline=Boeing%20Warns%20of%20Possible%20737%20Altimeter%20Fault.

[14] Hop Potter, *Implementation of Terrain Awareness and Warning System (TAWS)—Final Report to CAST*, Skybrary (May 2006), *available at*: https://www.skybrary.aero/index.php/SE001:_Terrain_Awareness_Warning_System_(TAWS)_-_Final_Report and subsequent analysis of aircraft accident databases since 2006.

[15] 14 CFR 121.354 (2022).

[16] Hop Potter, *supra* note 14.

[17] *Id.*

[18] *Id.*

[19] RTCA, Assessment of C-band Mobile Telecommunications Interference Impact on Low Range Radar Altimeter Operations, (October 7, 2020), *available at*: https://www.rtca.org/wp-content/uploads/2020/10/SC-239-5G-Interference-Assessment-Report_274-20-PMC-2073_accepted_changes.pdf.

[20] *Id.* at 88.

[21] RTCA, *supra* note 19.

[22] Bevin Fletcher, *Aviation Wireless Industries Clash Over C-band Interference*, Fierce Wireless, (August 2021), *available at*: https://www.fiercewireless.com/regulatory/aviation-wireless-industries-clash-over-c-band-interference.

[23] Valerie Insinna and Aaron Mehta, *As 5G auction continues, Pentagon turns to safety planning*, Defense News (January 21, 2021), *available at*: https://www.defensenews.com/air/2021/01/21/as-5g-auction-continues-pentagon-turns-to-safety-risk-mitigation-plans/.

[24] Bani Sapra, *Bringing 5G to the skies is more complicated than it seems*, Wired (May 5, 2021), *available at*: https://wired.me/science/bringing-5g-to-the-skies-is-more-complicated-than-it-seems/.

[25] *Special Airworthiness Bulletin on potential adverse effects on radio altimeters*, Federal Aviation Administration (November 2, 2021), *available at*: https://rgl.faa.gov/Regulatory_and_Guidance_Library/rgSAIB.nsf/dc7bd4f27e5f107486257221005f069d/27ffcbb45e6157e9862587810044ad19/%24FILE/AIR-21-18.pdf.

pected to roll out 5G services in the C-band on December 5, 2021, subsequently announced they would delay their 5G rollout for 30 days, in order to provide additional time to address the aviation industry's concerns.[26]

B. FAA Airworthiness Directives (ADs) on Radio Altimeters

In early December 2021, the FAA issued a set of ADs, which included a directive that required revising flight manuals to prohibit certain operations requiring radio altimeter data when in the presence of 5G C-band signals, such as landing in low visibility conditions.[27] This AD would apply to areas and airports later identified through Notice to Air Missions (NOTAMs).[28] The AD was expected to prevent the dispatch of flights to certain airports and locations during times of low visibility—such as fog, rain, and snow—and result in significantly more flight diversions and cancellations.[29] A4A estimated at the time that if the AD had been in effect in 2019, approximately 345,000 passenger flights, 32 million passengers, and 5,400 cargo flights would have been impacted in the form of delayed flights, diversions, or cancellations.[30] HAI also estimated that a large portion of their fleet could have been grounded without significant relief from the FAA.[31]

C. December 2021 Information Sharing Agreement

One of the primary reasons the FAA issued a wide-reaching AD to mitigate potential harmful interference from 5G signals is because the FCC did not possess, and the telecom industry had not provided, data which contained the requisite critical information the FAA needed to provide an in-depth technical analysis.[32] This prevented the FAA from conducting the critical risk assessments needed to put the proper mitigations in place prior to the originally scheduled deployment. Finally, in December 2021, the FAA confirmed that the telecom industry had begun transmitting the technical data (such as 5G base station locations) for the FAA to accurately assess the risk to aircraft radio altimeters.[33]

On December 22, 2021, Verizon and AT&T announced, through the wireless industry trade association, CTIA, an agreement between CTIA, AIA, and A4A, to begin sharing otherwise confidential technical data amongst their member companies.[34] This information sharing agreement was critical for providing engineers and experts from the airlines and aviation manufacturers with previously unavailable data that allowed them to more accurately assess the potential risk of 5G signals to aircraft radio altimeters.

D. January 3, 2022, Agreement

On January 3, 2022, Verizon and AT&T announced another two-week delay of 5G deployment, from January 5, 2022, to January 19, 2022, after DOT Secretary Buttigieg and FAA Administrator Dickson called on both telecom companies to delay deployment for two weeks in a December 31, 2021, letter.[35] As part of that deal, Verizon and AT&T agreed to continue sharing the geographical locations of 5G ground stations and supply a more in-depth understanding of how the more powerful 5G signals of those stations would function within the C-band.[36] Additionally, the FAA, in consultation with aviation stakeholders, agreed to identify 50 priority airports which would be subjected to temporary 5G "exclusion zones," areas where

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[26] Cat Zakrzewski, *AT&T and Verizon will delay rollout over airplane interference concerns*, Washington Post (November 4, 2021), *available at*: https://www.washingtonpost.com/technology/2021/11/04/att-verizon-5g-delay/.

[27] FAA, *supra* note 12.

[28] *Id.*

[29] FAA, *supra* note 6.

[30] David Shepardson, *U.S. airlines warn 5G wireless could wreak havoc with flights*, Reuters (December 15, 20221), *available at*: https://www.reuters.com/business/aerospace-defense/us-airlines-warn-5g-wireless-could-cause-havoc-with-flights-2021-12-15/.

[31] HAI, Statement on FAA ADs Related to 5G Wireless Interference, (December 8, 2021), *available at*: https://rotormedia.com/hai-statement-on-faa-airworthiness-directives-related-to-5g-wireless-interference/.

[32] Briefing provided to Committee staff by FAA on January 3, 2021.

[33] Information provided to Committee staff by the FAA on Dec. 20, 2021.

[34] CTIA, Joint Statement from CTIA, AIA and A4A on 5G and Aviation Safety, (December 22, 2021), *available at*: https://www.ctia.org/news/joint-statement-from-ctia-aia-and-a4a-on-5g-and-aviation-safety#:~:text=December%2022%2C%202021-,Joint%20Statement%20from%20CTIA%2C%20AIA%20and,on%205G%20and%20Aviation%20Safety%20.&text=%E2%80%9COur%20belief%20is%20that%20by,5G%20while%20preserving%20aviation%20safety.%E2%80%9D.

[35] Associated Press, *AT&T, Verizon delay new 5G service after Buttigieg request*, (January 3, 2022), *available at*: https://www.boston.com/news/technology/2022/01/03/att-verizon-delay-new-5g-service-after-buttigieg-request/.

[36] *Id.*

5G deployment would be prohibited within at least 1.25 miles beyond the ends of the runway and about a half mile to either side.[37] These priority airports were identified by the FAA and selected based on their traffic volume, number of low-visibility days, and role as a diversion location for other airports that may experience disruption.[38] This agreement was originally intended to only be in place for six months and gave the telecom industry the right to reject any of the originally agreed upon mitigations already in place. However, the terms of this agreement were later superseded by another agreement on January 18, 2022.

E. January 18, 2022, Agreement

On January 18, 2022, a day before the scheduled nationwide deployment of 5G, Verizon and AT&T announced they would delay deployment around certain airport runways.[39] This move was in response to an A4A letter expressing concern over the recently issued FAA NOTAMs that placed flight restrictions affecting a significant number of airports, not just the 50 priority airports previously covered under the January 3, 2022, agreement.[40] The new agreement,[41] which the DOT and FAA also helped broker, called for expanded exclusion zones that prohibit 5G deployment *within at least two*[42] *miles of runways at all 87 airports affected by FAA NOTAMs*.[43]

The expanded exclusion zones around specific airports were designed to allay the FAA's concerns with 5G interference enough to permit the agency to issue more alternative methods of compliance (AMOCs), which in turn would allow more aircraft to operate at those airports even in low visibility conditions.[44] According to the FAA, unlike the previous mitigation agreements that were agreed to, the terms of this agreement are not expected to expire until the FAA determines it is safe to deploy 5G within that two-mile radius.

IV. CURRENT STATE OF PLAY

Since the January 18, 2022, targeted delay, the FAA has issued a number of AMOCs which allow a large percentage of the commercial air carrier fleet to continue operations at all of the 87 airports that received Instrument Approach Procedure NOTAMs.[45] In the case of 5G, an AMOC is essentially an exemption to the AD, allowing (a) a specific aircraft, with (b) a specific radio altimeter, to land at (c) specified airports, even in low visibility conditions, regardless of whether the airport has a 5G NOTAM or not.

The aircraft models that have received an AMOC and are approved as of January 31, 2022, represent at least 90 percent of the U.S. commercial fleet (compared to just 45 percent before the January 18, 2022, agreement) and include Boeing 717, 737, 747, 757, 767, 777, 787, MD–10/–11 models; Airbus A300, A310, A319, A220, A320, A321, A330, A340, A350 and A380 models; Embraer 120, 170, and 190 regional jets; CL–600/CRJ regional jets; DHC–8 turboprops and ATR turboprops.[46] However, those AMOCs are limited to the above aircraft models that possess one of 20 approved radio altimeters.[47] While helicopter operators have not yet received an AMOC and are still restricted by certain airspace related NOTAMs, the FAA did

[37] FAA, *supra* note 12.
[38] FAA, *supra* note 6.
[39] David Shepardson, *AT&T, Verizon pause 5G rollout near U.S. airports to avoid flight disruptions*, Reuters, (January 19, 2022), *available at*: https://www.reuters.com/business/aerospace-defense/biden-administration-talks-head-off-5g-aviation-standoff-2022-01-18/.
[40] *See* David Shepardson, Major U.S. airlines warn 5G could ground some planes, wreak havoc, Reuters, (January 18, 2022), *available at*: https://www.reuters.com/technology/exclusive-major-us-airline-ceos-urge-action-avoid-catastrophic-5g-flight-2022-01-17/.
[41] While the FAA has briefed the Committee on the general outline of the January 18, 2022, agreement, some of the specific details of the agreement remain undisclosed.
[42] The actual area for which deployment is prohibited is approximately 3 miles, but this extra mile is to ensure that an aircraft's radio altimeter will be performing accurately within 2 miles of an affected airport's runway. The FAA also continues to refine these areas, based on evolving risk, and it may change over time.
[43] While there have been several different types of 5G-related NOTAMs recently issued by the FAA, this is specifically in reference to the Instrument Approach Procedure (IAP) NOTAMs that restrict specific low visibility approach operations at certain airports.
[44] FAA, *supra* note 12.
[45] FAA, *supra* note 6.
[46] FAA, *supra* note 12.
[47] *Id.*

grant a two-year waiver to the AD to allow most medical emergency flights to continue under certain conditions.[48]

When the FAA originally announced the first round of AMOC approvals prior to the January 18, 2022, agreement, low visibility operations were only permitted at 48 of the 87 affected airports. This agreement has enabled the FAA to expand the list of airports to all 87 airports.[49] It is worth noting that even with these AMOCs, sporadic disruptions are still expected throughout the NAS. For instance, there are still a significant number of commercial aircraft, particularly regional commercial aircraft, that have either yet to receive an AMOC or received a limited AMOC that still prohibits or severely restricts the aircraft from operating in low visibility conditions at certain airports.[50] Additionally, as the FAA continues to receive and review additional information pertaining to the deployment of new 5G base stations, the agency will need to issue new NOTAMs for airports and areas that subsequently face higher risk of 5G interference for aircraft. As the potential risks of 5G interference to aircraft are determined, AMOCs—which expire at the end of each month—will need to be reviewed and reissued.[51]

Thus, continued collaboration between the FAA, FCC, and aviation and telecom stakeholders, and compliance with the known terms of the January 18, 2022, agreement is necessary to ultimately maintain aircraft safety and reduce further disruptions to the NAS.

V. International 5G Deployment

While 5G deployment has started to occur in as many as 40 other countries, there are several significant differences that make comparisons between those countries and the United States difficult. For instance, most of these countries either (1) use drastically lower 5G power levels than the United States, (2) have implemented other mitigation strategies *prior* to deployment to prevent interference, namely 5G antennas' angle requirements or expansive exclusion zones near airport runways, or (3) operate their allocated frequencies for 5G farther away from the radio frequency band used by radio altimeters, thereby reducing the risk of interference. Additionally, they all have much less commercial aviation activity than the United States. Below are some examples of 5G deployment outside of the United States and the mitigations those regions have implemented:

- *Europe*: The 3.4–3.8 GHz band is utilized for 5G in Europe. However, there is a separation of an additional 100 MHz more than what will be provided in the U.S., reducing the risk of potential interference.[52] The power levels permitted in most of Europe are 23 percent less than those that would be permitted in the U.S.[53] The European countries specified below have additional mitigations in place.
- *France*: French regulators have imposed 5G exclusion zones (primarily around the Nice and Charles de Gaulle Airports) to protect public safety.[54]
- *Czech Republic*: Prague Airport has imposed 5G exclusion zones to protect public safety.[55]
- *United Kingdom (UK)*: Power levels are significantly lower in both the frequency ranges 3.4–3.8 GHz, and 3.805–4.195 GHz by 62 percent and 99 percent, respectively.[56] The UK Civil Aviation Authority (CAA) has stated that 5G mobile base stations operating below 3.8 GHz pose a viable interference threat to radio altimeters.[57] The UK CAA also stated that lower power levels in the 3.8–4.195 GHz range may be an issue for helicopters, especially those used for emergency services.
- *Australi*a: Compared to Europe and the United States, Australia operates farther away from the radio frequency band used by the radio altimeter. Addition-

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[48] Helicopter Ass'n Int'l Partial Grant of Exemption, Regulatory Docket No. FAA–2021–1028, Exemption No. 18973 (Jan. 13, 2022), *available at*: https://rotormedia.com/wp-content/uploads/2022/01/Approved-HAI-5G-Partial-grant.pdf.

[49] FAA, *supra* note 6

[50] FAA, *supra* note 12.

[51] *Id.*

[52] A4A, 5G Interference: Frequently Asked Questions, *available at*: https://www.airlines.org/5g-frequently-asked-questions/.

[53] *Id.*

[54] Ex Parte Letter from aviation stakeholders to Marlene Dortch, Secretary, Federal Communications Commissions, Docket No. 18–122 (filed Nov. 18, 2021), *available at*: https://www.airlines.org/wp-content/uploads/2022/01/Aviation-Industry-Reply-to-CTIA-11-19-2021-2022-01-03-15__57__10.pdf

[55] *Id.*

[56] *Id.*

[57] *Id.*

ally, the power levels permitted in Australia are 76 percent lower than allowed in the United States.[58]

- *Japan*: Japan has deployed 5G up to 4.1 GHz and the power levels permitted for 5G are at least 90 percent below those permitted in the United States.[59] The macro cell power levels are 96 percent below or only four percent of that permitted in the U.S., while the small cell power levels are less than one percent of what is permitted in the United States.
- *Canada*: Canadian regulators recently announced they would restrict certain 5G services around airports, placing "exclusion zones" around 26 airports where outdoor 5G base stations would not be permitted to operate—but indoor 5G operations would be allowed.[60] Canada also established "protection zones" where 5G operations would be allowed, with restricted power. Canada will now require, until it decides otherwise, that the 5G antennas tilt down, rather than horizontally or upward, so as not to interfere with radio altimeters.[61]
- *South Korea*: 5G is limited to 3.42–3.7 GHz and the maximum permitted 5G power is 95 percent less than the U.S. levels.[62]

WITNESSES

PANEL 1

- The Honorable Steve Dickson, Administrator, Federal Aviation Administration

PANEL 2

- Nicholas E. Calio, President and CEO, Airlines for America
- The Honorable Eric Fanning, President and CEO, Aerospace Industries Association
- Cathryn Stephens, A.A.E., Airport Director, Eugene Airport, on behalf of American Association of Airport Executives
- Captain Joe DePete, President, Air Line Pilots Association
- Faye Malarkey Black, President and CEO, Regional Airline Association
- James A. Viola, President and CEO, Helicopter Association International
- The Honorable Meredith Attwell Baker, President and CEO, CTIA
- Dennis Roberson, President and CEO, Roberson and Associates

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[58] *Id.*
[59] *Id.*
[60] Diana Furchgott-Roth, *Canada Limits 5G to Protect Air Travel*, Forbes, (November 21, 2021), *available at*: https://www.forbes.com/sites/dianafurchtgott-roth/2021/11/21/canada-limits-5g-to-protect-air-travel/?sh=593ae2737247.
[61] *Id.*
[62] A4A, *supra* note 52.

FINDING THE RIGHT FREQUENCY: 5G DEPLOYMENT AND AVIATION SAFETY

WEDNESDAY, FEBRUARY 3, 2022

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

The subcommittee met, pursuant to call, at 11:01 a.m., in room 2167 Rayburn House Office Building and via Zoom, Hon. Rick Larsen (Chairman of the subcommittee) presiding.

Members present in person: Mr. Larsen of Washington, Mr. DeFazio, Mr. Graves of Louisiana, Mr. Graves of Missouri, Mr. Young, Mr. Perry, Mr. Katko, Mr. Burchett, and Mr. García of Illinois.

Members present remotely: Mr. Carson, Ms. Davids of Kansas, Mr. Kahele, Mr. Johnson of Georgia, Ms. Titus, Ms. Brownley, Mr. Payne, Mr. DeSaulnier, Mr. Lynch, Mr. Stanton, Mr. Allred, Mr. Lamb, Ms. Norton, Ms. Johnson of Texas, Mr. Massie, Mr. Mast, Mr. Fitzpatrick, Mr. Balderson, Mr. Stauber, Dr. Van Drew, Mr. Nehls, Ms. Van Duyne, Mr. Gimenez, and Mrs. Steel.

Mr. LARSEN. I call the meeting of the House Subcommittee on Aviation to order.

I ask unanimous consent that the chair be authorized to declare a recess at any time during today's hearing.

Without objection, so ordered.

I also ask unanimous consent that Members not on the subcommittee be permitted to sit with the subcommittee at today's hearing and ask questions.

Without objection, so ordered.

And as a reminder, please keep your microphone muted unless speaking. If I hear any inadvertent background noise, I will request that the Member mute their microphone. And I will not say please, despite the instructions.

To insert a document into the record, please have your staff email it to DocumentsT&I@mail.house.gov.

I will now recognize myself for an opening statement.

Good morning, and welcome to today's Aviation Subcommittee hearing titled, "Finding the Right Frequency: 5G Deployment and Aviation Safety."

On January 24th, 25th, and 26th, Alaska Airlines cancelled over 50 flights at Paine Field in Everett, my hometown. Was it the thicker than unusual 24-hour fog? No, planes fly in worse. Was it the Embraer 175 radio altimeter? Also no; the airplane flies with that radio altimeter all the time. Was it the runway orientation?

Was it pointing the wrong way? Well, that is a silly assumption to make. Was it the presence of a radio tower with a soon-to-be activated 5G transmitter? No, not just that.

Unfortunately, the problem was all of those things coming together in a perfect storm of technology. This true story about 5G and aviation safety shows that the problem we are addressing today has more layers than a Dagwood sandwich.

So, what do we do when we are faced with a complex problem like this? We break it into parts, and we focus on basic principles. And our basic principle in this subcommittee is aviation safety.

So, how to ensure that 5G and aviation safety can coexist, in the words of several of our witnesses? What I hope emerges from this hearing is that the subcommittee has a firm grasp of what the telecommunication and aviation industry, the FAA, the FCC, the NTIA, and others can do to anticipate future 5G rollout conflicts, avoid them, what impact future FCC auctions may have on aviation operations, and establish a process, formal or informal, to proactively address these conflicts.

In preparation for today's hearing, here is what I concluded.

The aviation industry has expressed concerns about 5G interference as far back as 2015 at the World Radio Conference. I also found out there is actually something called the World Radio Conference.

I also found out the NTIA, the Federal agency responsible for coordinating spectrum policy, failed to communicate the FAA concerns through the formalized FCC process.

I found that telecom engineers and aerospace engineers have the name "engineer" in common, but beyond that, they speak actually different engineering languages when they speak to each other and when they speak to each other at all. But I understand that is changing as well, and that is a positive outcome.

I found that the industries, aviation and telecom, have misaligned cultures on this issue, with telecom being about clearer, faster communications as its selling point, and aviation has aviation safety as its selling point. It is what gives the public confidence in flying.

I also found out that this is not a Federal Government only problem. It is also an industry problem.

So, what can we do to help aviation safety and 5G coexist?

Well, I think there is an imperative here. There will be a continued rollout of the C-band from the 3.7 to 3.8 megahertz on the spectrum and eventually the 3.8 to 3.98, which will bring us that much closer to the 4.2 megahertz band where the aviation band starts.

There is a potential for future auctions as well. And then there is 6G coming down, and it means different things to different people. And we don't know what it means for aviation safety. So, we need to begin to understand that.

I think we need to establish informal and formal communication between the FAA and the FCC moving forward as well. So that, hopefully, we don't have to have another hearing like this.

I would like to think that, perhaps, that in foreign policy what they call a track 2 dialogue can be convened, which is an informal, nongovernmental discussion, in this case, on 5G, on radio altim-

eters, on next steps that can be then used to inform the more formal mechanisms. Sort of sort these things out informally and then inform the formal mechanisms.

I certainly look forward to other ideas that we are going to hear from our witnesses today. And as we move forward, maybe we can get this Dagwood sandwich down to bite-sized chunks moving forward.

With that, I yield the balance of my time, and I will recognize Representative Graves from Louisiana for an opening statement.

[Mr. Larsen's prepared statement follows:]

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

Good morning and welcome to today's Aviation Subcommittee hearing titled "Finding the Right Frequency: 5G Deployment and Aviation Safety."

On January 24th, 25th and 26th, Alaska Airlines cancelled over 50 flights at Paine Field in Everett, Washington, my hometown.

Was it the thicker than usual 24-hour fog? No, planes fly in worse.

Was it the Embraer 175 radio altimeter? Also no.

Or the runway orientation? Was it pointing the wrong way? That's a silly assumption to make.

Was it just the presence of a radio tower with a soon-to-be activated 5G transmitter? No, not just that.

Unfortunately, the problem was all of those things coming together in a perfect storm of technology.

This true story about 5G and aviation safety shows that the problem we are addressing today has more layers than a Dagwood sandwich.

What do we do when we are faced with a complex problem like this?

We break it into its parts and focus on basic principles. Our basic principle on this subcommittee is aviation safety.

So how do we ensure that 5G and aviation safety can coexist, in the words of several of our witnesses.

What I hope emerges from this hearing is that the Subcommittee has a firm grasp of what the telecommunication and aviation industries, the FAA, the FCC, the NTIA and others can do to anticipate future 5G rollout conflicts, avoid them, and what impact future FCC auctions may have on aviation operations, and establish a process, formal or informal, to proactively address these conflicts.

In preparation for today's hearing, here is what I have concluded:

- The aviation industry has expressed concerns about 5G interference as far back as 2015 at the World Radio Conference.
- The NTIA, the federal agency responsible for coordinating spectrum policy, failed to communicate the FAA concerns through the formalized FCC process.
- Telecom engineers and aerospace engineers have the name "engineers" in common, but beyond that, they speak different engineering languages when they speak to each other and when they speak to each other at all. But I understand that is changing as well, and that is a positive outcome.
- The industries, aviation and telecom, have misaligned cultures on this issue, with telecom being about clearer, faster communications as its selling point, and aviation has aviation safety as its selling point. It's what gives the public confidence in flying.
- This is not a federal government only problem. It is also an industry problem.

So what can we do to help aviation safety and 5G coexist?

- It is imperative that there will be a continued rollout of the C-band from 3.7 to 3.8 MHz on the spectrum and eventually 3.8 to 3.98, which will bring it closer to the 4.2 mHz band where the aviation band starts. There's a potential for future auctions as well. And then there's 6G coming down, and it means different things to different people, and we don't know what it means for aviation safety. So we need to begin to understand that.
- I think we need to establish an informal or formalized communication between the FAA and the FCC moving forward as well, so hopefully we don't have to have another hearing like this.

- I would like to think that perhaps in foreign policy what they call a Track II dialogue can be convened, which is an informal, non-governmental discussion, in this case on 5G, on radio altimeters, on next steps that can be used to inform the more formal mechanisms—sort of sort these things out informally and the inform the formal mechanisms.

I certainly look forward to other ideas that we are going to hear from our witnesses today.

As we move forward, maybe we can get this Dagwood sandwich down to bite-sized chunks.

Mr. GRAVES OF LOUISIANA. Thank you, Mr. Chairman. I appreciate you having this hearing.

Mr. Chairman, the United States has the safest aviation industry in the world. It is the safest way to travel. We have the gold standard in regard to safety and innovation. We also—I believe I can speak for everyone on this panel—Republicans, Democrats, everyone—supports the deployment of 5G C-band and trying to help to bridge the digital divide.

I don't think that there is anyone here that would stand in front of aviation safety and block efforts to advance, and I don't think that there is anyone here that would block efforts to improve technology, communication, and, again, to help to bridge the digital divide.

Yet, if we look at what has happened and we found ourselves in this absolutely ridiculous, inexcusable situation, after knowing for years that there were challenges here, that there were issues here, and finding ourselves in a situation where at the very last minute there were claims, cries, demands, what have you, to delay deployment in something that was entirely preventable, something as the chair noted, issues had been raised not months before, but years and years before, and we found ourselves in this situation.

There is something called Parkinson's law. Parkinson's law is that you are going to use every bit of time available to you to finish a task. In this case, we didn't even do that. We saw two very capable agencies, or three, if you include NTIA, just simply sit here and play chicken with one another or whatever ridiculousness happened and now we ended up threatening aviation safety. We had flights cancelled.

And let me tell you something, Tim Clark, the CEO of Emirates, the airline, said, quote: "This is one of the most delinquent, utterly irresponsible issues" he has seen in his aviation career. This is the CEO of a company, of an airline. There is no excuse for us to be in this situation. This is what you would expect from some other country without the governance structure, without the strong civil support structure that we have in the United States. It is embarrassing and I will say it again, ridiculous, and it is inexcusable.

The traveling public expects that airlines are going to be safe. We already have enough uncertainty related to schedules and weather and other things that we don't need to create our own problems further disrupting or creating uncertainty in airline travel.

This committee takes aviation safety incredibly seriously as you have seen from what we have primarily focused on over the last 3 years. So, how do you balance this issue of aviation safety and deployment of 5G C-band to make sure that you can continue to have altimeters that work, you can continue to have aviation safe-

ty, and you can continue to deploy this new technology and improved communication?

The first step is leadership. It is leadership, and it is fundamental changes in the two primary agencies, the FAA and the FCC, in terms of how they approach things in this case. Most of the time, I think the agencies sit there and they wait for people to come to them.

And in this case, we saw agencies, both sitting there waiting, in many cases, and it simply didn't work. It caused the problem that we are facing today.

I think we can partially blame the clash of cultures at the two agencies with very different missions. The communications regulator, the FCC, is searching for evidence that there are problems with altimeters and 5G interference. And the FAA, the aviation safety regulator, is searching for proof that there are none. Totally different approaches.

And make no mistake that what is going on right now, we are still in the middle of this mess. We have temporary extensions, mitigation features, and Band-Aids. We are still in the middle of a big mess.

And although the temperature has been turned down for now, there is an awful lot of work to be done by all parties as we move forward. To Administrator Dickson, I do want to thank you and your team for working through the holidays diligently and over the past month to keep our aviation system safe and operating while the significant rollout of 5G C-band across the country has occurred. And I know we have asked a lot of your team and I know they are going to be asking for a whole lot more over the next few months.

We need them analyzing the data they are receiving from radio altimeter manufacturers, wireless communication companies, and aircraft manufacturers, and reporting what they have learned about potential interference. We need a lot of work in terms of the alternatives, I guess, approved in order to allow aviation safety to continue.

We need them working with RTCA to expedite the development and publication of new radio altimeter standards and manufacturers to move forward. I look forward to hearing from the witnesses today. I want to say, again, I am glad everyone is working well together now. It shouldn't have taken this long, and I think that the White House and others should have stepped in well before we reached a level of chaos.

Mr. Chairman, thanks, again, for having the hearing, and I look forward to hearing from our witnesses.

[Mr. Graves of Louisiana's prepared statement follows:]

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

Thank you, Mr. Chairman, I appreciate you having this hearing

The United States has the safest aviation industry in the world. We have the gold standard in safety and innovation, something this committee has focused on significantly over the last three years.

I also believe I can speak for everyone on this panel, whether Republican or Democrat, that we all support the deployment of 5G C-band and efforts to help to bridge the digital divide and improve wireless connectivity throughout our country.

Unfortunately, a lack of leadership resulted in those two goals not being able to coexist, and we find ourselves in an absolutely ridiculous, inexcusable situation. After knowing for years that there would be hurdles in deploying a new band of spectrum, nothing was done to cooperate and mitigate those risks. At the very last minute before deployment of this new technology, we heard cries and demands for delay. This was entirely preventable.

We saw three very capable agencies—FCC, FAA, and NTIA—play chicken with one another. And that game of chicken ended up threatening aviation safety.

There is no excuse for us to be in this situation. This is what you would expect from a country that doesn't have the governance structure that we have in the United States. It's embarrassing and I will say it again—ridiculous and inexcusable.

The traveling public expects that airlines are going to be safe.

We already have enough uncertainty related to schedules and weather as the industry is recovering from the pandemic, and we don't need to create additional problems that further disrupt airline travel.

So, how do you balance aviation safety and the deployment of 5G C-band, ensuring that our altimeters are operational to support aviation safety and, at the same time, continue to deploy new technology to improve communication?

It starts with leadership and requires fundamental changes in the two primary agencies'—the FAA's and the FCC's—approach and anticipation of conflicts within their mission areas. Neither agency should sit back and wait to be acted upon by the other, and each agency should consider how its internal culture influences that operational procedure.

The communications regulator, the FCC, searches for evidence that there is interference between 5G and aviation safety technologies. And the FAA, the aviation safety regulator, searches for proof that there isn't any. Totally different approaches.

While both agencies are actively engaged in a constructive dialogue today, these challenges are not yet overcome. We are still in the middle of this mess with temporary extensions, mitigation features, and band-aids. And although the temperature has been turned down for now, there is an awful lot of work to be done by all parties as we move forward for this band of spectrum, and for future technological advances which will undoubtedly pose similar risks.

Administrator Dickson, I want to thank you and your team for working diligently through the holidays and over the past month to keep our aviation system safe and operating while the significant rollout of 5G C-band across the country has occurred.

And I know we've asked a lot of your team, and I know we are going to be asking for a whole lot more over the next few months. We need them to analyze the data they're receiving from radio altimeter manufacturers, wireless communication companies, and aircraft manufacturers, and report what they've learned about potential interference and deploy mitigation strategies which preserve aviation safety while ensuring deployment of this next generation of technologies. We need a lot of work in terms of the alternatives approved in order to allow aviation safety to continue.

We need them to work with RTCA to expedite the development and publication of new radio altimeter standards and manufacturers to move forward. I look forward to hearing from the witnesses today, but I want to say again that I am glad everyone is working well together now. But it shouldn't have taken this long. That the White House didn't step in well before we reached this level of chaos is inexcusable.

Thank you, Mr. Chairman, for holding this hearing and I look forward to hearing from our witnesses.

Mr. LARSEN. Thank you, Mr. Graves.

The Chair now recognizes the chair of the full committee. Mr. DeFazio of Oregon is recognized for 5 minutes.

Mr. DEFAZIO. Thank you, Mr. Chairman. Well, you both have well outlined the extraordinary lack of communication and coordination between the FCC and the FAA and, of course, the NTIA is supposed to arbitrate these sorts of things and intervene—National Telecommunications and Information Administration—but they just received their first permanent head since the beginning of the Trump Presidency.

There were five interim heads during his Presidency and, hopefully, the new head will be able to put them in their rightful place

of coordinating as we move forward, because we are not done with this yet. We have temporary measures in place, but there are going to be more towers put out there. The companies consider their towers, their heights, their strength, their location to be proprietary data. It can't be proprietary data.

You can't just plop one down next to a critical approach into an airport, but that is what was going on.

And the industry refused to share that data, even though there was a very specific request made by the FAA on November 2nd. And, finally, on December 22nd, they began to release data on where their secret towers were, what their powers were, where the antennas were pointed, and that is when we began to realize this was going to be a big problem.

And, in fact, for the first 2 days, they said, oh, you can't give this data to anybody. You can't share it. This is secret. So, till we finally—the lawyers worked it out, and the FAA could work with the manufacturers and the airlines, and the airports have not really been particularly well-informed throughout this whole process. And there is just phenomenal room for improvement.

There needs to be a formalized process. Memorandums of understanding between affected agencies, you know, dealing with the FCC. This isn't the first instance. The FCC decided to sell off half of the vehicle-to-vehicle safety band. We are moving to automated vehicles and we are trying to develop things, crash avoidance, vehicle communication, and they said, no, it is much more important that people can stream high D while walking down the street on their cellphone. So, they sold off half of that spectrum.

They are being litigated and hopefully they will lose, and we will preserve that for the future of automobile safety. They also disregarded the concerns of the Department of Defense on letting Ligado turn on its satellites with the potential degradation of critical GPS.

It is a pattern of ignoring consequences beyond the consequences to the profitability of the telecom industry. That is their only focus. Telecom wants this, they need this, they got to have it. That has got to change, and hopefully the NTIA can negotiate this, or maybe it has to be mandated by Congress.

You are going to have memorandums of understanding. You are actually going to meaningfully cooperate and coordinate with these other agencies. You are going to take your, sort of, regulated—we don't really regulate telecoms any more, that is why we have the crappiest cellphone service in the world. Your regulated entities are going to communicate things to us, to the affected parties, that will affect their industries. I mean, that only makes sense. That only makes sense.

It is so disappointing, and we still have denial. We are going to hear from a witness today that says, oh, we have much greater safeguards than France now. Oops, not true. Oh, they are operating at a much higher power in France. No, two and a half times higher here. The antenna angles are mandated to be tilted down in France and they have exclusion zones and the list goes on around the country, around the world. And they said, oh, because it is safe elsewhere, where everybody else has taken measures to protect aviation, but we didn't until the last minute. And it is a

temporary agreement and something has to be worked out long term in the next 6 months. As they deploy more of these towers, they want to put them right in the flightpath because we want to get to that neighborhood over there. That is going to be a high-profit center for us, so, we want to have an antenna right there.

There have to be some restrictions and agreements, because we cannot have conflicting industries. Having a dropped call is way less serious than having a dropped airplane out of the sky.

Thank you, Mr. Chairman.

[Mr. DeFazio's prepared statement follows:]

Prepared Statement of Hon. Peter A. DeFazio, a Representative in Congress from the State of Oregon, and Chair, Committee on Transportation and Infrastructure

Thank you, Chair Larsen, for calling this important hearing today focused on the recent deployment of 5G technologies and its impact on the aviation industry and National Airspace System. I would like to thank FAA Administrator Dickson as well as the many aviation and telecom stakeholders for appearing before us today. I would also like to note that while FCC Chairwoman Rosenworcel had a conflict and could not join us today, the committee very much looks forward to hearing from her in the future on this issue.

If the events of the last two months have taught us anything, it's that the current interagency process for auctioning off spectrum is completely broken. My colleagues and I watched in complete dismay as the deployment of 5G originally proceeded without any of the safety mitigations the FAA, aviation industry, and I have long called for. This resulted in a disorienting display of 5G fits and starts over the last several months, inevitably due to the FCC auctioning off 5G spectrum without any concrete plan in place to safely deploy these technologies without interfering with aviation.

But it did not have to be this way!

Despite what recent coverage of 5G deployment might suggest, the concerns expressed by the FAA and aviation industry are nothing new.

In fact, numerous aviation stakeholders, including many we will hear from today, expressed concerns to the Trump-appointed, former FCC Chairman Ajit Pai, prior to and after the FCC voted to open up the C-band for wireless use all the way back in 2018. But they were ignored.

In September 2019, the FAA sent a letter to the National Telecommunications and Information Administration, or NTIA, expressing concerns that critical aviation systems could be impacted by harmful interference from C-band emissions and requesting the FCC delay further action until more studies could be done. However, they were ignored.

In November 2019, I sent a letter to former FCC Chairman Pai expressing my concern about the FCC's continuing disregard for aviation safety and urging the agency to delay moving forward unless they include strong mitigations to prevent harmful interference with aircraft. I was ignored.

In December 2020, the FAA and DOT sent a letter to the NTIA stating the "FCC's [current] path in this proceeding is insufficient to address our concerns" and urging them to delay the FCC's upcoming auction. However, the NTIA failed to enter the letter into the FCC's docket for consideration, and again, they were ignored.

And this isn't exclusive to aviation or the FAA. In 2019, the FCC proposed to give away more than half the bandwidth previously reserved for transportation safety and connected vehicles, despite my objections and those of many other transportation stakeholders.

The FCC's history of subordinating transportation safety to corporate broadband interests has predictably resulted in the current mess we find ourselves in and must change if we hope to avoid a similar result in the future.

Now the telecom industry has argued that the safety mitigations the FAA and aviation industry are advocating for, and which the telecom industry has begrudgingly accepted only recently, are unnecessary because 5G deployment is occurring in as many as 40 other countries, with no confirmed reports of harmful interference with aircraft.

However, what they fail to mention is that most of these countries use either drastically lower 5G power levels than the U.S., operate 5G further away from the

frequency used by aircraft radio altimeters, or have required significant safety mitigations, such as airport exclusion zones or 5G antennae placement requirements, to limit the potential for harmful interference to aircraft.

Additionally, no other country even comes close to having the level and complexity of civil aviation activity that exists in the U.S.

As I've stated before, to make this comparison without recognizing the critical differences that exist between the U.S. and every other country that has deployed 5G technology is disingenuous, misleading, and displays a glaring disregard for the potential safety measures needed to protect the flying public.

Now I want to be clear. I do not oppose the deployment of 5G.

On the contrary, I know faster wireless speeds will help provide many great benefits for Americans, and have tremendous potential applications in the tech, healthcare, and national security fields.

But let's not suggest the risks of delaying 5G deployment were ever equal to the risks deployment could pose to aviation safety.

A dropped call or the inability to access a slightly faster internet connection is not nearly the same as the risk of a potential aviation accident. In fact, it's not even close.

Radio altimeters serve as a pilot's primary altitude measurement during flight and are critical to enabling safe arrivals, particularly during inclement weather or other instances of low visibility. The risk of flying an aircraft with a compromised radio altimeter can be disastrous.

For instance, in 2009 a Turkish Airlines flight experienced faulty radio altimeter readings while on approach, contributing to its fatal crash landing that resulted in nine deaths.

The consequences of getting this right are enormous. We cannot afford to dismiss the aviation industry's concerns regarding the importance of accurate radio altimeter readings.

We must do everything we can to prevent or limit the potential for 5G signals to interfere with these devices.

There are some who believe that the risk of 5G potentially interfering with aircraft radio altimeters is a "low risk" event that should be ignored. But this committee has learned that the consequences of ignoring even "low-risk" events in aviation can be catastrophic.

The two crashes of Boeing 737 MAX airplanes in 2018 and 2019 may have been considered "low-risk" by some, but ultimately led to the tragic loss of 346 lives.

Furthermore, in the wake of the 737 MAX crashes, this committee and the American public, rightfully, questioned the FAA's lax oversight of the 737 MAX certification process and its commitment to safety.

But now there are critics—mostly those who tend to have no background in aerospace engineering or aviation safety—condemning the FAA for doing the very thing this committee and the American public have been calling on for decades: to do everything in its power to protect the American public from any and all risks to aviation safety.

We must not now, or ever, condemn the FAA for prioritizing safety.

Despite my continued concerns for how this process has played out, I am strongly supportive of the recent agreement reached between Verizon, AT&T, and the Biden administration to ensure we have 5G exclusion zones near all airports affected by the recent 5G deployment.

This agreement and continued collaboration between the telecom industry, aviation stakeholders, and the FAA will help ensure we can maintain aviation safety while also limiting the disruption to the aviation industry and American travelers.

Important questions remain: What are the precise details of the recent deal announced? How long are the current safety mitigations expected to last? What is the FAA doing to ensure it is communicating with all aviation stakeholders in a swift and transparent manner, particularly with regard to new AMOCs or NOTAMs the agency plans to issue? And what are the FAA, telecom industry, and aviation stakeholders doing to ensure we are fully prepared for future broadband deployments?

I look forward to receiving answers to these important questions today. I yield back.

Mr. LARSEN. Thank you, Chair.

The Chair recognizes Representative Graves of Missouri for an opening statement.

Mr. GRAVES OF MISSOURI. Thank you, Mr. Chairman, Ranking Member Graves, for having this hearing. And I also want to thank our witnesses on both panels for being here. It is no secret that our Nation continues to grapple with one crisis after the next. Thankfully, though, we are here today to talk about one crisis that was narrowly averted, at least for the time being.

And I want to commend the aviation and telecom industries for their collaborative efforts to ensure that aviation safety and 5G deployment can safely coexist.

It goes without saying that alarmist headlines, especially those about complex avionics and spectrum issues, lead to unhelpful finger pointing and distract from serious and technical efforts that produce some lasting solutions.

Regrettably, many of these headlines were byproducts of a botched Government coordination process, even though the issues have been raised publicly now for years. The American people would have been better served had the Government acted much sooner than it did in bringing together the experts at FAA and the FCC, and related industries, to address the issues at hand.

Here we are now, and I know that Members on both sides of the aisle are eager to hear what is going to happen in the short term, the medium term, and the long term to fully and permanently resolve any issues with potential 5G interference with radio altimeters.

As always, aviation safety is the number one priority of this subcommittee and the FAA. And that safety can only be ensured when we are not lurching from one deadline to the other. Safety also requires certainty, and that is sorely lacking right now from both air carriers and wireless carriers.

This topic is an issue of immense economic significance to both the telecommunications and aviation industries. It is crucial that all parties, under the most recent agreement, use this time to work together to devise and implement a permanent solution that facilitates 5G rollout and ensures aviation safety that works for all of the users of the system, whether they are major air carriers, regional airlines, helicopters, or general aviation operators. That is the balance that we have to strike, and again, Mr. Chairman, I am not going to pile on anymore. I think we have made our point, all of us.

So, I look forward to hearing the witnesses and what they have to say and how we are going to move forward.

Thank you, again, Mr. Chairman.

[Mr. Graves of Missouri's prepared statement follows:]

Prepared Statement of Hon. Sam Graves, a Representative in Congress from the State of Missouri, and Ranking Member, Committee on Transportation and Infrastructure

Thank you, Chair Larsen and Ranking Member Graves, and thank you to our witnesses on both panels for being here today.

It's no secret that our Nation continues to grapple with one crisis after the next. Thankfully, though, we're here today to talk about one crisis that was narrowly averted, for the time being. I want to commend the aviation and telecom industries for their collaborative efforts to ensure that aviation safety and 5G deployment can safely co-exist.

It goes without saying that alarmist headlines, especially those about complex avionics and spectrum issues, lead to unhelpful finger pointing and distract from serious and technical efforts that produce lasting solutions.

Regrettably, many of these headlines were by-products of a botched government coordination process, even though the issues have been raised publicly for years now. The American people would have been better served had the government acted much sooner than it did in bringing together the experts at FAA and FCC, and the related industries, to address these issues.

But we're here now, and I know that members on both sides of the aisle are eager to hear what has to happen in the short-, medium-, and long-term to fully and permanently resolve any issues with potential 5G interference with radio altimeters.

As always, aviation safety is the number one priority of this subcommittee and the FAA. That safety can only be ensured when we're not lurching from one deadline to another. Safety also requires certainty, something that is sorely lacking right now for both air carriers and wireless carriers.

This topic is an issue of immense economic significance to both the telecommunications and aviation industries. It's crucial that all parties, under the most recent agreement, use this time to work together to devise and implement a permanent solution that facilitates 5G rollout and ensures aviation safety that works for all users of the system, whether they're major air carriers, regional airlines, helicopters, or other general aviation operators. That is the balance that we have to strike, and I look forward to hearing from our witnesses today to see how we do it.

Mr. LARSEN. Thank you, Representative Graves.

So, before we turn to our witnesses, there was a floor schedule put out earlier. So, for the Members, there is no plan for votes on the floor till about 4:15. There is a 1:30 p.m. bipartisan classified briefing, and the House floor will go into recess at 1:30 p.m.

It doesn't impact us, but just for your planning purposes, there won't be any need for us to break as a subcommittee, but at 1:30, the classified briefing is on the Russia/Ukraine issue, but the floor does not plan to vote till about 4:15 just for planning purposes. It should give us freedom to get through this, but folks may want to go to the briefing as well.

We will now turn to our witnesses. We will be hearing two panels today with each panel followed by questions from Members.

I will now like to welcome our first panel, which consists of one person, the Honorable Steve Dickson, Administrator of the Federal Aviation Administration. Administrator, thank you for joining us today, and we look forward to your testimony.

And without objection, your full statement will be included in the record. Since it is part of the record, the subcommittee requests that you limit your oral testimony to 5 minutes.

Mr. Dickson, you may proceed.

TESTIMONY OF HON. STEPHEN M. DICKSON, ADMINISTRATOR, FEDERAL AVIATION ADMINISTRATION

Mr. DICKSON. Thank you, Chair Larsen. And good morning, Chair Larsen, Chair DeFazio, Ranking Members Graves and Graves, and the members of the subcommittee.

Thank you for the opportunity today to discuss the FAA's efforts to keep aviation safe in the presence of 5G C-band wireless technology. We have continually maintained that through mutual cooperation, 5G and aviation can safely coexist.

We have the safest aviation system in the world, and we don't take that for granted, something that is hard earned every day.

We have achieved this because we take actions to mitigate known and potential risks to safety. And that is why the FAA has

been involved in a sustained effort since well before the 2020 spectrum auction to highlight and now mitigate potential 5G interference with critical flight systems.

I want to thank this committee for its help and support of aviation safety during this period. Our job would be significantly more difficult without the continued support of this committee.

We also appreciate the wireless companies voluntarily providing us with the data that we need to maintain safety while minimizing flight disruptions during this rollout. Now, we are always concerned about radio frequency interference when it comes to aviation infrastructure, but in 2018, a new potential threat emerged. The MOBILE NOW Act directed the FCC to evaluate the feasibility of auctioning spectrum that is adjacent to the band where radio altimeters operate.

The FAA and the aviation industry urged caution. Boeing and the Air Line Pilots Association on filings to the FCC back in 2018 called for more analysis of this issue.

The FAA collaborated with or supported research efforts that revealed that 5G operations could significantly degrade or completely interrupt radio altimeter operation during critical phases of flight.

And in December of 2020, the Acting Deputy DOT Secretary and I sent a letter to the NTIA outlining our concerns about aviation safety backed up by the recent studies.

We asked that the auction be delayed so that we could conduct safety risk assessment and identify mitigations. Ultimately, the auction occurred and two of the wireless companies that acquired the C-band spectrum scheduled the initial deployment in early December of 2021.

We engaged with our interagency partners throughout the year in an effort to access the information that was necessary to inform aviation safety mitigations.

Ultimately, as the deployment approached in late 2021, Secretary Buttigieg and I requested two pauses from the wireless companies until mid-January of 2022. During the delay, we established a direct relationship with the wireless companies to receive the necessary information, transmitter locations, power levels, and signal shape characteristics to begin making an aviation safety assessment.

The wireless companies also agreed to keep towers turned off around airports that have low-visibility approaches. The safety model that we developed, along with the new data that we had access to from the telecommunications companies, allowed the FAA to determine which combination of altimeters and aircraft could be cleared to land in low-visibility conditions for specific runways at airports with 5G towers nearby.

On January 19th, the wireless companies activated 5G C-band service in many of the 46 markets. Our analysis of the wireless company data has allowed us to target anticipated problem areas more precisely, reducing the impact of both industries. And while we have avoided significant disruption to commercial aviation, we recognize that some communities and operations have been affected because we have not been able to fully mitigate interference risk for certain radio altimeters.

Now we know from long experience that early and open data exchange between everyone, stakeholders and regulators, has proven to be critical to identify and mitigate safety risks.

Aviation remains the safest form of transportation because of our commitment to being data-driven in our processes, and we will lean on it as we set new standards for altimeter performance in the new environment that is created by the 5G C-band deployment.

Spectrum is a limited resource, but the demand is essentially infinite, and we know that it will increase in coming years. The FAA's primary concern is and always will be the safety of the aviation system, but we firmly believe that by working together, 5G and aviation, can and will, safely coexist.

Moving forward, we are also ready to work across industry and with our Federal partners on a more thoughtful, inclusive, and collaborative approach to future spectrum policy and initiatives.

Thank you very much for the chance to provide this update, and I look forward to answering your questions.

[Mr. Dickson's prepared statement follows:]

Prepared Statement of Hon. Stephen M. Dickson, Administrator, Federal Aviation Administration

Chair Larsen, Chair DeFazio, Ranking Members Graves and Graves, and members of the subcommittee: thank you for the opportunity to be here today to discuss fifth-generation wireless network technology—or 5G—and aviation. To start, I would like to thank each of you for your continued unwavering support for aviation safety. Although the Department of Transportation (Department) and the Federal Aviation Administration (FAA) have made great progress in advancing our safety objectives related to 5G, we understand that our job would be significantly more difficult without the continued support of this committee and we greatly appreciate it. Similarly, the progress we have made on 5G would not have been achievable without the active leadership and sustained commitment of Secretary Buttigieg. The Secretary's engagement on this issue has significantly raised awareness of the safety concerns associated with 5G and his collaboration with the FAA and the wireless telecommunications companies (wireless companies) has helped enable much of the progress we have achieved in support of the safety and efficiency of the national airspace. We also appreciate the ongoing positive collaboration with the wireless companies and the participation of the Federal Communications Commission (FCC). Their willingness to work with us and provide us with needed data has allowed us to effectively carry out our mission and chart a path forward that maintains safety while minimizing flight disruptions.

The FAA's first priority is the safety of the national airspace. That has guided the agency's actions so aviation and 5G can safely coexist. Cooperation with the FCC, the wireless companies, the aviation industry, and others has been critical to minimize disruptions to aviation while more than 90 percent of the wireless companies' 5G deployment has been able to go forward as planned.

BACKGROUND

Before I provide you with further details, I would like to lay the foundation of the 5G issue and offer some background on how we got to this point. At the outset, it is important to keep in mind that the FAA is responsible for the safe and efficient use of the national airspace. The FAA does not regulate electromagnetic spectrum or the telecommunications industry. Although the FAA manages assigned spectrum related to certain airspace management ground systems, for example, 5G has been a novel issue for the aviation industry. Also, all of the work that we have done in coordination with stakeholders outside of aviation, including the wireless companies, has been achieved through voluntary cooperation.

I wanted to provide some highlights of the history of this issue. In 2018, the MOBILE NOW Act directed the FCC to evaluate the feasibility of commercial wireless

deployments in the 3.7–4.2 gigahertz (GHz) band (C-band).[1] That same year, in filings with the FCC, Boeing communicated its concern that aeronautical safety services that operate adjacent to the C-band should be adequately protected.[2] Also in 2018, the Airline Pilots Association (ALPA) urged in a filing to the FCC that appropriate steps be taken to ensure that interference on avionics by mobile wireless systems be fully analyzed and mitigated.[3] The ALPA filing also referenced a study presented to the International Civil Aviation Organization expressing similar concerns as far back as 2014.[4]

Additionally, since 2018 the FAA has either partnered with or supported specific research conducted by the Aerospace Vehicle Systems Institute (AVSI), a cooperative research entity, and RTCA, a non-profit aerospace consensus standards development organization, concerning the potential effects of C-band interference on aircraft avionics. In 2019, the FAA sent a letter to the National Telecommunications and Information Administration (NTIA) requesting that it consider the implications of the AVSI research and that it work to ensure that aircraft altimeters that operate in spectrum adjacent to the C-band do not receive harmful interference.

In March 2020, the FCC released a report and order making 280 megahertz (MHz) of the C-band available for 5G services.[5] Their plan was to begin auctioning C-band spectrum on December 8, 2020.[6] Shortly before that auction, the then-Acting Deputy Secretary of Transportation and I sent a letter to the NTIA expressing our concerns with the potential impact on aviation safety.[7] We noted in the letter that recent testing had revealed the potential for harmful interference with radio (also known as radar) altimeters installed aboard aircraft and we requested a deferral of the auction to allow the FAA to conduct a safety risk assessment and identify mitigations. In our letter we referenced, for example, a 2019 study by AVSI that summarized preliminary data suggesting altimeter performance degradation from out-of-band interference.[8] An October 2020 report by RTCA was also referenced in the letter.[9] The RTCA report concluded that 5G operations in the C-band may create harmful interference to some radio altimeters that would significantly degrade or completely interrupt their operation during critical phases of flight. As concerning as these and other findings have been to us, we also noted in our letter that we recognized the importance of making spectrum available for commercial purposes and ensuring American leadership in this space. We have continually maintained that, through mutual cooperation, 5G and aviation can safely coexist.

Radio altimeters operate in the 4.2–4.4 GHz range. Even with a frequency separation of 220 MHz, from 5G operations, there may still exist potential harmful interference under certain circumstances. As a pilot, I know from experience that a radio altimeter is one of the most crucial pieces of safety equipment aboard an aircraft. Radio altimeters are used in low visibility landings and are the only sensors aboard civil aircraft that provide a pilot with a direct measurement of the distance between the aircraft and the ground or other obstacles. Many other critical safety systems rely directly upon input from radio altimeters including terrain awareness warning, wind shear surveillance, traffic collision avoidance, tail strike prevention, automated landing, and other related cockpit display and alert warning systems. Harmful interference affecting any of these systems has the potential to be catastrophic. There is no scenario under which harmful interference is acceptable from a safety standpoint, absent sufficient mitigations to address that interference.

OPERATIONAL MITIGATIONS

Before and since the 2020 spectrum auction, the FAA has been involved in a sustained effort to assess and mitigate the risks associated with potential degraded radio altimeter performance. Prior to the initially scheduled 5G roll out for Decem-

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[1] See section 605(b) of Title VI of Division P of the Consolidated Appropriations Act, 2018 https://www.govinfo.gov/content/pkg/PLAW-115publ141/pdf/PLAW-115publ141.pdf

[2] https://ecfsapi.fcc.gov/file/121184623679/Boeing%20C-band%20NPRM%20Reply%20Comments%2012%2011%202018%20final.pdf

[3] https://ecfsapi.fcc.gov/file/10531182083849/ALPA%20Comments%2017-183%2018-122.pdf

[4] https://www.icao.int/safety/acp/ACPWGF/ACP-WG-F-30/ACP-WGF30-WP14%20Radio%20Altimeter%20Adjacent%20Bands%20Compatibility%20Study%20with%20IMT-FINAL%20Rev1.docx

[5] https://www.fcc.gov/document/fcc-expands-flexible-use-c-band-5g-0

[6] https://www.fcc.gov/document/fcc-begins-major-5g-spectrum-auction

[7] https://www.faa.gov/sites/faa.gov/files/2021-10/DOT__Letter__to__NTIA__FCC3.7__GHz__Band__Auction.pdf

[8] https://avsi.aero/wp-content/uploads/2021/12/AVSI-RA-Interim-OOB-Interference-Report-211206.pdf

[9] https://www.rtca.org/wp-content/uploads/2020/10/SC-239-5G-Interference-Assessment-Report__274-20-PMC-2073__accepted__changes.pdf

ber 5, 2021, the Department and the FAA successfully worked with the telecommunications carriers to agree to a 30-day pause of the deployment to allow added time for safety mitigation actions. The FAA moved quickly to take advantage of the delay to protect the safety of the flying public:

- In November, and again in December of 2021, the FAA issued Special Airworthiness Information Bulletins to inform manufacturers, operators, and pilots of the planned deployment of 5G.[10] The bulletins contain detailed guidance for aircraft and altimeter manufacturers as well as aircraft operators and pilots and sought information from each group to further assist the FAA in assessing the reliability and accuracy of altimeters and the potential risks of 5G deployment on aviation safety.
- On December 7, 2021, the FAA issued an Airworthiness Directive (AD) for all transport and commuter category airplanes equipped with a radio altimeter.[11] The AD was based on our determination that radio altimeters cannot be relied upon to perform their intended function if they experience harmful interference from 5G C-band wireless broadband operations. The AD requires revising the flight manual to incorporate limitations prohibiting certain operations requiring radio altimeter data when in the presence of 5G C-band harmful interference in areas identified by Notices to Air Missions (NOTAMs). A similar AD was issued on the same day for helicopters.[12]
- On December 23, 2021, the FAA issued a Safety Alert for Operators (SAFO). The SAFO provides information and guidance to operators regarding the risk of potential adverse effects on radio altimeters when operating in the presence of 5G C-band wireless broadband signals, and the role of NOTAMs in identifying the geographic areas where certain operations requiring a radio altimeter are prohibited in the presence of 5G signals.

Simultaneous with each of these safety actions, the FAA and the Department continued to engage with wireless company officials, who agreed to an additional voluntary two-week pause in 5G deployment to provide the FAA with a path forward that would allow for sufficient safety mitigations and minimize disruptions in air travel. On December 31, 2021, Secretary Buttigieg and I proposed an interim solution to the wireless companies.[13] We suggested that with an additional two-week pause in deployment, the FAA and the aviation industry would identify key airports where a buffer zone with minimized 5G transmissions would permit aviation operations to continue safely while the FAA continued assessments of the interference potential around those airports. Our goal was, and continues to be, to identify mitigations for key airports to enable as many commercial aircraft as possible to operate safely in all conditions. This will allow for 5G C-band to deploy around these airports on a rolling basis, such that all C-band planned locations can be activated barring unforeseen technical challenges or new safety concerns.

We also conveyed that the FAA will safely expedite the review and determinations regarding proposals for Alternate Methods of Compliance (AMOC) for operators with high-performing radio altimeters to operate at those airports. The FAA may approve AMOCs for altimeter/aircraft configurations that have been proven to meet equivalent levels of safety in this novel environment. An FAA-approved AMOC allows an aircraft with a particular model of altimeter to conduct operations that require a radio altimeter in a geographic area where such operations would otherwise be prohibited because of 5G. As part of the agreement, the wireless companies agreed to provide the FAA with data relevant to existing and planned locations as well as operating characteristics of 5G base stations. The data provided has allowed the FAA to precisely determine which aircraft are cleared for specific runways at airports in the 5G area based on altimeter equipage and antenna location. This information is captured in the approved AMOCs and its accuracy is the foundation of the coexistence of aviation safety and 5G deployment in the short term. To date the FAA has issued over 20 AMOCs for commercial and business jets, covering approximately 90 percent of the U.S. commercial fleet.

Since January 19, 2022, wireless companies have activated more 5G C-band towers in 46 markets nationwide. Prior to and since the 5G deployment, the FAA has worked around the clock to enable implementation of mitigations, where needed, to

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[10] https://rgl.faa.gov/Regulatory__and__Guidance__Library/rgSAIB.nsf/dc7bd4f27e5f1074862
57221005f069d/27ffcbb45e6157e9862587810044ad19/$FILE/AIR-21-18.pdf
https://rgl.faa.gov/Regulatory__and__Guidance__Library/rgSAIB.nsf/dc7bd4f27e5f1074862
57221005f069d/379cfb187d16db10862587b4005b26fc/$FILE/AIR-21-18R1.pdf

[11] https://www.faa.gov/sites/faa.gov/files/2021-12/FRC__Document__AD-2021-01169-T-D.pdf

[12] https://www.faa.gov/sites/faa.gov/files/2021-12/FRC__Document__AD-2021-01170-R-D.pdf

[13] https://www.faa.gov/sites/faa.gov/files/2021-12/12.31.2021%20-%20DOT%20and%20FAA
%20Letter%20to%20ATT%20and%20Verizon%20.pdf

address risks. Approximately 80 airports with low-visibility approaches in 5G deployment areas were identified, and the wireless companies agreed to turn off approximately 500 towers in the vicinity of those airports. These mitigations have enabled airlines and other flight operators to access most runways at airports in places where 5G is deployed, even in low visibility conditions. Although some flights have been affected by safety mitigations required in 5G deployment areas, significant disruptions to the air transportation system have been avoided. Further, our analysis of the data received has allowed us to focus our efforts and work much more efficiently.

MOVING FORWARD

The FAA is continuing to work with avionics manufacturers to evaluate altimeters and review manufacturer testing data to measure the accuracy, reliability, and robustness of each model. This includes data for altimeters used in regional and business aircraft. Also, the FAA is allowing helicopter air ambulance operators to continue using safety-enhancing night vision goggles in areas where the aircraft's radio altimeter could be unreliable due to 5G C-band interference as identified by NOTAMs. Similar to commercial aircraft, helicopters may perform day and night operations that do not require the use of a radio altimeter. Further, despite the breadth and diversity of the general aviation fleet, the FAA is working as quickly as it can to enable these aircraft to operate safely and efficiently.

As referenced earlier, NOTAMs let pilots and others know where 5G is present and operations are restricted. Although the wireless companies' actions creating buffer zones reduce the strength of 5G signals around airports, they do not fully eliminate it. The restrictions in a NOTAM do not apply if an aircraft has an altimeter that is approved by an AMOC for that location. Some aircraft, however, still do not have an approved AMOC for their altimeter. Additionally, even aircraft with an AMOC-approved altimeter may not be allowed to operate at all runways in the 5G area. Consequently, the restrictions outlined in the NOTAMs remain in place while the FAA continues to determine the accuracy and reliability of other altimeters that have not been approved by an AMOC.

We are confident we will work through this issue safely with minimal disruptions, but we acknowledge that some altimeters—especially older models used by certain segments of the aviation industry—may not receive approval as being safe in the presence of 5G emissions and interference, and may need to be replaced. The strengthening partnership across the aviation and telecommunications industries and the federal government has enabled substantial progress. In coming weeks, FAA will move quickly to use testing data and other insights to further refine our models and safely enable additional 5G deployment.

Spectrum is a limited resource, and demand for it will likely increase in coming years, including new applications across the transportation sector. As we move forward, we will work with the industry and our federal partners to strengthen processes to safely unlock the rapid innovation that we seek as a nation. Early and open communications with stakeholders from all involved industries, and a robust interagency process, are key to identifying and solving potential issues long before they have a real-world impact.

Thank you for the chance to provide this update and we look forward to continued engagement with the committee and subcommittee on this important issue.

Mr. LARSEN. Thank you, Administrator Dickson.

We are going to start with the chair of the full committee, Mr. DeFazio of Oregon. Mr. DeFazio, you are recognized.

Mr. DEFAZIO. Thank you, Mr. Chairman.

Administrator Dickson, thanks for being with us today.

As we have said, we understand what happened and we want to be certain it doesn't happen again, but we are in sort of a temporary hold here, and it is not totally clear to me, and I think others, what happens at the end of the 6-month voluntary period.

I have heard some say, no, it is not limited to 6 months and others saying, yes, it is limited to 6 months. So, could you, for instance, where they have turned off towers in proximity to airports with CAT III approaches and low-visibility issues, the lower power, how is this going to be solved long term, and how long do the tem-

porary measures stay in place, and what are we going to do permanently?

Mr. DICKSON. Well, thanks for the question, Chair DeFazio. And all parties are working together very effectively at this point, and we have agreed to take the immediate steps necessary to avoid disruption to the aviation system and to stay at the table and work in good faith to determine the next steps. But so far, the telecom companies, as I mentioned, have agreed to refrain from activating their 5G towers that are unacceptably close to runways, according to the FAA safety model, which we continue to refine.

They are also providing us with more data in a timely fashion to provide certainty and more predictability to the aviation system and also to help refine our safety analysis. And they are working with us as I speak, actually, on a flight test program that will contribute meaningfully to establishing the new standards for radio altimeters and also to refine what we are doing right now.

So, I am encouraged by the progress. We are certainly in a much better place today than we were 2 to 3 weeks ago, and we certainly don't want to be repeating these deadlines that we have had to overcome. We are finally getting the specific detailed information that we need to make accurate safety assessments and that is what we are focused on.

And the wireless companies, again, I think they have learned a lot about aviation safety. And we have certainly learned about their business. We are asking them for data that they have never had to provide to the Government before. So, that has been very beneficial to both sides, and we will continue that dialogue as we go forward.

Mr. DEFAZIO. Right. I think we had two sets of engineers with different languages, and I am glad they are now communicating and understanding some of the concerns. We are going to hear from an industry representative, an organization that says, safe everywhere else in the world, and we are taking stronger measures than any other country in the world, things that haven't been done elsewhere. But I have seen pretty specific data that that isn't true.

Can you address that? I mean, other countries have taken measures for exclusion zones, antenna strength, antenna direction, and other things. Is that correct? Many other countries.

Mr. DICKSON. That is correct. But there really is no comparison with either the aviation system or what is going on in the United States with 5G deployment. Our environment is not the same in either case. The power levels in other countries are different, the location on the spectrum is different, and, again, we have the most complex and dynamic airspace in the world.

Also, I think, it is important to remember that we are regulating the manufacturers here as well, and so, to some degree, many countries around the world, their aviation safety regulators have a reduced scope of responsibility compared to the FAA.

So, we have got to make sure that if a hazard is identified that we prove that whatever that hazard is has been completely mitigated from a safety perspective and that the system remains safe.

And to that end, laboratory testing did show that there was a hazard from 5G C-band interference, and so, we have to prove,

again, to ourselves that there is no hazard, and we are working diligently to do just that.

Mr. DEFAZIO. OK. Thank you. I am about to run out of time, but I assume that we are going to be looking at perhaps a new generation of altimeters or some sort of filtration or something, but I mean, I am very concerned about the ongoing deployment and the ongoing protections that will be put in place. So, I am pleased the industry is cooperating at this point and, hopefully, we can work this out together.

Thank you, Mr. Chairman.

Mr. LARSEN. Thank you.

The Chair recognizes Representative Graves of Louisiana for 5 minutes.

Mr. GRAVES OF LOUISIANA. Thank you, Mr. Chairman. Administrator Dickson, thank you very much for your testimony today.

Look, I heard your answer to the chair about the U.S. system being more complex. I get it, but I also think that we have greater capabilities, and I am going to say it again, this is inexcusable. It is inexcusable to disrupt air operations, and I think it is inexcusable to delay or prevent the deployment of technology.

Can you just help us to understand, with the incredible, pardon the pun, runway we had in this instance knowing for years that—maybe that wasn't as good as a Dagwood sandwich, but——

Mr. LARSEN. Not even close.

Mr. GRAVES OF LOUISIANA. Not even close, but just help me understand, how did we get ourselves in this situation?

Mr. DICKSON. Well, really, two parts—I will try to answer both parts of your question, Ranking Member Graves. As was noted in some of the opening remarks, the aviation sector concerns date back to 2015, and I will provide a detailed chronology. I will go through all of those details here, but over a period of years, the FAA participated in testing, we connected with foreign authorities, including ICAO, and communicated our concerns clearly to the FCC via NTIA.

We also have, back to Chair DeFazio's point, RTCA Special Committee 239 formed in early 2020 to develop permanent radio altimeter standards and began that work later in the year, and that work continues to this day.

When the FCC released the R&O on C-band in March of 2020, we asked for the analysis that supported the conclusion that the limits that were being put in place were sufficient to protect aeronautical services, radio altimeters, in particular, but it wasn't until the summer of 2021 that we received that analysis, and it actually resulted in transmission limits and characteristics that indicated that the R&O values are not sufficient to protect radio altimeters.

And as I said a few minutes ago, we tried for over a year, and we were asking for this data. As it turns out, the FCC didn't even have the data that we needed. And we discovered that when we started to work directly with the telecommunications companies. They had never had to provide this kind of information to the Government before. They had never had to think about how the signal would impact an airplane moving in three dimensions through space.

And so, it is certainly my hope, and I think all of us recognize that the process did not serve anyone well, in this particular case, and so, it is in everyone's interest to examine the Federal spectrum process to ensure it's coordinated across executive branch agencies to ensure that we service and resolve issues——

Mr. GRAVES OF LOUISIANA. And Administrator, I am concerned about even during this interim time, do you believe the FAA has the bandwidth, has the capability to process the alternatives, the AMOCs between now and July?

Mr. DICKSON. It is a huge focus for us and all of the submissions that we have had—I am not aware that we have any pending submissions right now. In fact, we are meeting with the manufacturers on a daily basis, really, to refine their analysis as they discover more about the capabilities of the systems that are currently installed on aircraft.

Mr. GRAVES OF LOUISIANA. OK. And going back to your comment earlier about the timeline and information, that would be helpful if you could provide us with that. I would like to better understand the timeline and how we ran into this problem.

Now, look, it is no secret, we are going to have 6G, 7G, in addition to the immediate issue we have of between now and July of trying to resolve this. Can you, one, help us understand if you believe the FAA has the resources, the capabilities it needs to continue this process through July and beyond as we have new technology roll out and innovation rolls out and new capabilities within communications?

Can you give us some comfort or help identify resources you think that the FAA may need to ensure that this doesn't happen again?

Mr. DICKSON. Well, we are using not only internal agency resources, but also industry resources as well. And I think that now that we are past the initial deployment, we have asked the telecommunications companies for longer line of sight on their deployments. And you know what? This is one of the differences between the aviation industry and the telecommunications industry. They are not used to the precision that we need to have when we are rolling out new technologies.

If you think about air traffic control, when we make improvements to technology within our air traffic control facilities around the country, we have a very disciplined technology waterfall, training, change management, both inside and outside the agency as new capabilities such as data communications are rolled out.

That happens over a period of years, and because we are literally—we are not changing the tires on the cars that are going down the road, we are changing the oil on the engine as the airplanes fly. And 50,000 flights a day operating three dimensions. The telecommunications companies' customers are on the ground, and so, they have never had to think about how those signals impact airplanes moving in three dimensions. That is what we are working on now.

Mr. GRAVES OF LOUISIANA. Thank you. Appreciate it. Yield back.

Mr. LARSEN. Thank you, Mr. Graves. I recognize myself for 5 minutes. Thank you, Administrator.

Some questions. In testimony, we are going to hear later from Mr. Roberson, I hope I have the name pronounced correctly. He talks about, that "the unfortunate truth is that there is a real problem, but it is what can be described as an 'edge case' problem, that is, a problem that only occurs in unusual circumstances and for a very limited number of aircraft."

Does the term "edge case" exist in aviation testing, and if there is an edge case, is it allowed to exist in an aviation scenario?

Mr. DICKSON. No. We have to, as I said earlier, we have our commercial aviation system essentially engineered so that there is less than a one in a billion chance of a catastrophic failure. And so, any time there is any change in that system that creates additional risk, we have to prove to ourselves that it is safe.

So, it is not enough to be comfortable or to have low-risk activities. I think that in Chair DeFazio's written statement, he talked about the 737 MAX. I mean, that is a good example of something that some people might have thought was low risk or fairly remote possibility. We can't accept that. The traveling public doesn't accept it, and we certainly don't accept it at the FAA.

We have worked for decades to make sure that aviation safety risk is driven down to the levels that it is today.

Mr. LARSEN. I will even say that on the 737 MAX case, people thought what happened was an implausible scenario. Clearly, it was not, and we can't tolerate that at all.

I want to ask a little bit more about Mr. Graves' comments and actually Chair DeFazio's comments with regards to the AMOCs. Now, for those listeners at home, an AMOC is an alternative method of compliance, A-M-O-C. It is basically an exemption to what otherwise you couldn't do. It allows you to do the thing that you want to do, in this case, fly an airplane, land an airplane on a runway in the presence of a 5G signal.

And so, the FAA has been issuing these AMOCs, these essentially exemptions to the rule, but there are so many AMOCs that you have issued from the FAA with regards to this, that the exception is becoming the rule, but I don't think that is a very good way to run a National Airspace System. We have to get back to a point where the exception is an exception to the rule as opposed to the rule being the exception.

So, Administrator, what are you all doing to be sure that these AMOCs at some point go away and we get back to a National Airspace System that can be run safely and efficiently without all these AMOCs?

Mr. DICKSON. Well, it is a great question, and I would divide the answer into two parts. The first one is, what are we going to do to provide more predictability and certainty to all of our stakeholders around the system?

And we have been working on the problem. There has been a sense of urgency around that, but we are getting up on a cadence of we have asked the telecommunications companies for longer line of sight on their deployments, so that we are not within a week of the next tranche of towers having to put this relief out on very short notice.

And I am confident that in the coming weeks that we will get on a more regular cadence and hopefully reduced impact as we go forward.

We are also working to refine our safety model, which will help us as we recognize areas where risk may be acceptable. We are not yet looking at: can we refine power levels. And so, there are several levers here that we are looking at in terms of mitigations that can provide some relief.

The ultimate solution, though, and I think you will hear something about this on the second panel later, is the setting of new performance standards and airworthiness standards. That work is underway at RTCA Special Committee 239, as I speak. And I think, unfortunately, a lot of the people around industry who would be working on that effort, which is really the long-term solution, are involved in getting us through this period right now.

But what we think is going to happen is, once those new standards are set, then there will be new performance standards and new designs. Potentially, STCs for filtering devices and other things. There are some promising discussions that we are having with some of the manufacturers about being able to improve the performance of existing equipment that is out there, and we will continue to focus on that as an interim solution as well while we work toward the long term.

Mr. LARSEN. There is going to be a lot of technical detail that we—as I have talked to you in the past, we don't need to understand everything about this as Members of Congress, but we do need to understand enough of this so that we can inform the policy. And as you all move through this, we need to be sure that we move through this with you.

You have also outlined the fact that just within the C-band, there is still more to happen, just as a result of the C-band auction, including the 3.8 to 3.98 rollout. There are auctions in the future certainly, and the technology of communication is changing, and the discussion about 6G as an example of that, and we don't know right today what that means for the work of the FAA as well.

Is that a fair assessment?

Mr. DICKSON. I think that is definitely fair. And there are other executive branch agencies, DoD, in particular, that have some equities in this area with future auctions that are being contemplated. So, we need to address the process issue now as a country, I would be in 100 percent agreement with that.

Mr. LARSEN. Well, I will just turn it over—looking for ideas about how we can either see that it is formalized or at least an informal consultation process going forward better than what we have had.

With that, I do have next Representative Balderson from Ohio as next up for 5 minutes.

Mr. BALDERSON. Mr. Chairman, thank you very much.

Good morning, everyone, and Administrator Dickson, thank you for taking the time to come before this committee.

My first question is, the deployment of 5G is critical to America's competitiveness and it is crucial that we get these networks online as quickly as possible while minimizing any disruptions to aviation services ensuring safe air travel.

My question for you is, how did the FAA make the determination that 5G would ensure harmful interference, and did the FAA perform any testing to validate the concerns in the RTCA study?

Mr. DICKSON. Well, thank you for the question. As I mentioned, we had indicated our concerns with the C-band spectrum back in 2015 at the radio conference that Chair Larsen referred to in his remarks. We also participated in various testing, the AVSI testing, as well as the RTCA testing as well. We communicated our concerns to the FCC as all of this was happening through NTIA, and we worked in good faith through the interagency process.

When I asked for the delay of the auction, along with the Department of Transportation, we asked that our concerns be forwarded on to the FCC, and unfortunately, that didn't happen.

But we have been consistent in raising our concerns, and I know that there is a way to work together through this. As was said earlier, the two industries look at risk very differently and processes very differently, and we don't regulate the telecommunications industry. So, there was no way for us to access their data until we had the agreements in place with them in late December.

And now in that relatively short span of time, we have been able to make a lot of progress. In the future, we need to have processes in place that allow that to take place before the actual rollout, and I think we will be in much better shape.

Mr. BALDERSON. All right. Thank you very much. My followup: What specific measures or mitigations is the FAA looking for from wireless industry to make it possible to deploy 5G networks in the C-band around airports within the terms of their FCC licenses as soon as possible?

Mr. DICKSON. Well, as I said, we have already refined our safety model, which creates essentially a safety zone and a performance buffer for radio altimeters around airports, and we continue to refine that. The flight testing that we are doing with them right now, we are doing that in conjunction—we have designed those flight test scenarios using FAA flight test aircraft. We have designed those flights in conjunction with the telecommunications industry engineers.

As a matter fact, their engineers are actually onboard FAA aircraft. We are reporting all the parameters of what the signal looks like as it impacts the airplane in various performance scenarios. And so, as we get that data, that will help us to sharpen our analysis. It will also inform the performance requirements for modifications to radio altimeters or the new performance standards for retrofit equipment if that becomes necessary.

Mr. BALDERSON. OK. Thank you very much for both those answers.

And Mr. Chairman, I yield back. Thank you very much.

Mr. LARSEN. Thank you, Mr. Balderson, for yielding back 1 minute and 10 seconds. Appreciate it.

I now recognize the gentleman from Hawaii, Representative Kahele. You are recognized for 5 minutes.

Mr. KAHELE. Mahalo, Mr. Chair. And thank you so much for putting on this really important committee. And hello to Chair Larsen and Ranking Member Graves and Administrator Dickson for convening this critical hearing so that we can ensure that our sub-

committee is able to conduct proper oversight into the deployment of 5G.

As a commercial airline pilot with Hawaiian Airlines, I understand firsthand the importance that radio altimeters play to ensure pilots are able to fly in all weather conditions. The aviation industry has spent years warning that 5G signals could cause radio frequency interference with altimeters, and I am disheartened that it has come to this point.

There was clearly a breakdown in the interagency communications process. I think Chair DeFazio highlighted the failure of the Trump administration to put the right people in the right positions to ensure that this didn't happen. It did. And as a result, it has disrupted millions of passengers in our communities, especially our airlines.

I have a question for Administrator Dickson. The first question I have is—and I can only speak for the airline that I work for. Hawaiian Airlines' AMOCs expire on 28 February 2022. That is in 25 days. I don't know what the other expiration dates are for all the other U.S. airlines and the locations that they fly to, when their AMOCs expire. I can only speak to Hawaii's flagship airline, which expire on 28 February 2022.

The amount of workload that pilots have to deal with, that the airlines, the dispatchers have to deal with, they are already stressed in dealing with COVID, and now they have to deal with potential disruptions in their instrument approaches for CAT II and CAT III runways.

And so, my question is, what is the plan between now and the next 25 days? Are we going to extend those AMOCs again? Are we going to get right up to the 23rd, 24th of February and potentially have another disruptive day throughout our Nation's airspace system? What are we doing to plan between now and the next 25 days for not just this airline's current AMOCs, but the other U.S. domestic fleets' AMOCs that potentially have expiration dates in the near future?

Mr. DICKSON. Congressman, thank you very much for the question, because as you point out very correctly, predictability and consistency is extremely important in our business. I am an operator myself, I am a pilot myself, and I know exactly what you are talking about. The last thing that you want is uncertainty on the flight deck or at the dispatch desk.

The reason that the AMOCs expire is based on the next tranche that we expect from the telecommunications companies and their ability to be able to provide us with precise latitude/longitude, elevation, signal shape, all the things that I talked about earlier so that we can apply that. We have a tool that we have developed in the last few weeks that allows us to take their data—and this is getting to be more and more of a routine occurrence—we take their data, we put it into the tool, and determine where the pressure points are and whether their next deployment will comport with our safety model around airports to ensure safe performance for radio altimeters.

That process has been because the initial deployment happened on the 19th of January, and then there was another tranche the 1st of February, there has been pretty rapid succession of AMOCs.

We expect for that cadence to be longer as we go forward. We have asked for as much forward visibility as we possibly can. And this gets in to the difference that I talked about a minute ago between the two industries about how new technologies are rolled out.

This time of year, the telcos are experiencing delays with work crews and things like that. We are learning a lot about their business, and I promise you, we are going to smooth this process out and make it more predictable because that is in everyone's best interest. And they have committed to work with us on that.

Mr. KAHELE. Thanks, Administrator. I will use my last 20 seconds just for a yes-or-no answer. Can you ensure our operators on the flight deck and the passengers in the back to these critical airports that require CAT II or CAT III approaches that these airports are safe to fly into and execute a successful instrument approach with the current AMOCs that exist today?

Mr. DICKSON. Absolutely. Safety is something that we will not compromise. And if we have authorized low-visibility operations, you can count on the level of safety for the performance of those systems that we have always counted on and the public counts on.

Mr. KAHELE. Thank you, sir. And mahalo, Chair.

I yield back.

Mr. LARSEN. Thank you. The Chair recognizes Representative Burchett from Tennessee for 5 minutes.

Mr. BURCHETT. Thank you, Mr. Chairman. It is a pleasure following my ukulele-playing colleague from Hawaii. Hope to visit him soon. Maybe we could organize a codel over there, preferably beach side. That would be good.

Mr. LARSEN. Sorry. We didn't start the clock. Could you take 10 seconds off Mr. Burchett's clock, please?

Mr. BURCHETT. I am sure that will make YouTube.

Thank you, Mr. Chairman. This is for FAA Administrator Dickson.

Sir, the aviation industries' concerns about harmful 5G C-band interference aren't new, and I realize this was touched on earlier, but I want to get a little more specific. And as you pointed out in your testimony, you raised some of these concerns yourself in a letter to the National Telecommunications and Information Administration back in 2020, I believe.

So, why did the FAA wait until it is almost too late, dagummit, until the month before the originally scheduled rollout to start taking some safety mitigation actions?

Mr. DICKSON. Well, thank you for the question. If you are talking about the last few weeks, again, we did not have the data that we needed because we don't regulate the telecommunications companies. We did not have the data that we needed until we were able to work with them directly.

And as we discovered, when we began that dialogue, the data that we were asking for from them, they actually had never provided to the Government before. So, that really was where we started from in late December and early January, and has brought us to where we are now.

Mr. BURCHETT. So, the information that you got, they never delivered, was that the reasoning why it got to you so late or is that just after the fact?

Mr. DICKSON. That is certainly once we got to the point—we had asked for the delays because we didn't want disruptions to the aviation system. We knew that there was a risk to radio altimeters, but we didn't have the ability to put specific mitigations in place and tailor them by fleet type and by airport until we had the specific deployment data from the telecommunications companies; otherwise, we are in a position where we have to assume that 5G C-band is blanketing the entire country, and so, you are in this least common denominator situation.

That is where we were in November, and we are certainly in a much better place now than we were then. But we have got a lot of work in front of us, as I have been saying.

Mr. BURCHETT. Where are we now in relation to preparedness as in relation to November as you stated?

Mr. DICKSON. Well, we have the mainline fleet types, the larger aircraft. We still have some lower performing regional jets and other parts of the aviation community that are impacted. I am concerned about that. Helicopters are another area that we are going to have to pay close attention to.

So, we are working on alternative means of compliance for those types of operations, for first responders and air ambulance-type operations as well. So, a lot of the conversations have been about the air carriers, but the entire aviation community, you know, we need to make sure that their concerns are addressed as well.

Fortunately, for those other types of operations, there is not the kind of reliance on radio altimeters that you see in commercial aviation, but it is an important safety tool that we want them to have.

Mr. BURCHETT. Do y'all have some date, arbitrary or otherwise, of compliance?

Mr. DICKSON. We will have to—the performance standards for C-band resistant radio altimeters are in development now. That work has been going on for some months now, and it will be some period of time. These standard-setting processes take time.

I think the encouraging news to me is that this flight test activity that we are undertaking that is helping us get through the period that we are currently in, will also be very beneficial in setting those new standards. Because we will have real-world data that we can use to go back to the avionics manufacturers and help inform those new designs, but there will probably be some airplanes that we will have to retrofit new equipment.

At a minimum, I think, we will see significant retrofit of filtering devices to make sure that the existing avionics are C-band resistant.

Mr. BURCHETT. Thank you. I can hear my father saying as we are going down the beach in Myrtle—going down the road in our old station wagon in the 1970s when we were fussing in the back seat, my brother and sister and I, generally it was all their fault, not mine. I was generally in the role of the peacekeeper, but I could hear my dad saying, don't make me come back there.

So, I would hope at some point y'all would fix this up and don't make us come back here.

Thank you, Mr. Chairman.

Mr. LARSEN. Thank you, Representative Burchett.

The Chair recognizes Representative Johnson of Georgia for 5 minutes.

Mr. JOHNSON OF GEORGIA. Thank you, Mr. Chairman, for holding this very important hearing.

Aviation in the United States is the safest in the world, and I am sure my colleagues would agree that our intention is to make sure that it remains that way. So, the issue that we are facing right now is that the 5G services launched on January 19 used frequencies in a radio spectrum known as the C-band, which can interfere with the safety equipment in aircraft, specifically, radio altimeters.

Although the FAA raised concerns that the 5G networks may interfere with some aircraft, the Federal Communications Commission authorized the rollout of these networks. Hartsfield-Jackson Atlanta International Airport is one of the busiest and most efficient airports in the world. And while Hartsfield itself is not directly impacted by the 5G rollout, many of the airports that fly to and from Hartsfield-Jackson are.

The inability of the FAA, FCC, and the aviation and telecom industries to reach consensus on aviation safety regarding 5G is very concerning. Numerous stakeholders have been discussing and weighing the challenges to the rollout of 5G technology since at least 2015. That includes the FAA, the FCC, National Telecommunications and Information Administration, the aviation industry, and telecom companies. And despite 7 years of deliberation, Government agencies were unable to reach a consensus on whether 5G interference was safe for the aviation industry in time for the 5G rollout last month.

Mr. Dickson, what has prevented the FAA from coordinating more effectively with the FCC to address industry interference concerns?

Mr. DICKSON. Well, thank you, Congressman, and greetings to you in Georgia. I am very familiar from my heritage at Delta Airlines with the operations of Hartsfield-Jackson and understand and appreciate your concerns.

We recognize that the existing process for spectrum allocation did not serve anyone well. And it is in everyone's best interest, including aviation and the FAA, to examine the coordination process across the executive branch. Because we are going to be at this—you know, there is no free spectrum anymore. So, we are going to be at this, not only with 5G C-band, but with other spectrum auctions in the future. So, we need to make sure that we surface and then resolve, that is the key, I think that you are talking about, is have a resolution process for these issues.

My job is to make sure that the safety of the traveling public and the safety of the aviation system is not compromised. That is a very high bar. And so, I am not going to back off from that. And I would expect the FAA to do that.

Mr. JOHNSON OF GEORGIA. Well, thank you. I appreciate your diligence, and good to see you today. Is it your opinion, sir, that the 5G sale and rollout timeline as executed by the FCC under the previous administration overlooked safety concerns?

Mr. DICKSON. Again, I would just say that the process didn't serve anyone well. I am not pointing fingers at anyone or another

agency. We have to work together. And we have to recognize, as we said a few minutes ago, that these are two very different industries. But the airspace infrastructure has to be maintained. But it has to be able to coexist with 5G. We certainly all want that in our communities as we go forward.

So, we have got to make sure that we are working hand in glove with each other to enable these new technologies to roll out, but to do it in a safe and predictable manner.

Mr. JOHNSON OF GEORGIA. Well, let me ask you this then, Mr. Dickson, what steps can be taken now to ensure that as 5G technology is rolled out, the lack of interagency communication does not create additional problems down the road?

Mr. DICKSON. Well, I think Ranking Member Graves talked about leadership. It is going to take leadership. Secretary Buttigieg has been providing a lot of that leadership. We also have an interagency group, including the Department of Transportation and the FAA, the Department of Commerce, the FCC, the Department of Defense meeting now on spectrum issues and the coordination process. And I expect that to certainly leverage the lessons that we have learned throughout this journey that we are all on.

Mr. LARSEN. The gentleman's time has expired.

Mr. JOHNSON OF GEORGIA. I yield back.

Mr. LARSEN. Thank you. The Chair recognizes Representative Gimenez of Florida for 5 minutes.

Mr. GIMENEZ. Thanks, Chairman. A couple of questions concerning the safety aspect of this. Would you say that the telephones that are used by the passengers inside the airplane—I know we for years have been told we have to go on airplane mode—are the dangers now heightened because of this 5G, as more and more passengers have 5G phones? And if they fail to heed the instructions of the flightcrew, does that pose a danger to the airplane, to the aircraft? Could it pose a danger to the aircraft?

Mr. DICKSON. Well, you are highlighting an issue that is actually part of the testing that we are doing. Because what we have to do is—the towers are generally smart towers. So, if you look at 5G, as more demand is placed on the tower, the power will increase. And so, if you have demand on the telecommunications system that is coming from the airplane, could that focus power on the aircraft as it is flying in low-visibility conditions? These are the kinds of things that you can only determine through the kind of flight testing that we are doing now, and with the telecommunications and aviation industry sharing information with each other. So, I think it is an open question, but it is certainly one of the things that we are looking at.

Mr. GIMENEZ. Have you put some kind of instructions to flightcrews now to make sure that this happens? Because I know that on the flights—I fly all the time between Miami and my hometown and here, I know that people keep their phones on; they don't put it on airplane mode. Have you instructed the airlines to be more vigilant and to make sure that these phones are actually on airplane mode in light of the fact that we don't know what these things will do?

Mr. DICKSON. Well, it is a great question. And we have communicated that to the air carriers through the safety awareness bul-

letins that we have put out. We will continue to that, and we are continuing to have dialogue on how we make sure that that is not happening on aircraft. But it is a difficult issue. It is not like you have got flight attendants or pilots who are looking over everyone's shoulder on the airplane. So, it is a risk that we have to be very cognizant of.

Mr. GIMENEZ. And one thing you can do is actually tell people why it is important to put on it airplane mode. People just say, put it on airplane mode. We don't know why we have to put it on airplane mode. Well, now maybe it is a good reason to say, hey, you need to put it on airplane mode because we don't know what these things do to the altimeter. That would probably make me put it on airplane mode. So, if you could do that and inform the passengers, maybe more of them will comply. Because right now, I bet you most people don't have the faintest idea of why we go on airplane mode.

Mr. DICKSON. Well, we'll look at that.

Mr. GIMENEZ. OK. One other thing, when exactly did you know that this was an issue—not when you wrote the letter—but when did you know that this could have been an issue?

Mr. DICKSON. Well, I think the aviation community knew back in 2015. That is where the concerns were initially focused. But we started to—at the working level, my spectrum engineers and all that really were communicating directly with their counterparts at the FCC and elsewhere, back as early as 2019 and probably even 2018.

Mr. GIMENEZ. And nothing was done about it?

Mr. DICKSON. Well, again, we kept raising the concerns. And then after the—tried to get the auction delayed until we could work through the appropriate safety mitigations. And then we asked for the underlying data. And, again, it just shows the difference between how telecommunications looks at spectrum versus how it interacts with critical safety systems on aircraft.

Mr. GIMENEZ. Well, I guess we got caught up in the race to 5G. We wanted to be the first at the 5G, this Nation did. I guess that is why we wanted to sell spectrum. But it seems to me that in the 6 years in between, we could have figured out these solutions way before we had the implementation. But that is Monday morning quarterback. Thank you very much, and I will yield my time back. Thank you.

Mr. DICKSON. Thank you.

Mr. LARSEN. Thank you. The Chair now recognizes Representative Allred of Texas for 5 minutes.

[No response.]

Mr. LARSEN. Just a moment.

All right. We will go to Representative Lamb of Pennsylvania for 5 minutes.

[No response.]

Mr. LARSEN. Going once, going twice.

Representative Johnson of Texas, you are recognized for 5 minutes.

[No response.]

Mr. LARSEN. Representative Johnson from Texas, I see you on the screen, you are recognized for 5 minutes.

[No response.]

Mr. LARSEN. Just a moment. Administrator?

[Pause.]

Mr. LARSEN. We will come back.

Representative Lynch.

[No response.]

Mr. LARSEN. We have got a list of names here. I am assuming they are——

[Pause.]

Mr. LARSEN. Representative Payne of New Jersey. Representative Payne, you are recognized for 5 minutes. Hold on a second. Hold on a second.

Representative Johnson, are you ready?

Ms. JOHNSON OF TEXAS. I am sorry, did you call me?

Mr. LARSEN. I did call you, Representative Johnson, yes.

Ms. JOHNSON OF TEXAS. Yes, I am ready.

Mr. LARSEN. We are going to go to Representative Johnson from Texas for 5 minutes. You are recognized.

Ms. JOHNSON OF TEXAS. Thank you very much. Let me thank you and the witnesses. I would like to ask, Administrator Dickson, why did the data exchange between Verizon, AT&T, and the FAA, and the rest of the aviation community only begin at the end of December 2021, knowing that this was on the horizon?

Mr. DICKSON. Well, thank you, Representative Johnson. The real issue is that we don't regulate the telecommunications companies, so, we don't have a direct relationship with them. And so, we had to basically put in place nondisclosure agreements. In the aviation community, we regulate the manufacturers and the operators. And part of the safety that we enjoy in the U.S. with aviation is that they are required to share their data with us, even though it is proprietary. So, this was a new process for them.

And once we put that protocol in place, the data started to flow, but it was some time—it was a few days before it was really usable, because it was in different formats, and it wasn't really—there wasn't an understanding of the kind of data that we needed, because they had never had to produce it for the Government before, again, because we are talking about how the signal impacts aircraft that are flying through the air.

Ms. JOHNSON OF TEXAS. OK. I am wondering, do you believe that FAA and the Department of Transportation should have a more formal role in assessing the risk of spectrum or to the transportation safety?

Mr. DICKSON. Again, this process didn't serve anyone well, including, certainly, the aviation sector. And it also didn't serve the telecommunications industry well. So, I do believe that it is, again, in everyone's interest to examine this process, the Federal spectrum process. How it is coordinated across agencies, the FAA among the agencies, but not the only player, and make sure that we surface and then have a process to resolve concerns and issues upfront. That will put us in a much better place.

Ms. JOHNSON OF TEXAS. How close are you on getting the altimeter certification for private jets? Are you near? Or is it on the horizon?

Mr. DICKSON. Well, the permanent solution is going to be some months away, if not a year or two. Because, again, we have to set new airworthiness standards. There is an industry group that is working on that. We will take that information in, it will also be harmonized with Europe and other authorities around the world. Because so many aviation authorities around the world are very interested in what we are doing to regulate our aviation manufacturers in the U.S.

So, once those new standards are set, then the aviation manufacturers will come to us with their designs and then we will certify them for use on commercial aircraft going forward.

Ms. JOHNSON OF TEXAS. Thank you very much. And thank you, Mr. Chairman. I yield back.

Mr. LARSEN. Thank you, Representative Johnson. The Chair now recognizes Representative Mast of Florida for 5 minutes.

Mr. MAST. Thank you, Mr. Chairman. I appreciate it.

Sir, I want to talk a little bit about 5G, FAA, National Telecommunications and Information Administration, and a connection, a relationship between all of them and how they are working together in order to make sure that we have safe transportation. We can look at this on a number of different fronts. Did the National Telecommunications and Information Administration, which oversees public radio waves, did they offer to test civilian aircraft equipment last year?

Mr. DICKSON. Not that I am aware of.

Mr. MAST. There was a Wall Street Journal article that said that that took place. So, the reporting on that is wrong?

Mr. DICKSON. There is no NTIA testing that I am aware of, of the kind that we would need to do to demonstrate the [inaudible] performance of radio altimeters or critical systems on aircraft.

Mr. MAST. My understanding is that there was not any testing, but my understanding is also that there was an offer by the NTIA to do testing, and that the FAA did not allow the NTIA to move forward. Is that the case of what happened?

Mr. DICKSON. I will have to look into that specific. I am not aware of exactly what you are referring to. Again, it would depend on how the testing is set up and whether it has a sufficient level of rigor for aviation safety certification.

Mr. MAST. So, you are saying there would be a barrier for the FAA to say we are just not going to allow this testing to take place?

Mr. DICKSON. If it is FAA testing, and there would be other participation, I think that that would be something that we would be very interested in.

Mr. MAST. All right. Yeah, we will make sure that we get you the article, so that we can get a response from you on what exactly took place with that situation. I appreciate the testimony today. And with that, Mr. Chairman, I yield my time back.

Mr. LARSEN. Thank you, Representative Mast. All right. Now we have Representative Allred from Texas.

Mr. ALLRED. Yeah, I am here, Mr. Chairman.

Mr. LARSEN. All right. You are recognized for 5 minutes.

Mr. ALLRED. OK. Sorry about that, Mr. Chairman. You know, technical difficulties. And I want to thank Administrator Dickson

for being here with us. Nice to see you again, sir. As a Member representing Dallas, a region that has one of the busiest airports—and really, airspaces—in the country, this has been a very important discussion.

And I just have one question for you, sir. It is about whether if the aviation industry is able to design and manufacture new radio altimeters, how long would it take for FAA—as an estimate—to certify those?

Mr. DICKSON. Well, again, the new standards for C-band resistant radio altimeters are yet to be set. And so, we will participate in that activity. It is a special committee that has been set up under the auspices of RTCA Special Committee 239. And our technical experts are participating in that activity as are stakeholders from around the aviation community.

Once those standards are set, we will be using them to develop new certification standards that will determine which radio altimeters perform well and which ones need to be upgraded. And that is what the manufacturers will bring back to us, those new designs.

We are seeing some promising activity among the manufacturers for devices that may be added to the existing fleet out there. But those would be in the—not in terms of new certifications, but they would certainly improve the performance of what is out there in the fleet and provide additional operational flexibility to those airlines or other operators that may have low-performing equipment right now.

Mr. ALLRED. Where are y'all in reviewing those additional items?

Mr. DICKSON. We are talking with manufacturers on a regular basis. I know that we had actually one of the radio altimeter manufacturers in, I believe, yesterday, talking about product improvements that they were planning to make. So, those discussions are ongoing on a pretty frequent basis.

Mr. ALLRED. That wouldn't need an entirely review process. Is that right, or no?

Mr. DICKSON. Not if it is an improvement to an existing design or a filter, for example. Remember that radio altimeters actually—the same radio altimeter on different airplanes can perform differently——

Mr. ALLRED. Right.

Mr. DICKSON [continuing]. Depending on how it is installed in the aircraft, how long the wiring is, and things like that. So, we have to look at the actual radio altimeter and the airplane combination together.

Mr. ALLRED. OK. Well, obviously, whatever we do, we want to do it as safely as possible. But given places like Dallas where you have these big airports, and we want to also move forward with this technology, I hope that we can find something together. If there is anything we can do as a committee to support you in that, I hope you will let us know.

Mr. DICKSON. Thank you.

Mr. ALLRED. Yeah.

With that, Mr. Chairman, I yield back.

Mr. LARSEN. All right. Thank you very much, Mr. Allred. The Chair recognizes Representative Massie of Kentucky for 5 minutes.

Mr. MASSIE. Thank you, Chairman Larsen. The FCC has an obligation to ensure over time that the radio spectrum is used for its highest and best use. In fact, it was Obama in 2010 who said, free up some space for these telecommunications devices. And I was shocked when I dug into this to find out how much of the spectrum the aviation industry uses.

And I am wondering, by 1982 standards, it might have been the highest and best use of that spectrum. But now that we have got better radio frequency modulators and an ability to use this space—by the way, no more frequency is getting manufactured. We have got all that God has given us. It is like land on the planet. So, we have to be really careful with this space, and use it the best way.

What I was shocked to find out is that the radio altimeter, which is basically a 1980s version of Mark Twain putting a rope in the water and measuring how far down things are, uses 200 megahertz of spectrum. And it has got a 200-megahertz guard band if you are not concerned about the low-power satellite spectrum, and you are actually concerned about the 5G spectrum.

It is like you are sitting in an airplane seat, and there is an empty seat next to you, and you are complaining about the seat on the other side of the aisle, is kind of the analogy here. Which in 1982, I understand, which is the last time these standards came out, it all worked out.

But here is how valuable this spectrum is. It was auctioned off—280 megahertz of it was auctioned off 1 year ago and brought $81 billion. So, to use the radio altimeters—we are using 200 megahertz, which is about $300 million of megahertz. That is its commercial value. We are using about $60 billion of spectrum to figure out how far from the ground the airplane is when it gets within a couple thousand feet of the ground. It makes me wonder if we are kind of being sloppy with the spectrum usage in other aviation fields.

I know that, FAA Administrator, I think you were involved in helping to develop the ATC digital communication between the plane and the tower. Do you have some familiarity with that?

Mr. DICKSON. Yes.

Mr. MASSIE. And it is my understanding that all of the VHF NAV for aviation fits in 10 megahertz, from 108 to 118 slot. And then we have got the audio communications that fit in 20 megahertz above that. And y'all were able to use just 1 megahertz to get all of the digital communications between the ATC and the planes.

Mr. DICKSON. Yes, sir. Do you want me to respond?

Mr. MASSIE. Well, if I am wrong, just correct me, but let me go on a little bit forward. If we were going to design radio altimeters now, how much spectrum do you think we would need? Would we need the whole 200 megahertz, which is $60 billion worth of spectrum? Could we do it with 10 megahertz, which would be $3 billion? Could we do it with 1 megahertz?

Mr. DICKSON. I am not a spectrum expert myself, but if you are asking me whether we can use spectrum more efficiently, I think the answer is yes. But we have to have a strategy for being able to do that. And remember, when commercial aircraft are certified

and put into service, they will operate safely. And we engineer them to carry the public for a period of 30 to 40 years.

And so, if we are going to put that kind of retrofit mandate and standards development into avionics, that needs to be part of our national strategy. And maybe that is something that can come out of this spectrum process.

But my point here is, we need to have the data of what we are designing around so we can set the standards for the avionics manufacturers and the airframe manufacturers to be able to produce those new units. And will they use spectrum more efficiently? I would say that they will.

Mr. MASSIE. That was the whole point of my questioning, and you completely understand it. So, I want to make sure that we don't just solve this problem, but we solve the problem going forward. Because we are not inventing anymore spectrum. We can't create it. And we want to make sure that the aviation industry is a good steward. And I understand the changes happened faster with telecommunications than they could have possibly been certified in aircraft. But I appreciate you being willing to get in front of it and look for ways to sort of be a better steward——

Mr. LARSEN. The gentleman's time has expired.

Mr. MASSIE [continuing]. Of the spectrum. Thank you, Mr. Chairman.

Mr. LARSEN. The Chair recognizes Representative Payne of New Jersey for 5 minutes.

Mr. PAYNE. Thank you, Mr. Chairman.

I thought I was going to keep getting bumped back. It is like the bunny hop. Two steps forward; one, two, three back.

Mr. LARSEN. I apologize for the confusion.

Mr. PAYNE. No problem. No problem. I am team player, and I am with you, sir.

Mr. Administrator, 5G deployment has the potential to provide high-quality cellular service to millions of Americans. However, we must ensure that the deployment is, obviously, in a safe manner, and that it does not impact aviation operations, which you have articulated today, so we are on the same page there.

Having multiple airports located in or near densely populated areas, such as my congressional district in Newark, adds another layer of complexity to keeping Americans safe when they travel on airplanes. How is the FAA taking this into account regarding the future actions on 5G deployment?

Mr. DICKSON. Well, I would say, again, we are working in good faith. And the telecommunications companies are working with us as well, Verizon and AT&T currently. And that is creating opportunities for us to deploy additional 5G C-band, but make sure that aviation safety is protected, not only in terms of the technical performance of the aircraft and the radio altimeters, but also in terms of greater predictability for the flying public and for everyone that is using the National Airspace System. That is always going to be our top priority, ensuring the safety of our national airspace and the ability of Americans to be able to travel domestically and abroad safely.

Mr. PAYNE. Thank you for that. Now, on to the future. There are areas in which the Federal Government could have done better,

quite a few, in anticipating issues with 5G deployment and taking proactive steps to avoid problems so close to the rollout of services, which has been a common theme today.

I don't know when, but eventually, there will be a successor to 5G. It is my sincere hope that history does not repeat itself with these problems. What lessons has the FAA learned so far with the problems encountered with 5G deployment, and how will it inform future actions with next-gen networks?

Mr. DICKSON. It is a great question, and I think that—you know, I have talked about the Federal spectrum process, and that there are interagency discussions right now on spectrum issues. But I think, more broadly, different industries that are intersecting each other—for example, a lot of our aviation infrastructure these days that used to be on the ground is actually on the aircraft. And we don't use radar, for example, as a primary means of surveillance anymore. Radar is still very important. But we have data link, the ADS–B system on the aircraft transmitting very precise positions to our controllers. GPS, certainly, are on commercial aircraft. And we are talking here about radio altimeters.

So, as we go on, it is not just C-band, it is also other spectrum activities. We just need to make sure that we are very coordinated as a Federal Government, but also that industries are able to share data and information with each other. And that, certainly, the proprietary nature of their corporate information is protected, but that they are able to have dialogue and interchange so that we don't have one set of engineers saying one thing and another set of engineers saying something else.

Mr. PAYNE. Thank you for that. And I feel that in the future we need to maybe look at the agency that has jurisdiction over a certain area. You can go to and request help in getting information that you need if it is lagging. So, I think that would be a really, really useful thing to have.

Part of your problem was that you didn't have any jurisdiction over them. So, whatever is the entity that does, you should be able to go and request that they work with you on these matters. So, that is something that maybe I will take a look at. But thank you for your time. And, Mr. Chairman, I yield back.

Mr. LARSEN. Thank you, Representative Payne. Next up will be Representative Katko. You are recognized for 5 minutes. After which will be Representative Carson. Katko and then Carson.

Representative Katko, you are recognized for 5 minutes.

Mr. KATKO. Thank you, Mr. Chairman. And thank you, Ranking Member Graves, for having this hearing today. This discussion is essential to providing clarity to millions of Americans who are understandably confused about the rollout of 5G and its impact on aviation.

You will be hearing from a panel of industry stakeholders later today, but I want to focus on the Federal response to the 5G and, more specifically, the lack of coordination between FCC and the FAA leading up to this deployment.

In my district in central New York, this issue gained very significant attention during the week of January 17 when we found out that Syracuse Hancock International Airport had temporarily lost clearance from the FAA for certain low-visibility landings.

Now, I want to tell you something that is earth shattering, it is often a lot of clouds in Syracuse, especially this time of year. Today, for example, we are getting 1½ feet of snow. So, it is not uncommon to have this issue. And we didn't know about any of this until January 17 when they were informed.

Now although some of these have been resolved right now, questions still remain, and it is understandable than this initial disruption raises significant concerns for the airport and for passengers. In our region, Hancock International Airport plays a very key role in facilitating travel and acting as an access point for a very large area for commerce. The same is true for hundreds of other airports across the country and for the communities they serve.

Even temporarily jeopardizing the availability of services at these locations can cause major disruptions and diminish public trust in air travel, at a time when industry is already struggling mightily to recover from the impact of the COVID–19 pandemic. And given that the Federal agencies involved had years to prepare for this rollout, it just seems like this is an absolutely unacceptable way to handle it.

I agree with Chairman DeFazio's comments earlier that no one wants to see planes falling out of the sky, obviously, and we've got to make sure we are safe. Well, how the hell did we get to the point where there is so much brinkmanship going on with this when we had 5 years in the making? It wasn't until December of 2021 that the FAA and FCC even entered into an information-sharing agreement.

So, I have got to ask you, Mr. Dickson, how did it come to this where the airports were just basically at the last minute getting these directives coming out? I mean, this was bubbling up for quite a long time.

Mr. DICKSON. Well, thank you, Congressman. I am very familiar with having spent a few years in my youth in upstate New York, a beautiful part of the country. I am very familiar with the weather up there having flown into Syracuse many times.

So, as a former pilot myself and with an operational background, I understand that our stakeholders and the airport's community feel frustrated. I don't blame anyone for being frustrated by the use of——

Mr. KATKO. So, yes, I understand that, there is frustration, but how did it come to this, and how are we going to make sure this doesn't happen again? Because we are talking about an awful lot of commerce here, we are talking about—you know, there are obviously safety issues. But it kind of makes me worried about safety issues when you get directives at the last second, which tends to indicate that you really didn't have a plan, number one, or you didn't understand the gravity of the situation ahead of time. So, how did it come to it—briefly—and how are we going to fix it to make sure it doesn't happen again?

Mr. DICKSON. Well, until we have the direct dialogue with the telecommunications companies and their commitment to modify their initial deployment, we weren't in a position to authorize the kinds of poor weather operations. So, we had had to communicate several weeks prior that this was an issue. When we provided the

relief, we are actually providing that relief to the manufacturers, not to the airlines or the airports.

And so, part of what we are working through now, and I think we are in a much better place, is if we get earlier deployment data from the telecommunications companies, that will allow us to have better line of sight on issues. And——

Mr. KATKO. I understand that, but, sir, it goes back again, 5 years. You knew this possibility was coming for 5 years. And, again, I am at the last second. So, how can we help you if you need help from us? Is there something we need to do, or is there something you need to do to make sure you don't get caught like this again in the future? Because, quite frankly, it gives people the feeling that the bureaucratic malaise in Washington is alive and well. There are two agencies that weren't talking to each other until the last minute, number one.

And then, number two, you not knowing what is going on until right at the end, and then you have to issue these things which cause disruptions in the system, when you have been working on this issue for 5 years.

Mr. DICKSON. Well, so, talking about not the actual initial rollout, but again, the broader issue of spectrum policy and strategy as a country, absolutely, that needs to be addressed. And so, again, we are involved in the interagency conversation with the Department of Transportation, Department of Defense, Department of Commerce, and others to make sure that——

Mr. LARSEN. The gentleman's time has expired. Please finish up. Thank you. Representative Carson, you are recognized for 5 minutes.

Mr. CARSON. Thank you, Chairman. Administrator Dickson, while I respect the need for an independent FCC, that does not mean that the FCC does what it pleases without real collaboration with other agencies and robust oversight. I think it is a shame, sir, that the FCC declined our invitation to testify today, quite frankly. NTIA is supposed to act as an intermediary between these agencies and the FCC. One can only look at where we are today and really conclude that the process has failed. Do you agree with me on the process being broken, sir? What are your thoughts?

Mr. DICKSON. Well, as I said before, the process did not serve anyone well. It did not serve the aviation community well, and, certainly, the FAA. And it also did not serve the telecommunications industry well. We certainly need to do better as a country.

Mr. CARSON. Yes, sir. Do you see the process which led us to this hearing today being workable without Congress stepping in to clarify the intent of the process? How do we keep this kind of problem from happening again?

Mr. DICKSON. Well, I think that we need to stay focused on it. I believe that this is something where we can have—Chair Larsen talked about informal dialogue. If we can put mechanisms in place so that affected agencies are not interested parties in these proceedings, but actually their equities are recognized in the process, and that there is a mechanism for early data sharing. Because that is really what it comes down to is the data that we need to be able to make the decisions within—in this case, to preserve and protect aviation safety. That is what really needs to happen throughout

this spectrum process. And I believe that the conversations that we are having within the executive branch certainly have that goal in mind.

Mr. CARSON. Thank you, sir. I yield back, Chairman.

Mr. LARSEN. The Chair recognizes Representative Brownley of California for 5 minutes.

Ms. BROWNLEY. Thank you, Mr. Chairman. And thank you, Mr. Administrator, for being here. In answering some of the other Members' questions, you talked about leadership being necessary so that this doesn't happen again, to bring agencies together and working together. You mentioned that Secretary Buttigieg has been demonstrating some of that leadership currently.

So, I just—I guess I don't want to beat a dead horse here—so, what was the White House doing to help you and assist you during this timeframe?

Mr. DICKSON. Well, I am grateful for the support from the National Economic Council, its engagement in this matter to facilitate the dialogue that we needed to have between two very different industries.

Again, as I have stated several times, the FAA had communicated our safety concerns over a period of several years. And, ultimately, the decision was made to proceed with the spectrum auction consistent with the FCC's determination, and then we had to act upon that reality. I wish there would have been a way to avoid that. I think that with this subcommittee's support, and certainly what we are doing now as part of this interagency process, we will see an improved process in the future.

And, again, I think that this is an area that we just need to stay focused on to make sure that we can have a better outcome. Because this is not the last spectrum issue that we are going to be facing as a country. As someone said earlier, there is only a finite amount, and we have got to figure out how to enable future spectrum for beneficial public use.

Ms. BROWNLEY. Thank you for that, Mr. Administrator. So, I have two general aviation airports in my district. I have a naval base, and I have the 146th Airlift Wing of the California National Guard. So, my question is how is all of this impacting general aviation, and how are we working with DoD in terms of military National Guard?

Mr. DICKSON. Well, we are working very closely with DoD as we do on a whole host of issues because, obviously, they share the civil airspace for their training and other activities that the FAA is responsible for. And, certainly, we have commercial flights occasionally flying into military bases, so we have got to pay attention to the issues there as well.

In terms of general aviation, we have raised awareness in that community. The vast, vast, vast majority of those operators are not certified to do what we call Category II and Category III low-visibility approaches at less than a half mile visibility. So, they are not seeing the same kinds of impacts as the commercial air carriers. But there are other systems on the airplane that we have raised their awareness of, but they aren't in critical phases of flight.

So, we are soliciting, we are working with our General Aviation Joint Steering Committee to make sure that we are getting infor-

mation both from individual operators and the associations that represent them, so that we can all add that into the mix as we develop new standards for this equipment on airplanes going forward.

Ms. BROWNLEY. So, would you characterize general aviation airports as being out of the woods in terms of any danger?

Mr. DICKSON. I would say the biggest impacts are on a couple hundred airports that we have that have low-visibility approaches. In a 5G environment, where you don't have that kind of capability, it is very expensive. You are usually not going to see a general aviation airport with that kind of capability. It is a very expensive infrastructure to put in place because you have got a certified flightcrew, certified airplane, and a certified runway with approach lights, and a lot of very expensive infrastructure. That is usually not going to be what you've got at a GA airport. So, the impacts are not as great, but that community is something that we are paying very close attention to to make sure that they can continue to operate the way that they have previously.

Ms. BROWNLEY. Well, I hope that will continue to be the case. Thank you. Mr. Chairman, I yield back.

Mr. LARSEN. Thank you. The Chair recognizes Congresswoman Holmes Norton for 5 minutes.

Ms. NORTON. Thank you, Mr. Chairman. Can everybody hear me?

Mr. LARSEN. We can hear you just fine.

Ms. NORTON. My question is to Administrator Dickson. 5G operates on the C-band, but that is a mid-band wireless spectrum from 3.7 to 3.98 GHz. But that is adjacent to a 4.2 to 4.4 GHz band used by certain aviation safety equipment, including radio altimeters.

In 2021, there was a safety alert to operators where the FAA warned, and here I am quoting, "the receiver on the radio altimeter is typically accurate, however it may deliver erroneous results in the presence of out-of-band radio frequency emissions from other frequency bands."

So, my question, Administrator Dickson, is if the deployment of 5G wireless services in the C-band poses potential, unsafe interference with aviation safety equipment, are there alternative frequencies that telecommunications companies can use for their 5G rollout, and what is the nearest frequency in which 5G can operate that would not pose a risk of their interference to radio altimeters?

Mr. DICKSON. Well, thank you, Congresswoman Norton. It is good see you this morning. In answer to your question, there are other 5G frequency bands. But the C-band is particularly attractive. It has certain characteristics that make it, in terms of coverage and power levels, that make it very beneficial for 5G. And I think everyone—we certainly recognize that.

In terms of the safety information that we have put out, we had a responsibility to notify the aviation community of the potential for interference based on the studies that had been done, and then the work that we are doing now in terms of testing, and also the avionics manufacturer is doing in terms of testing, is continuing to demonstrate the performance of the radio altimeters. And we will continue to work as we move forward.

Ms. NORTON. Thank you. This next question is for Mr. Viola. Mr. Viola, I am interested in this because——

Mr. LARSEN. Congresswoman?

Ms. NORTON. Yes?

Mr. LARSEN. He is on the second panel, if you want to put it in the record.

Ms. NORTON. Oh, he is on the second panel.

Mr. LARSEN. Yeah.

Ms. NORTON. OK. Sorry.

Mr. LARSEN. That is fine.

Ms. NORTON. Thank you. Finally, let me ask if it is impossible or impracticable for 5G to operate on a different frequency, how costly would it be to upgrade the radio altimeters on regional jets and helicopters that are most susceptible to interference? How much time would be needed to approve of this new equipment?

Mr. DICKSON. Well, again, what we are doing is we are addressing the rollout that we have in front of us, making sure that we take appropriate steps to ensure that aviation safety is maintained. But in parallel, the new standards for radio altimeters are in the process of being developed. And once they are developed, it could be that some existing radio altimeters that are out there have satisfactory performance with the new standard. We don't know exactly where that cut point is yet.

But then for those that do need to be replaced that don't meet the new standard, the manufacturers will produce new designs that the FAA will certify, and then those can be installed on those fleet types. I don't have the specific numbers on what that potential expense is, but I would imagine there is probably somebody on the second panel that can speak to that point.

Ms. NORTON. How much time it would take to approve the new equipment?

Mr. DICKSON. You know what, again, once the standards are set, which is probably, in my estimation, it is going to be probably about this time next year, is an optimistic scenario, but then I know that there is work going on at the manufacturers right now in anticipation of new standards being set, and we will have to see what that looks like once we get those newer standards in place.

Ms. NORTON. Thank you very much.

Mr. LARSEN. Thank you, Congresswoman Holmes Norton. Next up is Representative Stauber of Minnesota.

Mr. STAUBER. Thank you very much, Chair Larsen. I thank you all for being here today. As we look at 5G deployment and in general other advancements in technology, we obviously need to ensure that we were using fact-based analysis. This will best facilitate an economic environment that allows the economy to grow and technology to advance while also ensuring customer safety.

When it comes to 5G, we have all heard both sides of this argument, and to be fair, it is a little difficult to decipher at times. I agree that passenger safety must be the most paramount priority and any interference with navigational or operational instruments demands a solution. I also understand that advances in technology like 5G can be important tools for the future. And it is important that the Government foster innovation, not stifle it.

Mr. Dickson, in your opinion, what is the perfect solution to this issue? Is it more buffer zones? Is it reorienting the towers? Is it an instrument fix to the altimeters? What do you think can be nego-

tiated that is fair to both parties, and how soon do you think that can be achieved?

Mr. DICKSON. Well, it is a great question. And, again, we have got the short-term solution. I think the key to all of this is early and very transparent data exchange. And that process only began in earnest between the aviation sector and the telecommunications companies back in late December. And we made tremendous progress in a very short period of time. I wish there had been a mechanism for that kind of exchange to happen earlier, and I think that we would be in a different place, but we can't rewrite that history.

So, moving forward, I think we want to enable technology and innovation as you state, but we have got to make sure that there is a mechanism for affected stakeholders' interest to be accounted for. And that does happen on occasion, but it did not happen in this particular case, and we need to make sure that it does.

Mr. STAUBER. And how soon do you think it can be achieved? Can you give the committee a timeline? What is your thought?

Mr. DICKSON. Well, again, the mitigations we have in place in terms of the 5G deployment patterns and the presence around airports, what our safety model looks like, the flight testing that we are doing right now, all of that is going to continue to refine what the problem set is. It is going to continue, I believe, to shrink the problem over the next few months.

But the ultimate solution is using the data that we have now and the performance characteristics of the existing radio altimeters out there in the fleet to develop these new airworthiness standards. And that is probably not going to happen within the next year or so. An optimistic scenario is probably early 2023, and then the manufacturers will have the information that they need to be able to manufacture new units for those lower performing parts of the fleet that are operating currently.

But in the meantime, working together and the mitigations that we have in place will be very beneficial in making sure that we can continue air commerce and have it done in a safe way for the public, but also enable additional 5G C-band to form, to happen simultaneously.

[Pause.]

Mr. DICKSON. I am sorry, you are on mute.

Mr. LARSEN. Representative Stauber, you are on mute.

Mr. STAUBER. Thank you, Mr. Chair. So, what is your agency's very near-term plan to ensure this is resolved and working together? Do you have a working plan to get together so we are not doing this at the last minute, or rushing the information or rushing the process?

Mr. DICKSON. Yes, that is a great question. And Secretary Buttigieg in our meeting with the telecommunications companies on a regular basis to ensure that we are staying, that we are continuing to focus on, on moving forward together. And our technical teams are meeting daily, if not multiple times a day. As I had mentioned earlier, we have set up flight test scenarios at some airports around the country, and we will continue do that. And that will give us the fidelity that we need in terms of what does this signal look like when it is actually arriving at the airport. That is re-

search that had never been done before. And that will be very beneficial in both the near-term mitigations that we need to continue to pay, but also in developing a long-term solution.

Mr. STAUBER. Well, thank you very much. Mr. Chair, how much time do I have left?

Mr. LARSEN. Sorry you are out of time, Mr. Stauber.

Mr. STAUBER. Well, thank you, Mr. Chair. I turn it back to you.

Mr. LARSEN. Right. I have two words for you, Mr. Stauber, stay warm.

Mr. STAUBER. Thank you.

Mr. LARSEN. It is minus 6 in Duluth, Minnesota, right now, folks. I would like to recognize Representative Titus of Nevada for 5 minutes.

Ms. TITUS. Thank you, Mr. Chairman. And thank you, Administrator, for being here. I would like to go back to the question that Ms. Brownley posed, and just to put a point on it, general aviation is so important to the Las Vegas economy. We fly a lot of tourists in commercially, but those corporate jets and those executive jets that fly into Henderson and North Las Vegas bring people to Raiders games, to prize fights, to conventions, so, I am glad that you are working on that to be sure that they are accommodated with this new technology as well.

Mr. DICKSON. Absolutely, no, it is very important. And, again, the initial focus was on international commercial wide-body aircraft. We didn't want Americans to be stranded overseas and not be able to get back up and get back home. And we have continued to work through all of the approvals.

And as the manufacturers bring us for their proposals for how their systems will perform, we will process them as quickly as we possibly can. I am really proud of how quickly the agency has been able to respond at a time that has been very important to our country.

Ms. TITUS. Well, I appreciate that because so often we are reacting as opposed to being ahead of the game, and then we get behind Europe, we get behind Australia, and we try to catch up. And that is especially true of the FAA before you were there. I am not putting this on you, but they were so hidebound, we couldn't get them to do anything to keep up with the technology.

And with this new 5G that we are trying to deal with, I would ask you too about the advanced air mobility. This new technology is coming. I was pleased to introduce a bill with the chairman and the ranking member. I wonder, are we trying to get ahead of the game with that, or is that also going to be reactive? And the same question I might ask about drones, we have all heard a lot about drones, and the development of the drones in the airspace and all. Are we thinking about any plans to deal with that?

Mr. DICKSON. Well, and I will—taking drones first, we have made a lot of progress, but we have got a ways to go. An example of the rigor of the approval process that we go through is when we did the rulemaking on remote identification.

We engaged all of our Federal partners in that and had to actually change our approach a little bit based on the work that we had done with them. But, ultimately, we want to get drones. We just completed an aviation rulemaking committee on beyond visual line

of sight operations rather than doing it at scale, rather than with individual exemptions. And I am excited to see that proceed on into the future.

That rulemaking is definitely on our very short to-do list. With advanced air mobility, we are working with several manufacturers. I have actually spent some time with several of them. I was at an industry roundtable about 3 months ago talking about the near-term opportunities. I think the good news there is that our existing regulatory structure that we have around a lot of helicopter operations and other types of air mobility-type operations will serve us well in the early going.

We have the first machines that we expect to be certified probably around 2024. So, in the aviation business that is right in front of us. So, we are looking forward to seeing that technology roll out. Think it will be very beneficial to society and great for our communities as well.

Ms. TITUS. Well, thank you. It is a difficult job you have balancing this 5G, so we can be competitive, especially now we are talking about competitiveness with China. We need to do that and yet the FAA's main priority has always been safety, which we want to be sure that the American public feels like they can travel by air safely.

Mr. DICKSON. Absolutely. We need to do both.

Ms. TITUS. Well, thank you very much.

I will yield back, Mr. Chairman.

Mr. LARSEN. Thank you. Representative Titus yields back.

And I recognize Representative Van Drew of New Jersey for 5 minutes.

Dr. VAN DREW. Thank you, Chairman, and thank you, Ranking Member, for holding this hearing on this critical issue.

This committee has no higher responsibility than ensuring the safety of the flying public. The issue of 5G interference with aircraft radio altimeters is very serious. It is unfortunate that we are in this situation and it was certainly preventable. We can and must act to address the immediate problem and to ensure that it never happens again.

Administrator Dickson, you and the FAA are working diligently, you are working hard to move this issue forward. It is clearly the FAA's top priority right now to ensure that the 5G rollout occurs in the safest and least disruptive way possible.

I commend your focus, and I know that you will keep it up. I am concerned that this will not be the last time that the FAA runs into spectrum management issues. Spectrum conflicts are only going to become more common as the airspace fills with new entrants. With the growth of the UAS industry, the United States airspace could have millions of drones flying around the country with hundreds of different operators. These companies will need spectrum to manage these drones without question.

Much of the FAA's spectrum capability comes from the Spectrum Engineering Office. So, Mr. Administrator, I have several questions to ask. What role has the FAA Spectrum Engineering Office played in the process of detecting and solving the 5G interference issue before us? And now and into the future, do we need more resources?

These are changing times and changing technologies, we need the resources to deal with this.

How will the expansion of the UAS industry complicate the spectrum environment?

Thank you.

Mr. DICKSON. Thank you, Congressman Van Drew. And I know that you have particular focus on this. We have talked about the capabilities of the tech center and our very highly capable team there. As I said, this process did not serve anyone well, and we needed to do better, and we will.

In terms of resources, I think that if we can improve the process, we are well resourced for what we have in front of us. My spectrum engineers, the last 3 months I have been talking with them on almost a daily basis. They are a very capable group, but this is not an issue that is going away.

And as a matter of fact, in order to be able to continue to enable the kind of innovations that you are talking about, it is something that we are focused on in our workforce plan. We really need to make sure that we are bringing the kinds of 21st-century expertise and experience into the agency that we will need to move these forward.

So, I look forward to continuing to work with you on those very important issues.

Dr. VAN DREW. Good. I appreciate it. I look forward to it as well. Nothing could be more important right now.

And I yield back, Chairman.

Mr. LARSEN. Thank you, Representative Van Drew.

The Chair recognizes Representative Stanton for 5 minutes.

Mr. STANTON. Mr. Chairman, thank you very much. Can you see me OK?

Mr. LARSEN. Yes. It is fine and hear you fine.

Mr. STANTON. All right. Our Nation needs 5G and the capabilities it brings. At the same time, safety of our national airspace must be a key priority for passengers, pilots, and crew. Administrator Dickson, you are tasked with the hard job of making both of these things happen right now.

When did the FAA begin the process to review and improve existing radio altimeters in 5G deployment areas and were there barriers that prevented FAA from doing those assessments earlier?

Mr. DICKSON. Well, again, the formal process for providing the approvals was dependent upon having the deployment data from the telecommunications industry, because—remember, we are not certifying new equipment right now. We are addressing what we call an unsafe condition that has been identified in radio altimeter avionics.

So, when you do that, we issue an airworthiness directive that essentially, in this case, does not allow the use of that technology on the airplane. So, to continue to enable poor weather, low-visibility-type operations, again, operations in most cases of less than a half mile visibility where the pilot is doing what we call Category II or a Category III auto landing approach, the radio altimeter is very critical in that phase of flight.

And until we had the specific deployment data, for example, latitude/longitude, elevation, is the tower on a hill, what is the height

of the tower, signal strength, all of that deployment information, that is the information that we needed to be able to put our protection zones in place.

And then once we did that, the aviation manufacturers came to us with the level of performance that they are testing indicated their radio altimeters would perform satisfactorily. Some of them range from a few hundred feet. Some of them are well over several miles where they are potentially vulnerable at this point to C-band interference.

And so, we continue to work that, and we will continue to work with the manufacturers to ensure that only those operations that can be conducted safely will be allowed to continue.

Mr. STANTON. Are there other technical concerns with interference other than just with radio altimeters?

Mr. DICKSON. Well, there are other—some airplanes have—the root cause of all of this is the performance of the radio altimeter, but what has happened with certain aircraft types is that the radio altimeter has been architected into other automatic systems on the aircraft.

For example, thrust reversers or spoilers, they are the panels that come up on the wing after landing to help slow the airplane down, those types of things in older aircraft types, you may have had a sensor on the wheel that detected when the airplane was on the ground. Now with some newer aircraft designs, the radio altimeter is used as a backup or perhaps even primary to those sensors, and that safety enhancement, actually, becomes compromised as well.

I think the good news here is that the same relief that we are providing for low-visibility approaches is also protecting those systems on the aircraft as well.

Mr. STANTON. What measures does the FAA have in place to ensure that the data provided by the telecom industry regarding 5G deployment areas, such as tower locations and activations, power levels, et cetera, what measures do you have in place to ensure that it is accurate, reliable, and shared with you in a timely matter moving forward?

Mr. DICKSON. Well, again, I am having regular conversations with their leadership. We are having technical exchanges on a daily basis. We have developed a level of familiarity and a level of collaboration, and frankly, a building level of trust.

It is always trust but verify, and that is part of what flight testing is telling us is, we think that the technical specifications and what they have committed to us is actually the way that things will perform in the real world. The flight testing is helping us to validate things like signal shape and power.

And again, frankly, the kind of information exchange that we are having with them is information that they were never required to provide before. In fact, they had never even really thought about the impact of a C-band signal on a moving aircraft. It was just not something that was within their calculus.

And so, now we are, just in the last few weeks, we are certainly working with each other much more effectively than we were before.

Mr. STANTON. Trust but verify.

I yield back.

Mr. LARSEN. Thanks, Representative, very much.

So, as I understand it, for this panel, that is all the Members who have questions. And we have other Members waiting, but that is for the second panel. Going once? Going twice? Great.

Administrator Dickson, thank you for joining us and thank you for giving us a little over 2 hours of your time to ask some questions.

I think the second panel will also give us some very interesting perspective for us to explore based on some of the things you said. And we will be in touch with you with further questions, as well as some followup on how we can help out, but thank you very much for joining us today.

Mr. DICKSON. Thank you for your support and for your leadership.

Mr. LARSEN. For the members on the panel, we are going to take a 10-minute recess. Some of us haven't had the chance to get up and walk around like others. So, we are going to take a 10-minute recess and we will back for the second panel.

[Recess.]

Mr. LARSEN. I call the subcommittee back into session.

I now call up panel 2. I will ask the witnesses on panel 2 to please turn your cameras on and keep them on for the duration of the panel. I want to welcome the witnesses on our second panel.

I will just go through the introduction of each one.

Nick Calio, the president and CEO of Airlines for America.

The Honorable Eric Fanning, president and CEO of the Aerospace Industries Association.

Cathryn Stephens, airport director, Eugene Airport, on behalf of the American Association of Airport Executives.

Captain Joe DePete, president of the Air Line Pilots Association.

Faye Malarkey Black, president and CEO of the Regional Airline Association.

James Viola, president and CEO of the Helicopter Association International.

The Honorable Meredith Attwell Baker, president and CEO of CTIA.

And Dennis Roberson, president and chief executive officer of Roberson and Associates and also a proud graduate of the Washington State University.

Thank you for joining us today, and I look forward to your testimony.

Without objection, our witnesses' full statements will be included in the record. And since your written testimony has been made part of the record, the subcommittee requests that you limit your oral testimony to 5 minutes.

With that, we will start with Mr. Calio. You are recognized for 5 minutes. You may proceed.

TESTIMONY OF NICHOLAS E. CALIO, PRESIDENT AND CHIEF EXECUTIVE OFFICER, AIRLINES FOR AMERICA; HON. ERIC FANNING, PRESIDENT AND CHIEF EXECUTIVE OFFICER, AEROSPACE INDUSTRIES ASSOCIATION; CATHRYN STEPHENS, A.A.E., AIRPORT DIRECTOR, EUGENE AIRPORT, ON BEHALF OF THE AMERICAN ASSOCIATION OF AIRPORT EXECUTIVES; CAPTAIN JOSEPH G. DEPETE, PRESIDENT, AIR LINE PILOTS ASSOCIATION, INTERNATIONAL; FAYE MALARKEY BLACK, PRESIDENT AND CHIEF EXECUTIVE OFFICER, REGIONAL AIRLINE ASSOCIATION; JAMES VIOLA, PRESIDENT AND CHIEF EXECUTIVE OFFICER, HELICOPTER ASSOCIATION INTERNATIONAL; HON. MEREDITH ATTWELL BAKER, PRESIDENT AND CHIEF EXECUTIVE OFFICER, CTIA; AND DENNIS A. ROBERSON, PRESIDENT AND CHIEF EXECUTIVE OFFICER, ROBERSON AND ASSOCIATES, LLC

Mr. CALIO. Thank you, Chairman DeFazio and Larsen and Ranking Member Graves and Graves.

A4A appreciates the opportunity to testify. Given the unprecedented impacts of the pandemic, it is quite notable that an unrelated problem would rise to be the most disruptive issue facing our industry, yet here we are. Commercial aviation is the safest mode of transportation in the world due in part to technology like radio altimeters. They are essential tools that provide input to many other critical safety systems on an airplane.

Since the spring of 2018, A4A and others in the aviation industry, have been raising concerns about radio altimeters in the new 5G environment. I point you to the timeline of cautions we raised, which is attached to our written testimony. As time ran out ahead of the scheduled, and then rescheduled deployment dates, A4A sounded the alarm.

I and all of our member CEOs signed a letter warning of significant disruption to air passengers, shippers, the supply chain, and delivery of needed medical supplies. The restrictions that were being imposed on the industry would have impacted approximately 345,000 passenger flights, 32 million passengers, and 5,400 cargo flights each year in the form of delayed flights, diversions, or cancellations.

The past few months have been nothing short of a harrowing sequence of looming deadlines and impending Government action. The process that led up to this operational nightmare or potential operational nightmare should be held up as a cautionary tale of lack of communication and coordination gone awry.

It is not a partisan problem or issue; it is a Government coordination problem that needs to be rationalized going forward. As a result of the FCC's decision not to address aviation safety concerns, the FAA rightly did.

The situation could and should have been directly addressed prior to the spectrum auction, but we are encouraged by recent progress. Today, we are in a far better place thanks to the work of many, including the White House, the NEC, DOT, FAA, aviation stakeholders, and the telecommunications companies.

Both the telecom and aviation industries have been thrust into this avoidable calamity by a Government process that failed to provide an adequate amount of interagency communication and rec-

ognition of decisional consequences down the line. We sincerely appreciate the telecoms' coordination efforts.

We are also grateful to those in Congress who have lent their voices to drive solutions. Chairman DeFazio, in particular, we would like to thank for giving attention to this issue going back at least 3 years. For A4A, we are acutely focused on driving our Government partners to quickly find a permanent set of solutions that will allow 5Gs to expand while also protecting aviation from disruption.

Specifically, we are asking for a long-term, transparent process that brings everyone to the table to work in a collaborative manner. Unfortunately, the current process has provided a complicated web based on aircraft-by-aircraft, runway-by-runway, radio altimeter-by-radio altimeter determinations made on a flight-by-flight basis.

The situation isn't static either, but rather there are a constant ebb and flow of new 5G towers and airline and airport operating changes. The complexity that has been added to the aviation operations, along with the impacts on human factors involved, which I am sure Captain DePete will talk about, desperately calls for a stable approach that only the Government can provide.

Just this past weekend, there was another round of reevaluations referred to as the AMOC process as mentioned by Administrator Dickson. It is paramount that the FAA continues to implement a permanent and more accurate risk evaluation tool, as well as improving its notifications and limitations process. There is no reason the types of mitigations that have been implemented internationally at the onset of the process, not after, through intergovernmental communication, could not have been effectively dealt with here in the United States.

We are now trying to manage through the existing crisis, but it will likely take years, not weeks, to fully address. In the near term, we need a razor-sharp focus on the FAA honing a permanent evaluation tool.

In the long term, we need a critical review of the intergovernmental communication during spectrum reallocation processes, and we need a long-term transparent process, as I said, that includes all stakeholders. Make no mistake about it, the aviation industry fully supports new technologies in deployment of 5G, however, it must be done in a manner that allows aviation and 5G to coexist safely.

There likely will be a 6G and 7G and many other spectrum utilization issues in the future. They should be seamlessly integrated in the broader economy without causing seismic disruptions to critical industry segments.

We have no doubt the United States can find a way to lead both aviation safety and 5G access, but it needs to be done right.

Thank you, and I look forward to your questions.

[Mr. Calio's prepared statement follows:]

Prepared Statement of Nicholas E. Calio, President and Chief Executive Officer, Airlines for America

Airlines for America (A4A) appreciates the opportunity to testify today regarding the ongoing implementation and deployment of 5G C-band transmission and its impact on the aviation industry, supply chain and broader economy. Given the unprecedented impacts of the COVID–19 pandemic and the unpredictability caused by the ever-changing global disruption it has caused, it is notable that a non-pandemic issue would rise to be the most disruptive issue facing our industry.

While the last three months have been nothing short of a harrowing sequence of looming deadlines and impending government action, I am encouraged by the progress that has resulted from the collaborative actions taken by the stakeholders represented on the panels today. There is still much work to be done, and we are unfortunately only at the beginning of what is expected to be a long odyssey, but we are in a much better place today than where we were just a few short weeks ago.

Progress would not have been possible without the work of the White House, the National Economic Council (NEC), the Department of Transportation (DOT), the Federal Aviation Administration (FAA), Federal Communications Commission (FCC), aviation stakeholders and the telecommunications industry. In no small part, many in Congress have also lent their voice to raise concern and provide the leadership necessary to drive solutions. I would like to specifically thank Chairman DeFazio for his long-standing attention to this issue. He recognized the gravity of the situation well over two years ago, highlighting concerns to the FCC prior to the spectrum auction. Mr. Chairman, we are grateful for your actions on this matter.

From a commercial aviation perspective, we are acutely focused on finding a set of solutions that allows 5G to expand to the C-band while also protecting aviation from any operational restrictions. It is imperative the data sharing, testing and honing of safety assurance tools continues at a rapid pace. The breadth and complexity of the operating changes to the aviation environment caused by these events, along with the impacts on human factors, desperately call for a methodical, predictable and routine set of solutions to stabilize our operating framework. This should be the mutual goal for all stakeholders.

BACKGROUND

In 2017, the FCC signaled its intention to auction C-band spectrum that would reallocate a portion of the 3.7–4.2 GHz frequency band, making the frequency spectrum from 3.7–3.98 GHz available for flexible use, including 5G in the C-band applications.

Before the FCC's auction, the FAA determined that C-band mobile telecommunications signals could interfere with low range radio altimeter operations. The interference concerns were material because radio altimeters are the only device on every aircraft that can directly measure the distance between the aircraft and the ground. Data from those radio altimeters also feeds into several other safety-critical flight control and warning systems that are needed in all phases of flight.

Subsequently, the FAA and DOT jointly wrote to the National Telecommunications and Information Administration (NTIA) expressing interference concerns. Despite being aware of the concerns, the FCC auctioned the spectrum to new licensees in December 2020 in a manner that did not address the core aviation interference concerns.

Per the FCC order, starting on December 5, 2021, the telecom licensees were allowed and scheduled to activate their 5G in the C-band. The telecom licensees have subsequently voluntarily modified their deployments to work with the FAA and aviation stakeholders to address interference issues around U.S. airports. Those efforts are ongoing.

AVIATION SAFETY

Safety is the top priority of U.S. airlines. Through decades of work and collaboration, air travel is the safest mode of transportation both domestically and globally. For airlines, our first commitment is to the safety of our passengers, our crewmembers and the public. Commercial aviation has achieved historical levels of safety due, in part, to technology investments made to enhance landing safely and which rely on the radio altimeter, such as Enhanced Ground Proximity Warning Systems, auto throttle, Head-Up Display, stability augmentation, tail strike warning, windshear warning, braking scale and pointer.

Consistent with our culture of safety, through a series of meetings and filings with the FAA, the broader aviation industry has long conveyed its safety concerns

with the FCC's actions and the potential consequences. These concerns include radio altimeters providing erroneous information to a variety of critical onboard aircraft systems when the aircraft is in the vicinity of 5G C-band broadcasting towers, especially for flights operating in Instrument Meteorological Conditions (IMC). The aviation industry has also consistently attempted to engage the FCC to discuss aviation safety risk mitigations and allow for the safe and efficient deployment to 5G technology. A timeline of these engagements is attached below.

As a result of the FCC's decision to not address aviation safety concerns, the FAA has taken their own actions to address the aviation safety risks of 5G in the C-band. The FAA determined that "radio altimeters cannot be relied upon to perform their intended function if they experience interference from wireless broadband operations in the [5G C-Band]." The FAA issued an Airworthiness Directive (AD) requiring revisions to airplane flight manuals (AFM) to incorporate limitations prohibiting certain radio altimeter-dependent operations when the operation is in the presence of 5G C-band interference from known or suspected 5G C-band deployments near airports, which the FAA identifies through Notices to Air Missions (NOTAMs). Accordingly, operational prohibitions are the new operating baseline at airports with nearby 5G C-band deployments under low visibility conditions, resulting in extreme operational impacts. However, pursuant to its Alternative Methods of Compliance (AMOC) process, the FAA has permitted (on a time-limited basis) certain aircraft that are equipped with radio altimeters capable of functioning without adverse interference to operate without restrictions at airports with known 5G C-band deployments.

However, we continue to be concerned with the operational uncertainty of a monthly AMOC process that requires a revaluation of the approved airports each time the telecom companies provide new 5G C-band tower locations, which could result in the loss of access to a previously covered airport. In the near term, we believe the FAA should continue its collaboration with stakeholders to find and implement permanent, efficient and more accurate risk evaluation tools and mitigations, including fixes to 5G in the C-band deployment as well as FAA's notification and limitations process.

Initial Aviation Impact Analysis

Shortly after the FAA issued its AD, A4A surveyed our members to assess the potential impact of the FAA actions and found:

> The expected costs to the flying public, shippers and airlines would be significant as the AD would materially disrupt airline operations. For example, if the AD were applied in arrears to A4A members' 2019 operations, approximately 345,000 passenger flights, 32 million passengers and 5,400 cargo flights would have been impacted in the form of delayed flights, diversions or cancellations. A4A estimates that U.S. passenger airlines would incur an incremental $1.7 billion in operating costs annually. Separately, A4A cargo operators estimate that the directive would have cost them $400 million annually resulting from the disruption to their time-sensitive operations.

Further, the FAA AD would exact a heavy toll on passenger and shippers in the form of lost wages and productivity as well as higher operating costs. According to the FAA, the value of air travelers' time is worth $47.10 per hour. In 2019, the actual duration of the average flight arrival delay was 64 minutes. Based on this, A4A estimates the annual impact cost to passengers to be approximately $1.59 billion. At the time, we stressed that these estimates were also conservative as they did not address the ripple effect of delays throughout the system that result when flights are cancelled, diverted or delayed.

Additionally, the estimates only measured the direct impacts to airlines and their customers. The analysis did not account for the impact to lost business for hospitality providers (i.e., missed meetings, hotel stays, restaurants, lost wages from indirect service providers, etc.). The ripple effect would be felt well beyond the airline sector and significantly impact the broader economy.

Revised Aviation Impact Analysis

As more information was disseminated throughout January, it became clear the harm to aviation that would result from deployment of 5G in the C-band near airports would be substantially worse than originally anticipated for two key reasons.

First, most of the 50 airports that were identified by the FAA for relief would still be subject to flight restrictions. Unless major hubs are cleared for aircraft to fly, the vast majority of the traveling and shipping public would essentially be grounded.

This means that on any given day, more than 1,100 flights (both passenger and cargo) and 100,000 travelers would be subjected to cancellations, diversions or delays.

Second, flight restrictions would not be limited to poor weather operations. As outlined above, because radio altimeters provide critical information to other safety, flight control, alerting and navigation systems in modern airplanes, multiple modern safety systems on aircraft would be deemed unusable causing a much larger problem than what was known in early January. Airplane manufacturers also informed operators that there are huge swaths of the operating fleet that would need to be indefinitely grounded. In addition to the chaos caused domestically, this lack of usable widebody aircraft could potentially strand tens of thousands of Americans overseas.

As of late January, the FAA has codified the manufacturer's concerns on four fleets of large aircraft, severely limiting or curtailing their operations at NOTAM-affected airports regardless of weather conditions, and more directives are expected.

The impact of these additional variables, along with the ripple effects they would create across passenger and cargo operations, our workforce and the broader economy would simply be incalculable and untenable. Airline customers rely on airlines to transport time-sensitive perishable products such as pharmaceuticals, vaccines, organs, critical supply chain parts and many other high-value items. Every one of the passenger and cargo carriers would also be struggling to get people, shipments, planes, and crews where they need to be. We were on the precipice of the nation's commerce grinding to a halt. Thankfully, the ongoing coordination and progress has allowed us to avoid these massive economic and operational disruptions for the most part.

CLEARING THE 'AIR' & 'AIRWAVES'

Some in the media and other observers have tried to portray this situation as a conflict between the airline industry and the telecommunications industry. That is simply not the case. In fact, airlines fully support 5G—but it needs to be deployed in a manner that allows 5G and aviation to coexist safely. We are grateful to our telecommunications colleagues and are hopeful they continue to play a critical role in sharing information with the FAA and FCC to help mitigate any interference issues. We cannot avoid significant disruption to the aviation system without their continued collaboration and transparency.

The truth of the matter is that both of our industries have been thrust into this avoidable economic calamity by a government process that failed to provide an adequate amount of interagency communication, understanding and recognition of decisional consequences. The circumstances and challenges we face currently could and should have been directly addressed prior to the spectrum auction.

INTERNATIONAL EXAMPLES: IT'S NOT WHAT YOU DO, IT'S HOW YOU DO IT

Much has been said and inferred regarding 5G deployment internationally. The FAA has noted that international examples versus U.S. 5G deployment are apples-to-oranges comparisons. As opposed to the process cited above, other countries reportedly heeded aviation concerns and addressed them through various mitigations prior to 5G C-band technology deployment.

On its dedicated 5G website, the FAA cites France as an example for comparison to the U.S. The FAA chart (attached) indicates the resulting deployment of 5G C-band in the U.S. is significantly distinguishable from deployment of 5G C-band in France because the FCC licensed the use of the spectrum at exponentially higher power levels. The allocated frequencies are also generally farther away from the radio frequency band used by radio altimeters. We understand that many other countries have also effectively utilized a combination of exclusion zones around airports, lower power levels and directional changes to antennas to mitigate interference.

There is no reason to believe these types of mitigations could not have been contemplated and implemented at the on-set of the regulatory process through proper inter-governmental communication channels.

LESSONS LEARNED

The Committee and Congress should be aware that it will likely take years, not days or weeks, to fully and permanently mitigate the interference issues caused by deployment of 5G in the C-band. The interference issues have created a complex web of aircraft-by-aircraft, runway-by-runway, radio altimeter-by-radio altimeter determinations on a flight-by-flight basis. They have created a complicated matrix of

variables and uncertainty in the operational deployment of aircraft assets and as we have seen, will still cause cancellations, delays and diversions even under the best of scenarios. In some cases, we are simply hoping for good weather so flights can be cleared to land at their intended destinations.

The U.S. aviation industry should not be in this position and the process that led to this operational nightmare should be held up as cautionary tale of government communication and coordination gone awry. It is not a partisan problem; it is a government process problem that desperately needs to be addressed. One can assume there will be a 6G, 7G and many other spectrum utilization issues in the future; those efforts should be seamlessly integrated into the broader economy without causing seismic disruptions to critical industry segments. Unfortunately, there are no easy answers for the current dynamic, but there a framework can be put in place to make sure this never happens again to our industry, or any other for that matter.

CONCLUSION

We appreciate all the actions taken by various stakeholders to avert catastrophic disruption to the traveling and shipping public, the global supply chain and the U.S. economy. The day-to-day unpredictability remains a significant challenge for airlines, but the work over the course of the last few weeks is an important step toward achieving a permanent solution that will allow the U.S. to continue leading the world in aviation safety while also expanding our nation's 5G network.

ATTACHMENT 1

MYTH: AVIATION RAISED 5G CONCERNS AT THE LAST MINUTE
FACT: AVIATION STARTED RAISING CONCERNS AS FAR BACK AS MAY 2018

TIMELINE

2018

MARCH 2018—The Mobile Now Act is enacted, authorizing the Federal Communications Commission (FCC) through notice and comment on the feasibility of allowing commercial wireless services, licensed or unlicensed, to use or share use of the frequencies between 3700 megahertz and 4200 megahertz.

APRIL 2018—FCC issues public notice encouraging the public to comment on potential for more intensive use of the 3.7–4.2 GHz Band to submit those filings in this docket.

MAY 2018—A4A files comments in response to FCC public notice raising radio altimeter and satellite communication (SATCOM) interference concerns.

JULY 2018—FCC issues Order and Notice of Proposed Rulemaking on Expanding Flexible Use of the 3.7 to 4.2 GHz spectrum band.

OCTOBER 2018—AVIATION SPECTRUM RESOURCES, INC. (ASRI) files comments to FCC reiterating aviation industry concerns on the potential impact to radio altimeter and SATCOM.

2019

OCTOBER 2019—AEROSPACE VEHICLE SYSTEMS INSTITUTE (AVSI) files "Behavior of Radio Altimeters Subject to Out-Of-Band Interference" report in FCC rulemaking docket, raising the potential for interference issues affecting the 4.2–4.4 GHz band start for commercial aircraft.

NOVEMBER 22, 2019—HOUSE TRANSPORTATION AND INFRASTRUCTURE (T&I) COMMITTEE Chair DeFazio sends letter to FCC warning of potential interference to radio altimeters from 5G deployment in the C-Band.

2020

FEBRUARY 21, 2020—AVIATION INDUSTRY COALITION sends ex parte letter and presentation to FCC raising safety concerns.

FEBRUARY 28, 2020—FCC issues Order to move forward with auctioning "C-band" spectrum.

MAY 2020—AVIATION INDUSTRY COALITION files petitions for reconsideration of the FCC Order.

OCTOBER 7, 2020—RADIO TECHNICAL COMMISSION FOR AERONAUTICS (RTCA) completes a six-month assessment of interference from 5G network emissions with radio altimeter performance, revealing a "major risk that 5G telecommunications systems in the 3.7–3.9 GHz band will cause harmful interference to [radio] altimeters on all types of civil aircraft."

DECEMBER 2020—AVIATION INDUSTRY COALITION submits letter of support for petition for reconsideration.

DECEMBER 1, 2020—DEPARTMENT OF TRANSPORTATION (DOT) AND FEDERAL AVIATION ADMINISTRATION (FAA) submit joint letter voicing interference concerns to the National Telecommunications and Information Administration (NTIA)and request NTIA to submit their letter to the FCC public docket. NTIA did not submit the letter to the FCC docket.

DECEMBER 7, 2020—HOUSE T&I COMMITTEE Chair DeFazio sends letter to FCC asking the agency to delay its C-Band auction.

DECEMBER 8, 2020—FCC begins auction of the 3.7–3.98 GHz frequency band.

2021

FEBRUARY 2021—FCC completes $81 billion auction of the 3.7–3.98 GHz frequency band and subsequently issues licenses to AT&T and Verizon to begin deployment on December 5, 2021.

MAY 2021—AVIATION INDUSTRY COALITION sends letter to FCC supporting aviation petition for reconsideration and responding to Cellular Telecommunications Industry Association (CTIA) FCC filing.

JULY 2021—AVIATION INDUSTRY COALITION sends letter to DOT raising imminent safety risk facing aviation industry.

AUGUST 2021—AVIATION INDUSTRY COALITION sends presentation to FCC raising safety concerns and asking for a taskforce to resolve concerns.

NOVEMBER 2, 2021—FAA issues Special Airworthiness Information Bulletin alerting manufacturers, operators and pilots that action might be required to address potential interference with aircraft radio altimeter caused by the rollout of 5G wireless broadband on December 5, 2021.

NOVEMBER 3, 2021—FAA AND FCC announce that AT&T and Verizon have agreed to delay the 5G C-band deployment from December 5, 2021 to January 5, 2022.

NOVEMBER 5, 2021—AVIATION INDUSTRY COALITION sends letter to National Economic Council (NEC) urging it to "work with the FCC and FAA to convene a joint industry working group and continue to delay the deployment of 5G technologies in this band until the safety and efficiency of the [National Air Space] is ensured."

NOVEMBER 19, 2021—HOUSE T&I COMMITTEE Chair DeFazio and Aviation Subcommittee Chair Larsen send letter to FCC urging the agency not to go through with any 5G C-band deployments until the FAA conducts a risk assessment that proves no further "mitigations are necessary or that all necessary mitigations are in place," and requesting FCC to provide FAA with any technical data related to aviation and 5G broadband service.

NOVEMBER 24, 2021—AT&T AND VERIZON issue a proposal committing to adopt "additional precautionary measures" for 6 months to mitigate the potential impact of 5G on radio altimeters.

DECEMBER 3, 2021—AIA AND OTHER AVIATION STAKEHOLDERS circulate a counterproposal to the telecom industry's November 24 mitigation proposal.

DECEMBER 7, 2021—FAA issues two Airworthiness Directives (ADs) identifying safety concerns and outlining potential flight restrictions. The ADs state that "radio altimeters cannot be relied upon to perform their intended function if they experience interference from wireless broadband operations in the 3.7–3.98 GHz frequency band (5G C-Band)."

DECEMBER 22, 2021—A4A, AEROSPACE INDUSTRIES ASSOCIATION (AIA) AND CTIA announce agreement to work together in coordination with the FAA and FCC to "identify a path forward."

DECEMBER 23, 2021—FAA issues second Special Airworthiness Information Bulletin and a Safety Alert for Operators regarding the "Risk of Potential Adverse Effects on Radio Altimeters when Operating in the Presence of 5G C-Band Interference."

DECEMBER 30, 2021—A4A files emergency petition with the FCC to stay initiation of the deployment of 5G around certain airports until a solution can be identified.

2022

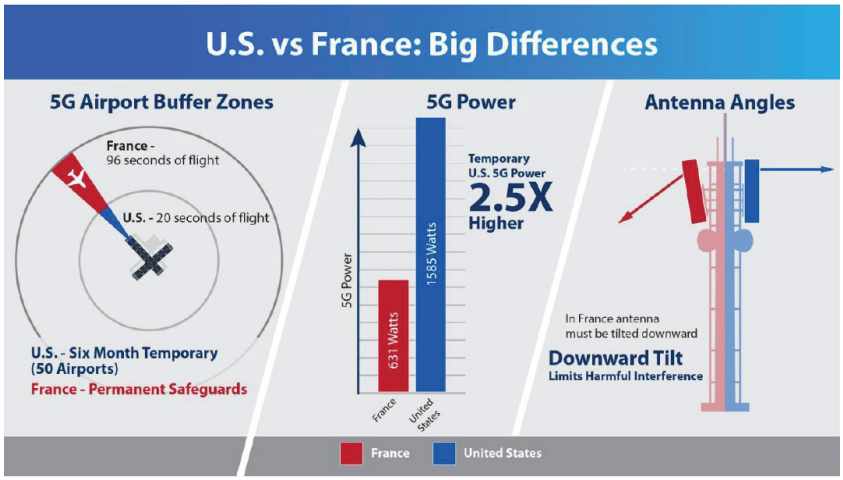
JANUARY 4, 2022—WHITE HOUSE announces agreement with AT&T and Verizon to delay the 5G C-band deployment by two weeks from January 5 to January 19, 2022 and to reduce the 5G signal power and not activate transmitters in close proximity to up to 50 priority airports for six months through July 5, 2022.

JANUARY 17, 2022—A4A sends a letter—signed by the CEOs of the leading cargo and passenger airlines—to National Economic Council Director Brian Deese, Transportation Secretary Pete Buttigieg, FAA Administrator Steve Dickson and FCC Chairwoman Jessica Rosenworcel urging immediate action to address major disruptions to the traveling and shipping public as a result of the deployment of new 5G service near airports scheduled to begin on January 19.

JANUARY 18, 2022—WHITE HOUSE announces agreement with AT&T and Verizon to deploy 5G on January 19, 2022 except around key airports and to continue working with the federal government on safe 5G deployment at those locations.

ATTACHMENT 2

FAA Comparison Chart



Source: FAA.gov/5G

Mr. LARSEN. Thank you very much, Mr. Calio.

I will now turn to Mr. Fanning. Mr. Fanning, you are recognized for 5 minutes.

Mr. FANNING. Thank you. Chairman DeFazio, Chairman Larsen, Ranking Member Sam Graves, Ranking Member Garret Graves, and members of the committee, thank you for inviting me to appear today and for your leadership on this important matter.

In partnership with the FAA and other Government partners, U.S. aviation manufacturers and our airline customers set the gold standard of safety worldwide. Maintaining this unprecedented level of safety is our priority mission. For this reason, we have been expressing serious concerns about possible interference with a key

aviation safety device known as a radio altimeter upon deployment of the new 5G service in the C-band.

Spectrum is the lifeblood of our industry, and we support 5G rollout. It will be important to our industry, it will be important to the more than 2 million people who work in our industry, and it will usher in new advances for our society, but it must be done in a way that assures the U.S. gold standard of safety defined as the chance of 1 catastrophic incident in 1 billion flight-hours.

We know we can do this because as an industry we do it every day, introduce complex technologies into society safely. AIA members manufacture first-in-class fixed-wing and rotary aircraft of all sizes, each with extensive safety features. One of the most critical is the radio altimeter, which is the workhorse of the overall integrated safety system.

While it is a simple device, it has the most consequential of purposes, helping to save lives. Altimeters help pilots determine an aircraft's altitude. These highly reliable devices are essential to a number of aircraft functions, including precision approach, landing, ground proximity, and collision avoidance. All commercial and most general aviation aircraft, as well as helicopters, use an altimeter.

Altimeters are unique to each aircraft type and model. They are designed, manufactured, tested, and certified against the most rigorous safety requirements as a single component and then again as part of the aircraft's integrated safety system.

Altimeters are especially important for pilots dealing with low-visibility conditions and in other situations like wind sheer, which causes rapid decrease in airspeed due to wind flows near the ground. It can be particularly hazardous during takeoff and landing. In such an environment, fluctuation in atmospheric pressure can result in airspeed indicators and barometric altimeters providing misleading indications to the flightcrew, but the radio altimeter can be trusted, and it is this device they must rely on to execute a successful escape maneuver.

Beginning in 2018, aviation stakeholders began calling for collaboration to address potential interference because of the altimeter's essential safety function. While progress is now occurring, this is not the same as declaring the problem solved. The mitigation measures underway are temporary and focus on our largest cities. We need to ensure that all airports, including airports in small and mid-sized communities, can maintain their operations' safety as rollouts continue.

The U.S. aviation system is incredibly complex. It is not nearly as simple as adopting another country's safety playbook for 5G development for reasons including orientation of the base tower and differing maximum power levels. Our efforts must be specific to U.S. needs and safety requirements.

Based on where we are today, the development of new standards will take considerable time. Because of this, a proposal to retrofit out-of-band filters or other solutions cannot be accomplished overnight.

Manufacturing and certifying new radar altimeter designs on a forward-fit basis is the ultimate goal, but that will take even longer. It will take extensive testing, certification, and time. The U.S. has set the gold standard as the safest aviation system in the

world, and we have incredibly high requirements to keep it that way. Policy is an essential element to maintaining this level of safety, but currently there is no formal requirement for 5G interference tolerance, an incomplete understanding of spurious emissions, and no agreed-upon worst-case interference scenario.

One of the lessons learned in this case is that the effects of spectrum relocation or sharing are not simple. The auction process seeks to address and indemnify in-band users that are being relocated, but the effects of interference on nearby users and the requisite mitigation, as in this case, is not adequately addressed by all regulations.

There will be future generations of technologies and spectrum auctions. We need to modernize the regulatory framework before this happens again. The ultimate goal is to maximize 5G while minimizing disruptions. There will be a gap between the end of the 6-month compromise and when the ultimate solution is identified and implemented.

That means a process must be established to provide ongoing information sharing and dialogue between Government and all private-sector stakeholders, and a process that also helps us avoid finding ourselves in this position again as we contemplate future additions to spectrum.

Thank you to the committee for listening to our perspectives, and I look forward to your questions.

[Mr. Fanning's prepared statement follows:]

Prepared Statement of Hon. Eric Fanning, President and Chief Executive Officer, Aerospace Industries Association

INTRODUCTION

Chairman DeFazio, Chairman Larsen, Ranking Member Sam Graves, Ranking Member Garret Graves, and members of the committee, thank you for inviting me to appear before the Aviation Subcommittee today. My name is Eric Fanning, and I serve as the President and CEO of the Aerospace Industries Association (AIA). For over 100 years, AIA has advocated for America's aerospace and defense (A&D) companies and the more than two million men and women who are the backbone of our industry.

AIA applauds this committee for its ongoing leadership in ensuring 5G in the C-Band will safely coexist with users of the National Airspace System. Chairman DeFazio and Chairman Larsen, we are particularly thankful for your ongoing work to highlight aviation safety concerns about potential 5G interference to multiple federal agencies and the White House as far back as November 2019. Over the past two-plus years, your staff continuously took time to meet with AIA and other members of the coalition to best understand how we can safely deploy 5G. For these things, we are grateful.

OUR INDUSTRY'S ROLE IN PROTECTING AVIATION SAFETY

Today, AIA represents over 300 aerospace and defense (A&D) companies ranging from family-run businesses to larger corporations exporting products around the globe. Our membership includes aircraft and engine manufacturers, companies that design and build radio altimeters and other aircraft systems that are integrated with them, as well as a vital supply chain network of companies that provide equipment, parts, maintenance, repair, and other services. Our members would tell you that our companies are in the safety business. And over the latest 25 years, in partnership with the Federal Aviation Administration, we set the highest safety standards across the globe. We are proud to be considered part of this "gold standard" safety system.

AIA members manufacture fixed-wing and rotary aircraft of all sizes. These aircraft are first-in-class—superior in design and performance. The safety features are extensive, starting in the cockpit, deployed throughout the cabin, found in the engines, and even on the wings. One of the most critical safety features in an aircraft is a radio altimeter, which is the workhorse of the overall integrated safety system. While it is a simple device, it has the most sophisticated of purposes—helping to save lives.

Altimeters help pilots determine a jet's altitude and its distance from other objects. These devices are essential to a number of aircraft functions, including precision approach, landing, ground proximity, and collision avoidance. It is the only sensor that provides this crucial information. All commercial and most general aviation aircraft, as well as many helicopters, use an altimeter. The devices are unique to each aircraft type and model. They are each designed, manufactured, tested, and certified against the most rigorous safety requirements and standards as a single component. They also go through the same stringent process once integrated into a specific aircraft where they are tested and certified as part of a coordinated aviation safety system.

Altimeters are especially important for pilots when dealing with low-visibility conditions and in other situations such as encountering windshear. Because of the rigorous safety standards of the aviation industry and their reliability, radar altimeters are the backbone of an aircraft's overall safety system.

To provide a real-world example of one of many critical instances where radar altimeters are used, consider when an aircraft encounters windshear. Windshear is a weather phenomenon that causes aircraft to experience a rapid decrease in airspeed due to wind flows near the ground. This can be particularly hazardous during takeoff and landing. When encountering a windshear, the pilot flying the aircraft may need to execute a manual escape maneuver, which adjusts pitch to a nose-up altitude and increases engine thrust to full power. It is worth noting that escape maneuvers often happen at low altitudes. The co-pilot or cockpit audible alerts then continuously call out radar altitude to help with decision making as they work to avoid ground contact. Loss of, or erroneous, radar altitude readings during the escape maneuver due to interference would greatly reduce the chances of a successful and safe outcome.

Because of the unique and necessary role altimeters play in aviation, concern arose quickly about possible interference upon deployment of new 5G service in the C-Band from a broad group of stakeholders, ranging from the airlines, commercial pilots, the helicopter and regional airline associations, the manufacturers, and others.

AVIATION INDUSTRY SUPPORT OF 5G

While safety is the cornerstone of our business, the aerospace and defense (A&D) industry is also an ecosystem rooted in technology and innovation. That means our sector needs advanced telecommunication services to include 5G and beyond and supports their rollout. Spectrum is the lifeblood of our industry, and we need safe, reliable, and continuous access to various bands, not just for today's technologies, but also for technologies that will be integrated into our airspace in the future.

Perhaps more than any other industry, the A&D industry knows what it is like to introduce complex technologies into society and is committed to doing it safely. That is why we are confident that 5G in the C-Band and aviation can safely coexist. Over the past several years, our industry's concerns regarding the pending use of 5G in the C-Band have been focused on continued adherence to the highest level of aviation safety. Safety isn't as easy as flipping a switch, so the manufacturers' design and technical expertise must be brought into play. Again, I want to reiterate that you can't just provide a band-aid solution to assure gold-standard safety, which is defined as the chance of one catastrophic incident in one billion flight hours. We will continue to offer industry expertise to our government partners and airline or general aviation customers to help mitigate any possible interference.

HOW DID WE GET HERE?

While we would all like to focus our efforts on continuing to make progress toward a safe and comprehensive resolution, examining how we arrived at this hearing is important for policymakers, the public, and the organizations involved in this issue.

In 2018, the FCC released the first Public Notice expressing its intent to auction spectrum in the 3.7–4.2 GHz band (or C-Band). Consequently, AIA submitted comments to the FCC highlighting the potential inference to aeronautical communications and safety services, including radio altimeters, operating in the 4.2–4.4 GHz band. Over the last four years, AIA and our colleagues across the aviation industry

have worked diligently to provide the FCC, FAA, National Telecommunications and Information Administration (NTIA), Department of Defense (DoD), the White House, and Members of Congress with as much data as possible on the potential for interference.

Additionally, with the FCC's encouragement, the Radio Technical Commission for Aeronautics (RTCA) studied this issue. While the telecommunications industry was invited to participate in the analysis, it chose not to do so. In October 2020, RTCA concluded that 5G systems operating in the C-Band would likely cause interference with altimeters. Shortly thereafter, in December 2020, the Acting Deputy Secretary of Transportation and the FAA Administrator wrote to the NTIA expressing safety concerns over the planned auction and asking that it be deferred.[1] According to the Wall Street Journal,[2] this letter did not receive broad attention because it was not made public in the NTIA regulatory docket.

One of the key arguments against the aviation industry's concern is that 5G technology has been deployed in other countries around the world without causing harm to public and aviation safety. However, conditions are different in the United States due to three important factors: power levels, proximity to airports, and orientation of base towers.

The U.S. aviation system is incredibly complex. It's not nearly as simple as adopting another country's safety playbook for many reasons, such as orientation of the base tower and differing maximum power levels. The deployment examples from other countries come with specific government-mandated restrictions, lower power levels, and different technical features that must be considered in making any comparison between the U.S. and overseas 5G deployment. Here are some specific examples which make the American deployment of 5G in the 3.7–4.2 GHz range different:

- *Japan*: While Japan has deployed 5G up to 4.1 GHz, the power levels permitted for 5G are at least 90% below those permitted in the United States. If 5G providers in the United States operated 5G with this mitigation, then the issue with aviation users would be reduced.
- *Europe*: The 3.4–3.8 GHz band is utilized for 5G. However, the amount of separation from adjacent bands is 100 MHz farther than authorized in the United States, meaning that interference is less likely to occur, and the maximum power level permitted in most of Europe is well below the level permitted in the United States.
- *France*: Regulators in France imposed mitigations on the use of 5G—exclusion zones—to protect public safety. This type of mitigation is consistent with recommendations made to the FCC by the aviation industry.
- *Australia*: Compared to Europe, Australia operates even farther away from the radio frequency band used by the radio altimeter. In addition, the power levels permitted in Australia are 76% lower than that allowed in the United States.

The A & D industry believes in the incredible potential of 5G for our country and our companies, and we are committed to find ways to ensure that 5G in the C-Band and aviation can safely coexist. For this reason, in 2018 we called for a collaborative environment for the aviation industry and the telecommunications industry to share information. Our goal was to provide both the FAA and FCC with necessary data to address potential interference and, in turn, come to a long-term mutually agreeable solution that addressed the needs and concerns of all parties. Unfortunately, that collaboration did not begin until December 2021, the same month FCC licenses allowed 5G services to begin.

In July 2021, the FAA met with AIA and the aviation industry and we expressed a need for information from the telecommunications industry including details such as 5G tower locations, antenna angles, and power levels. AIA subsequently joined a letter of 20 aviation associations and aerospace companies to the Department of Transportation and Department of Commerce requesting support from the Administration to facilitate interagency coordination and information sharing between the aviation and telecommunications industries.[3] In November 2021, the National Economic Council (NEC) began discussions with both respective industries and the deployment of 5G in the C-Band was delayed by one month to January 5, 2022.

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[1] Letter to National Telecommunications and Information Administration re: "Expanding Flexible Use of the 3.7 to 4.2 GHz Band", December 1, 2020, signed by Steven G. Bradbury, Acting Deputy Secretary and General Counsel, U. S. Department of Transportation and Steve Dickson, Administrator, Federal Aviation Administration.

[2] "*Agencies Feud Over Aviation Safety, 5G Rollout*", Wall Street Journal, November 15, 2021.

[3] Aviation industry stakeholder letter to Transportation Secretary Pete Buttigieg and Commerce Secretary Gina Raimondo, July 14, 2021.

Between December 2021 and the beginning of this year, aviation engineers and technical experts worked tirelessly to collaborate and examine the consequences of interference. We are grateful Verizon and AT&T agreed to another delay on January 3, 2022, until January 19, 2022, as we began to receive the FAA's Notice to Air Missions (NOTAMs) and manufacturers could empirically analyze the impact to specific aircraft and their radio altimeter models and ultimately propose Alternative Means of Compliance (AMOCs).

Thanks to strong communication and cooperation among the government and the aviation and telecommunication industry, significant progress has been made over the past few weeks. The intervention of this Committee, along with that of the NEC, the DOT, and the FAA has been a catalyst for bringing the different stakeholders together. Since the January 3rd agreement was signed, AT&T and Verizon have been working with aviation manufacturers daily—sharing data and developing additional mitigations to allow most commercial flights to take off and land safely. Fortunately, the telecommunications companies agreed to delay full deployment on January 18, 2022. While the process is belatedly making significant positive progress, there is more work to be done for 5G to deploy safely.

While the FAA is currently working with the manufacturers, airlines, and the telecommunications companies, and progress is being made, it is important to note this is not the same as declaring the problem solved. What matters most is the percentage of overall U. S. aviation operations that are affected because they do not have an appropriate temporary approval from the FAA as reflected in an Alternative Means of Compliance (AMOC). Delays are still occurring, and AMOCs have not yet been approved for most regional airline operations, general aviation aircraft, or most helicopter operations.

As this subcommittee knows well, our aviation system is a complex network of airports in small and mid-sized communities as well as big cities. FAA's 2021 National Plan of Integrated Airport Systems lists 3,300 active airports in the United States. Many of these airports in small communities depend heavily on aviation because of remoteness or other factors. We need to ensure that all airports can maintain their operations, not just the large ones, as the 5G rollout continues. Furthermore, we will need to ensure the same agreements are in place as additional licensees deploy their systems. It is clear there is much more to be done over the coming months.

While we wish intergovernmental coordination had been stronger and given more credence to the views of aviation experts and regulators, our industry needs 5G services and is committed to seeing their rollout, while preserving the highest levels of aviation safety at the same time. The aviation industry has the most knowledgeable and accomplished engineers, pilots, systems operators, and avionics experts in the world. Moving forward, it is our hope that their expertise on the complex science of machines in flight is given deference and greater weight as the NTIA and FCC continue their difficult job of deciding how to effectively utilize limited radio-frequency spectrum.

We are glad to be making progress and working together, but by no means are we on a glide path. With many outstanding questions still on the table, there are disruptions in our future, even with further compromise and collaboration.

WHAT CAN THIS COMMITTEE DO?

The United States has set the gold standard as the safest aviation system in the world, and we have incredibly high requirements to keep it that way. But currently, there is no formal requirement for 5G interference tolerance, an incomplete understanding of spurious emissions, and no agreed-upon worst case interference scenario. Based on where we are today, the development of new standards, including the implementation of minimum performance standards via Technical Service Orders (TSOs), will take considerable time. Because of this, a proposal to retrofit out-of-band filters or other solutions cannot be accomplished overnight. Manufacturing and certifying new radar altimeter designs on a forward-fit basis is the ultimate goal, but that will take even longer. In fact, it will take testing and take time.

One of the lessons learned in this case is that the effects of spectrum relocation or sharing are not simple or clear-cut. The auction process seeks to address and indemnify in-band users that are being relocated to make room for new purchasers, whether 5G or other licensees. However, the effects of interference on nearby users and the requisite mitigation—as in this case—is not adequately addressed by the regulations governing spectrum allocation and auction. Aviation is left with the task of financing these fixes, over both the short- and long-term, and it is not clear whether auction proceeds are available for this purpose. We believe that needs to be considered.

Finally, we hope Congress will consider changes to the spectrum auction process to consider the views of the government's aviation safety experts more appropriately in the DOT and the FAA. Just three months ago, Congress provided the DoD and the Congressional Armed Services Committees with additional authorities in future spectrum actions affecting the 3.1 to 3.45 GHz band in H.R. 3684, the Infrastructure Investment and Jobs Act. This provision was designed to ensure this potential auction does not cause DoD the same kind of problems we are now experiencing in aviation, and ensures the appropriate Congressional committees are involved early in the process. Our aviation system is too important to our economy, and too vital to our small, rural communities, to face mass groundings again in the future. We urge this Committee and the Congress to explore similar authorities for the DOT, to ensure that the coordination with this committee, and the role of our government's aviation authorities, are strengthened in future spectrum decisions.

We are not out of the woods yet and some disruptions are likely. The process will take a while because the stakes are so high. We are hopeful we can anticipate and address challenges or concerns earlier in the future. We know that the telecommunications industry carriers will continue to innovate, as will aviation. Spectrum is the lifeblood of our industry, and we need safe, reliable, and continuous access to various bands, not just for today's technologies, but also for technologies that will be integrated into our airspace in the future.

Thank you, and I look forward to your questions.

Mr. LARSEN. Thank you very much, Mr. Fanning.

For the introduction of Ms. Stephens, I turn to the chair of the full committee, Chair DeFazio.

Mr. DEFAZIO. Thank you, Mr. Chairman. Yes. Thank you for the opportunity to introduce the next witness, Cathryn Stephens. She is the airport director in Eugene, Oregon, and she will offer both the perspective of an airport that does have a lot of low-visibility issues in the wintertime.

In fact, many, many years ago, I had to kind of strong-arm the FAA to get a CAT II system because they said we didn't have enough flights, but we had more diversions and cancellations than almost any other airport that I could find, so they relented, and we got it. But if we couldn't use it, we would be back to those days of people ending up in Portland and driving down on a bus. So, that is not acceptable.

She is a recognized leader in the city of Eugene, largest city in my district. She was named airport manager of the year by the Oregon Airport Management Association. She is a director for the AAAE and chairs the association's Diversity, Equity, and Inclusion Committee. She has done a lot for inclusion and innovation broadly across the airport community, not just for my airport. And she was helpful also to the committee as we work through coronavirus relief and the IIJA, Infrastructure Investment and Jobs Act, and highlighting as she will, perhaps today a bit, the 5G issues in transitioning our airport, and I appreciate her taking the time to be here today.

Thanks, Cathryn.

Ms. STEPHENS. Thank you so much for that introduction, Chairman DeFazio.

Mr. LARSEN. You are recognized for 5 minutes.

Ms. STEPHENS. Thank you. Chair DeFazio, Ranking Member Graves, Chair Larsen, Ranking Member Graves, and members of the subcommittee, thank you for the invitation and for your continued leadership on issues of importance to airports and the aviation industry.

I am testifying today on behalf of the American Association of Airport Executives where I am a member of the board of directors. I currently serve as airport director at the Eugene Airport, and I would like to briefly express my personal appreciation to Chair DeFazio, my hometown Congressman, who has done so much for our community and for airports and the aviation industry during his distinguished career.

Thank you, Chair DeFazio.

Getting it right with the continued rollout of 5G and subsequent enhanced telecommunication services is imperative for airports in every segment of the highly interdependent aviation system. As the deployment continues, it must be done in a way that does not jeopardize aviation safety or significantly limit operations during low-visibility conditions.

Delays, diversions, flight cancellations, and the grounding of aircrafts during low-visibility events, all of which remain possible as the 5G C-band rollout continues, aren't just an inconvenience, they ripple across the country and the globe quickly with significant negative impacts.

Airports are on the front line of dealing with the fallout when disruptions occur, yet we haven't had much involvement in the 5G C-band deployment to this point or insight as to what the path will be moving forward, and that must change moving forward.

At the Eugene Airport, for example, there are currently low-visibility flight limitations related to the 5G C-band deployment, even though Eugene is not one of the initial 46 markets in which these services are being offered.

We were surprised and concerned to learn of these limitations which posed significant challenges at EUG and flight disruptions for our passengers. To give you a sense of the magnitude of the issue, if the FAA's flight restrictions had been in place in 2021, there would have been about 90 low-visibility days impacting up to 40 percent of our flights per day.

More broadly, it is positive that the immediate systemwide crisis we all feared with the initial deployment on January 19th has been averted. We commend AT&T and Verizon for their voluntary actions to establish deployment buffer zones at affected airports, and we appreciate the FAA's diligence to clear more than 90 percent of the U.S. commercial fleet to operate into affected airports in certain low-visibility situations as part of the AMOC process.

Unfortunately, these fixes are both limited and temporary. We understand that the buffer zones where 5G C-band signals have been limited since January 19th around more than 80 affected airports are shifting short term and remain in effect only because of the good graces of the telecommunications companies.

We further understand that the FAA's AMOCs for aircraft will be subject to constant review, refinement, and alteration potentially. Additionally, there are still some regional aircraft that are not yet approved to fly during low-visibility conditions, including at the Eugene Airport.

While only a small percentage of the fleet, these aircraft provide critical air service to many small communities. The recent cancellations at Paine Field, which appear to be resolved at least for now using the newly approved AMOCs, illustrate the painful impact

that can be felt at smaller airports when key aircraft are prohibited from operating. Over the past few weeks, airports have seen cancellations, diversions, and other impacts resulting from the inability of aircraft to operate at affected airports in low-visibility conditions.

Problems at spoke airports aren't just a local problem, they cascade and create disruptions, hassles, and problems throughout the system. So, how do we move forward? First, we need a permanent solution that provides long-term certainties at airlines, airports, passengers, and all segments of the industry. Not knowing long term what aircraft can fly where, under what conditions, is a serious problem for an industry that requires certainty for scheduling and planning.

We also need better communication from our Federal partners and additional data and information sharing, transparency, and aviation industry involvement. The lack of insight into the location of 5G towers that could impact operations at individual airports is incredibly frustrating. With better information and more active involvement, airports and our aviation industry partners could be proactive in preparing rather than reactive as we have been forced to be in recent weeks.

In closing, I would summarize by saying that the temporary reprieve of recent weeks has been positive, but airports have significant concerns about what lies ahead. We need a permanent solution that acknowledges the benefits of 5G services while also addressing the critical need for our Nation's aviation system to function 24 hours a day, 365 days a year, and in low-visibility conditions. AAAE stands ready to work with our Government and industry partners to address these critical needs.

Thank you, and I look forward to your questions.

[Ms. Stephens' prepared statement follows:]

Prepared Statement of Cathryn Stephens, A.A.E., Airport Director, Eugene Airport, on behalf of the American Association of Airport Executives

Chair DeFazio, Ranking Member Graves, Chair Larsen, Ranking Member Graves, and members of the subcommittee, thank you for the opportunity to appear before you today to highlight airport industry concerns and the perspective of an individual airport operator on the effects of 5G C-Band deployment on the nation's aviation system.

My name is Cathryn Stephens, and I am the Airport Director for the Eugene Airport (EUG) in Eugene, Oregon. I am testifying today on behalf of the American Association of Airport Executives (AAAE), where I serve on the Board of Directors. AAAE is the world's largest professional organization representing individuals who manage and operate more than 850 public-use commercial and general aviation airports across the country.

As you have clearly recognized in putting together today's hearing, getting it "right" when it comes to the continued rollout of 5G and other critical telecommunication services in the months and years ahead is imperative for the continued safe and efficient operation of the nation's highly interdependent aviation system. The fact that you have gathered witnesses representing airports, mainline carriers, regional carriers, manufacturers, helicopter operators, and pilots speaks to the importance of this issue across the aviation industry.

As has been widely reported, progress has been made in recent weeks to mitigate the immediate impacts of the 5G C-Band rollout on the aviation system and to prevent potential interference with aircraft operations that could have resulted in a significant safety hazard. The voluntary action taken by Verizon and AT&T on January 18 in advance of the January 19 rollout and the subsequent work by the Federal

Aviation Administration to clear a large percentage of the U.S. commercial aircraft fleet to conduct low-visibility operations into affected airports are notable.

Still, questions and concerns remain about what the days, weeks, months, and years ahead will mean as the situation evolves and as the deployment of 5G continues in communities across the country. Already, some airports—including Paine Field in Washington State—have seen significant flight cancellations during low-visibility events because of limitations placed on specific aircraft that routinely operate at their facilities. Other airports are seeing flight delays and diversions due to similar aircraft limitations as bad weather impacts operations at nearby airports. The list of affected airports could grow as more low-visibility events occur.

Disruptions, diversions, flight cancellations, and the grounding of aircraft during low-visibility events—all of which hang over our industry and our passengers as a real possibility as the 5G C-Band rollout continues—aren't just an inconvenience, they ripple across the country and the globe quickly with significant, negative impacts on passengers, airports, communities, businesses, our supply chain, and the economy.

While we are grateful for the measures that have been put in place to partially address immediate concerns—and commend AT&T and Verizon for their voluntary actions to date—we need to be clear: the temporary and partial fixes that have been in place to this point simply aren't acceptable in the long-term. We need a *permanent* solution that acknowledges the importance of 5G services to consumers, businesses, the economy, and national security and the significant investments by telecommunications providers while also addressing the critical need for our nation's aviation system to function 24 hours a day, 365 days a year, in low-visibility conditions.

We also need better communication from our federal partners and *additional data and information sharing, transparency, and aviation industry involvement* to understand exactly where we are with 5G deployment and where we are headed.

It's incredibly frustrating to me and my airport colleagues, for example, to not have insight into the location of 5G towers that could impact operations at our facilities and to lack information and certainty on what aircraft will be able to serve our airports under what circumstances in the future as 5G deployment continues. Uncertainty is a major problem in the aviation industry. Unfortunately, we find ourselves awash in uncertainty at the present time.

Airports and our aviation industry partners need more insight and involvement on the path ahead so that we can be *proactive* in preparing rather than *reactive* as we have been forced to be in recent weeks. All airports—including those not immediately impacted by the initial January 19 rollout—must prepare for and deal with potential delays, diversions, cancellations, and other impacts, but we lack the information, insight, and involvement to do so effectively. That must change moving forward.

THE EUGENE PERSPECTIVE: UNCERTAINTY, QUESTIONS, AND POTENTIAL OPERATIONAL IMPACTS

The challenges, frustrations, questions, uncertainty, and potential operational impacts for affected airports are readily apparent at Eugene. Despite being outside of the 46 Partial Economic Areas (PEAs) where 5G C-Band was deployed on January 19, EUG and a handful of other airports outside of the initial PEAs have been subject to Instrument Approach Procedure (IAP) Notice to Air Missions (NOTAMs), which significantly limit aircraft operations during low-visibility conditions—conditions that can be routine in our area. These NOTAMs were issued by the FAA to identify the airport IAPs affected by 5G C-Band interference and prohibited for use by the U.S. commercial fleet through an FAA airworthiness directive.

At EUG and the 87 other airports with similar IAP NOTAMS related to 5G deployment, no operations can occur in low-visibility conditions unless the FAA has granted the aircraft manufacturer an Alternative Means of Compliance (AMOC), which allows specific aircraft to fly into specific airports under specific conditions. Unfortunately, we have no insight into the conditions specified or the ability to review them as they are provided only to the manufacturer that holds the AMOC. The FAA does not make those approvals publicly available.

While it is positive that the FAA has reviewed and approved AMOCs on an expedited basis to cover at least 90 percent of the U.S. commercial aircraft fleet, we are not yet at the point where all aircraft previously serving my airport and others can continue to operate in low-visibility conditions. The continued inability for certain aircraft to operate during low-visibility conditions poses a particular problem for airports that may only receive service or that receive the vast majority of service from those aircraft.

Unfortunately, we do not know whether or when all aircraft that previously served my airport can continue to operate in low-visibility conditions now or in the future. The FAA has already acknowledged that some altimeters will have to be retrofitted or replaced based on existing data. As altimeters that are unable to function properly in a 5G C-Band environment are identified, those aircraft will presumably be taken out of service until the altimeters can be upgraded, which will cause further impact on my airport and others.

As I understand it, the recent cancellations at Paine Field offer an example of how unique and limited some of the recent fixes are. When fog rolled in and visibility became limited, one of the main aircraft serving the airport was effectively banned from operating, forcing the carrier to cancel all flights in and out of the airport. For smaller airports, including mine, where regional flights on smaller jets are common, we can't afford to simply shut down when the weather turns bad. As I mentioned previously, given the interdependent nature of the aviation system, problems at "spoke" airports aren't just a local problem, they cascade and create disruptions, hassles, and problems throughout the system.

The potential for significant disruptions is apparent at my airport. If the FAA's flight restrictions had been in place in 2021, conservatively there would have been about 90 low-visibility days impacting up to 40 percent of our flights per day. We would have projected similar disruptions this year without the issuance of the AMOCs. But with those AMOCs under monthly review and anticipating additional disruptions as the next rounds of 5G C-Band rollout, we know there will be additional disruptions if no action is taken to immediately and safely return additional regional aircraft to service.

EUG operates under low visibility conditions frequently during the winter months. For airport operations we utilize a ground control protocol, called the surface movement guidance control system or SMCGS, about 50 percent of winter days, usually lasting an average of about three hours.

During low-visibility conditions, our airline partners utilize the CAT II/CAT III Instrument Landing System (ILS CAT II/III) on the field to land with visibility down to as low as 300 feet.

Before the ILS CAT II/III system was installed 17 years ago, fog impacted air service reliability at EUG, and frequent delays and cancellations literally drove our local passengers two hours away to Portland International Airport. With the current ILS, our local passengers were finally able to stay off the freeway and fly local with confidence.

Unrestricted utilization of the ILS CAT II/III approach by the U.S. commercial fleet is critical for safe and functional commercial air service at EUG, as well as the rest of the airport system where our flights connect.

WHAT'S NEXT?—QUESTIONS AND RECOMMENDATIONS

The recent positive developments related to the initial 5G C-Band deployment have been welcome news to protect the safety of the National Airspace System and avoid major disruptions to our air transportation system. However, they may be a temporary reprieve and only made possible by the good graces of AT&T and Verizon. Lingering questions must be answered, and action must be taken to ensure that the remaining underlying issues are addressed and fixed permanently. Our questions at this point, include:

- Does the FAA anticipate that *all* aircraft that were previously allowed to operate in low-visibility conditions at affected airports will eventually be able to operate again?
- If so, what is the timeline for gaining AMOCs for these aircraft?
- If not, what percentage of the fleet could be rendered inoperable under low-visibility conditions at affected airports? Will those aircraft need to have their altimeters upgraded and what kind of impact will that have on our aviation system?
- Why did the FAA issue NOTAMs and restrict some operations from occurring at some airports outside of the 46 PEAs? Were the telecommunications companies authorized to have their 5G C-Band network deployed in areas outside of the 46 PEAs?
- How long are AT&T and Verizon willing to keep the buffer zones—areas around runways where the companies agreed not to activate 5G towers—that helped limit the impacts of 5G C-Band deployment at affected airports?
- How many 5G towers exist within these buffer zones and how are these towers affecting operations at our airports?
- By what criteria is the FAA evaluating and approving AMOCs for specific aircraft to operate at specific airports under certain conditions? For example, how

did the FAA determine that a buffer zone was necessary to ensure that low-visibility operations could continue at affected airports?
- How can airports—and other stakeholders that are unable to review AMOCs—easily determine what aircraft have been approved by the FAA to service what runways at what airports and under what conditions?
- If or when the telecommunication companies decide to remove or narrow the buffer zones, potentially on July 5, what airports would be impacted and how would the FAA proceed to mitigate those impacts?
- What efforts is FAA engaged in to determine if low-visibility operations could occur at affected airports within a smaller buffer zone? What is the FAA doing to mitigate the operational impact at those airports?
- How will the FAA ensure that similar operational impacts do not occur when the 5G C-Band network is deployed in the rest of the country in December 2023?

Answers to these and other questions raised by the industry along with additional transparency and data and information sharing are critical for airport operators and the aviation industry. Again, we need to be proactive in preparing for what comes next rather than reactive. In a recent letter to the FAA and FCC leadership, AAAE made the following, specific recommendations for a long-term solution:
- Creating narrowly tailored and sufficiently sized "buffer zones" around runways at *all affected airports* where the 5G C-Band will be deployed to ensure continued operations in low-visibility situations.
- Providing substantially more transparency into the scope of operational impacts that are expected to occur at individual airports to enable them to better prepare for and manage disruptions. We believe this can best be accomplished through the implementation of permanent data sharing mechanisms between the telecommunications companies, FAA, airports, and the aviation industry. To that end, we believe the establishment of a high-level working group to include airports merits serious consideration.
- Canceling, or providing substantial justification for, the IAP NOTAMs that were issued for airports that are located *outside* of the 46 markets where Verizon and AT&T have been authorized to deploy the 5G C-Band base stations.

In closing, I do not want to downplay the significant actions that have been undertaken in recent days by AT&T and Verizon or the FAA. What looked to be a potential crisis for 88 airports across the country, including EUG, beginning on January 19 has been averted largely, and we are learning every day of additional aircraft cleared to fly into affected airports.

Unfortunately, pockets of pain persist, and it is clear that the reprieve may be temporary and dependent on the willingness of the telecoms to operate in a limited fashion in some areas. As the situation evolves, continued vigilance is required from Congress, the FAA and DOT, the White House, telecommunication companies, and the entire aviation industry. AAAE stands ready to work with the government and our industry partners to address these critical needs.

I am grateful for the opportunity to provide the views of the airport community on how we can minimize operational impacts moving forward and appreciate your attention to this issue. Thank you for your consideration and the opportunity to testify.

Mr. LARSEN. Thank you very much, Ms. Stephens.

The Chair now recognizes Captain DePete for 5 minutes.

Mr. DEPETE. Thank you, Chairman DeFazio and Ranking Member Graves, Chairman Larsen and Ranking Member Graves, and the subcommittee members. I am Captain Joe DePete, president of the Air Line Pilots Association, International, which represents more than 62,000 U.S. and Canadian pilots.

For airline pilots, safety is nonnegotiable. It is not about politics or profit. For this reason, it was an affront to us when the Federal Communications Commission, the FCC, licensed part of the C-band spectrum to the telecom sector without heeding or even acknowledging our concerns about aviation safety.

This situation shows that the FCC's stovepiped approach threatens safety and is also forcing pilots to conduct extensive workarounds for the foreseeable future. This is no way to run a railroad,

and it is certainly no way to operate the world's safest air transportation system.

So, thank you, Mr. Chairman, for holding this hearing. We would also thank Chairman DeFazio and committee members for voicing concern for aviation safety in the new 5G rollout.

Your leadership, along with that of Transportation Secretary Buttigieg and FAA Administrator Dickson, forced telecom companies to delay implementation until risks are addressed.

As early as 2018, ALPA took issue with the 5G deployment plans. We urge the FCC and telecom companies to share the data to identify potential risk. We contacted the FCC Chair and Commissioners, but they ignored our concerns and instead ceded to those with an $80 billion interest in a quick launch.

Radar altimeters use radio waves to calculate how high the aircraft is above the terrain. Pilots and onboard safety systems use this data to navigate flights, especially during approach and landing in poor conditions.

We have already seen the effects of the new 5G service at locations like Paine Field in Everett, Washington, and ALPA is sharing with the FAA all reports of interference. Deploying the new service in the United States held challenges. FCC authorized 5G signals here transmit using antennas aimed at the horizon and at higher power levels and closer to airports than anywhere else on the planet. For example, France approved 5G with antennas aimed below the horizon at one-third the transmission power and with runway safety areas two and a half times larger than those in the United States.

For pilots, new 5G service injects more complexity and more risk into already complex flight operations. We must now analyze how 5G regulatory directives affect departure, arrival, and alternative airports. The increased pilot workload reinforces the importance of having at least two qualified, trained, and rested pilots on every flight deck.

The U.S. air transportation system is the world's safest. If another industry seeks to introduce risk into the system, the burden should be on that industry to prove its actions won't degrade aviation safety. The launch of the new 5G service caused an avoidable crisis. The process must be reformed so that the United States can continue to be a world stage competitor in 5G and set the global standard in aviation safety.

So, what can we do? We need action to fund and charge the FAA with staying informed and included in national spectrum strategies. We need to require the FCC to share publicly the new service transmitting data when issuing new or revising an existing license. We need to require the FCC to collaborate with and defer to U.S. Government agencies charged with safety oversight. We need to grant the FAA authority to reject new or expanded FCC spectrum applications that affect aviation until safety can be ensured. And finally, we need to require the FAA to share information on approved alternative methods of compliance.

Airline pilots, as the arbiters of safety, are trained for life to decide when every flight is safe. However, the U.S. Government must do more to safeguard air transportation as 5G service expands, and ALPA pilots are more than ready to assist.

Thank you very much.
[Mr. DePete's prepared statement follows:]

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

Chairman DeFazio and Ranking Member Graves, my name is Captain Joe DePete, and I am the president of the Air Line Pilots Association, Int'l (ALPA). I am proud to say that I represent 62,000 pilots flying for 38 airlines in the United States and Canada. The airline pilots flying the line today are literally on the front lines of aviation safety, working in very challenging circumstances that have been created by the deployment of 5G mobile wireless in the C-Band of radio spectrum.

For ALPA pilots, safety is nonnegotiable. It's not about politics or profit. On every flight, our customers—including members of this committee—entrust us with their lives and livelihoods. For that reason, it was an affront to airline pilots when the Federal Communications Commission (FCC) sold and licensed a section of the C-Band spectrum to wireless companies without heeding—or even acknowledging—our concerns about potential interference with the radar altimeters we use to safely navigate our aircraft. Their stove-piped policymaking process and single-minded focus on doing the bidding of the telecom industry not only put the public at risk, but it has also forced pilots to perform extensive workarounds to ensure the safety of flight—workarounds that we expect will be needed for the foreseeable future.

This is no way to run a railroad, and it's certainly no way to operate the world's safest air transportation system.

We have been tracking the potential interference that mobile wireless transmissions in the C-Band could have on aircraft radar altimeters for years. Our first written submission to the FCC docket was on May 29, 2018, less than 30 days after the FCC opened the docket for comments. At that time, ALPA expressed concerns about the proposal and encouraged the FCC to work with the Federal Aviation Administration (FAA) and aviation industry representatives to mitigate the potential interference concerns. Radar altimeters are the only sensor onboard a civil aircraft which provides a direct measurement of the clearance height of the aircraft over the terrain or other obstacles. In addition to pilots' use of radar altimeters during a flight, many other aircraft systems utilize the data they generate, to properly function.

The situation we find ourselves in has taken the complexity of an already intricate operation to a new level. The current system of preflight planning and dispatch of an airline flight—which already includes fuel planning; review, minimum equipment list, and status of all aircraft systems; review of weather at departure point; monitoring weather and systems en route; and monitoring weather at the destination airport while planning for contingencies along the way—now includes additional risk. Flight crews are now expected to know the type of radar altimeter the aircraft is equipped with, applicable airworthiness directives, whether that airframe/altimeter combination has been issued an alternate method of compliance (AMOC) for the intended destination airport and runway, and whether the alternate airport is still legal. This added complexity reinforces what everyone in this room knows: The most important safety feature on every airline flight is two highly experienced, well trained, and rested pilots on the flight deck.

Anyone who believes that this process can be automated, flight deck crew reduced, or required experience levels shortened seriously needs to go on the line and attempt this operation for themselves.

Two full weeks of 5G interference with radar altimeters have gone by. Incidents of radar altimeter anomalies have occurred. Pilots operating in today's 5G-induced chaos have had significant burdens added to each and every workday. Meanwhile, flights have been canceled and delayed, costing families money while introducing unwelcome delays in the supply chain for businesses large and small. Here are some of the new steps and considerations that each pilot faces when they go fly.

NOTICES TO AIR MISSIONS

Pilots must review Notices to Air Missions (NOTAMs) published by the Federal Aviation Administration (FAA) to understand how each flight they make is affected by 5G interference with their radar altimeters. Frequently, the print-out for all the NOTAMs on a domestic flight between two large cities can be many pages, discussing items such as unlit obstructions, changes to procedures, taxiway closures, and other important flight data. Some of this data is static and does not change.

The 1,851 5G-related NOTAMs that were published by the FAA are unique in that the NOTAMs change with the ongoing 5G deployment. This requires pilots to find and then carefully review them each time, even if they have seen them before. There may be differences for this flight than what they flew to the same airport, even if it was yesterday.

AIRWORTHINESS LIMITATIONS ON THE AIRCRAFT—AIRWORTHINESS DIRECTIVES AND AMOCS

Pilots are now required to know and follow the details regarding 5G's effects on aircraft airworthiness. Every aircraft has a new limitation due to 5G. An airworthiness directive (AD) published by the FAA in December 2021 limits aircraft approach and landing operations during periods of low clouds and visibility when NOTAMs are published for 5G interference. However, the FAA has subsequently approved alternate methods of compliance that provide relief from the 5G AD for certain aircraft types and radar altimeter combinations. Pilots now need to evaluate the aircraft to determine which of two 5G airworthiness scenarios applies each time they are dispatched an aircraft to fly.

If the aircraft is operated with reduced capabilities as described in an AD and activated by the 5G interference NOTAMs, pilots must plan accordingly. The AD mandates changes to the minimum weather conditions acceptable for landing. The AD requires the evaluation of weather conditions at the departure, destination, and alternate airports and makes sure that they can safely conduct the flight with the reduced capabilities as stipulated in the AD. The AD requires pilots to continuously monitor weather conditions while en route to the destination and alternate airport weather more closely, so that if the need to divert arises, they can select a diversion airport that has weather conditions suitable for the aircraft capabilities.

If the aircraft is operated with fewer or no restrictions because the aircraft has an approved AMOC for 5G, pilots must study the AMOC that applies to their aircraft carefully. They will need to verify that the AMOC can be applied at the airports and anticipated runways for their flight. In some cases, the AMOC applies to the departure but not the destination (or vice versa). Other possible situations are where the AMOC can be used at an alternate airport where a 5G NOTAM is published, but otherwise the flight can be conducted normally because neither departure or arrival is a 5G impacted airport.

The complexity of the situation gets worse because the FAA has issued some AMOCs that approve low-weather operations only to specific runways at certain airports. Therefore, when low-visibility conditions exist, the pilot will need to plan ahead and be sure to only utilize the runways allowed by the AMOC. When needing to access the "approved runway for the AMOC," the flight crew will need to coordinate with air traffic control, which adds to both pilot and controller workload.

The AMOC is valid for 30 days, so the list of airports and runways that an aircraft is allowed to apply the AMOC to will change frequently. It is possible that an aircraft with an approved AMOC today, may no longer be approved the next time a pilot is assigned to that aircraft. In addition, if a pilot is rated to fly multiple types with one Type Rating, such as multiple models of the Boeing 737 or the common type among the Airbus 319/320/321 and/or if the airline has multiple makes or models of radar altimeters installed, they will also need to stay on top of the AMOC approvals for the specific aircraft they will be flying.

Finally, as the FAA has stated, some aircraft may never be able to receive an AMOC due to the installed performance of the radar altimeter on the aircraft.

ADDITIONAL LIMITATIONS NOT COVERED BY ADS OR AMOC

Some aircraft manufacturers have added additional guidance and revised certain flight deck procedures that need to be followed at airports where there is a 5G NOTAM. This is above and beyond the AD from the FAA. This means that, even on a sunny, cloudless day, the aircraft manufacturers have modified aircraft flight manuals for operating in the United States 5G environment. The pilot must now review these additional or revised procedures prior to flight and implement them when operating to or from the 5G airport.

SELECTING ALTERNATE AIRPORTS AND PREFLIGHT PLANNING

Even more than usual, the pilot must also work very closely with airline dispatchers to ensure that alternate airports are still viable given the forecast weather and aircraft's 5G limitations. If the likelihood for poor weather is high, then the pilot and dispatcher will need to decide which alternate airport is less likely to be impacted by weather based on forecast conditions hours into the future. For some

flights, there are multiple alternate airports. Once the flight plan, with alternate airport selection is finalized, pilots will then need to evaluate the fuel required for the flight, with the necessary reserves. In some cases, pilots may need to add more fuel to account for weather forecasts or other unanticipated delays created by the 5G situation, thereby making the flight more expensive to operate and increasing our carbon footprint.

MONITORING AND ADDRESSING RADAR ALTIMETER ISSUES IN-FLIGHT

The 5G deployment has also added to a pilot's in-flight workload. There is now the potential for weather to wreak havoc with the flight. For example, low clouds or low visibilities at the destination airport will more frequently force decisions to divert to the alternate airport. If the low clouds and low visibilities "go up and down" over the course of several hours, then pilots may need to enter a holding pattern in hopes that the weather will improve to acceptable conditions for landing. Or, as discussed above, they will need to coordinate with air traffic control for a specific runway that is approved as part of their AMOC. All of these scenarios add workload and complexities that flight crews now need to work through.

Pilots must also be prepared for in-flight 5G interference to result in a radar altimeter failure on the flight deck. When that happens, there may be additional failure alerts or changes in aircraft system behavior as critical safety systems are affected by unreliable radar altimeter altitude information. For example, the Traffic Alert and Collision Avoidance System (TCAS) changes its alerting behavior based on radar altitude.

Pilots will need to plan for the fact that certain systems may be unavailable in the arrival, approach, and landing phase of the flight. Although pilots pay close attention to the aircraft's operation, degraded safety systems such as terrain avoidance, certain collision warning features, and the automatic deployment of spoilers and reverse thrust are unwelcome changes in the aircraft's capabilities. The loss of these systems eliminates safety features, thereby adding risk.

If this all seems complicated—that's because it is. And to think that airline pilots may do this multiple times per day while changing aircraft resulting in new AMOCs and NOTAMs to consider is daunting and adds risk. It is not an understatement to say that every airline pilot flying in America's airspace system today has the additional burden of reading, understanding, and making contingency plans based on a full understanding of all the above for each and every flight.

What I've described above is a summary of what pilots face today. While some airlines have provided pilots with information and tools to help navigate the 5G situation, other airlines have provided only a minimal amount of guidance. It appears that the FAA might need to spend a bit more time ensuring that all operators are stepping up to consistently provide accurate data to flight crews. We are monitoring this situation very closely and listening to our pilots who are navigating this difficult situation.

ACTION NEEDED GOING FORWARD

ALPA appreciates the productive technical discussions between the aviation industry and the wireless industry that began in early January. The discussions allowed the FAA to rapidly approve the AMOCs described earlier, which in turn has to date largely prevented a breakdown in reliable airline services for passengers and shippers.

This current situation was avoidable. If FCC and the wireless industry had been willing to talk to the FAA and aviation industry experts in 2019, prior to the FCC report and order, or even prior to the auction in 2020, we are certain that a better technical solution to this issue could have been worked out without the rancor expressed in public, and that the mobile wireless industry could have bid on the spectrum with a more complete understanding of the future operating environment and without the threat to aviation safety. We have seen other countries address 5G in the C-Band much more successfully.

One of my fellow witnesses testifying at this hearing today is the president of CTIA, the mobile wireless trade association. They have been fond of saying that 5G works in 40 other countries, why not here? Well, I can tell you that if the FCC had adopted the 5G C-Band rules that are currently used in Japan, for example, we wouldn't even need to be here today.

The maximum power level permitted in Japan is two percent of the maximum power authorized in the FCC Order for the U.S.[1] And even with this significantly lower power, Japan *still* restricts the siting of 5G transmitters away from aircraft flight paths. CTIA simply can't have it both ways.

We can further contrast what happened in the U.S., with what happened in Canada and in France. In both countries, when the issue of radar altimeter interference was raised by the aviation safety regulator, they collaborated with each countries' spectrum regulator to put in place restrictions around airports before the 5G signal broadcasts began.

In Canada authorities placed zones around each of the 26 most critical airports that prohibit deployment of 5G transmitters, and further place power limits in a protection zone that covers up to 1000' above ground. Canada has also put in place a national antenna down tilt requirement to further reduce the power of the 5G signals that are seen by aircraft, including for helicopter operations like medevac, which routinely must operate at low altitudes and away from predefined heliports and landing zones.

Action by Congress is needed. A detailed analysis of the risk mitigation strategy for 5G in the C-Band should have been completed by the FAA, the FCC, the aviation industry, and the wireless industry much earlier in the process. With millions of air travelers' lives on the line, a federal agency with no foundational knowledge of our aviation system should not be the final arbiter of spectrum decisions.

There are more hurdles for aviation as the 5G rollout in the C-Band continues. The expansion of the 5G network and the expiration of certain temporary mitigations requires immediate action. Failure to reach a data-driven solution that does not needlessly introduce additional risk to the national air space and costs to the aviation industry will result in the same chaotic and inefficient situation we find ourselves in today.

The FAA's use of an AD and NOTAMs to ensure airline safety was the right step to take, and we fully support that action. The U.S. airline industry's safety record did not reach the current levels of performance without significant expertise and dedication by frontline employees including pilots, air traffic controllers, aviation maintenance technicians, flight attendants, and air traffic system maintenance personnel. ALPA and aviation labor in partnership with the FAA and the airlines have assembled risk-predictive, data-driven safety analysis systems and methodologies that have resulted in documented safety levels far above any other mode of transportation. Going forward, we welcome and should demand ongoing and detailed information-sharing with other stakeholders in government and the private sector.

Action is needed, and a process needs to be established to ensure that in the future, the FCC shares information and data that allows airlines to fully engage our risk analysis and safety data reviews before spectrum decisions are finalized. The FCC should be required to be forthcoming with as many details as possible on the transmitting specifications that they are proposing when issuing a new or revised spectrum approval, and they should work collaboratively when other regulators are involved in approving safety-related matters. In our view, the norm should be for FCC to defer to the federal safety regulators of the FAA or other agencies charged with safety oversight. I urge you and others on the committee to insist going forward that we require the use of a collaborative process as other countries successfully utilized.

Legislation is also needed to allow FAA to share critical information needed for safety analysis and risk mitigations that affect aircraft operators. This is information approved as part of any applications or petitions and should be publicly shared with key aviation stakeholders. In the current situation, the FAA should be allowed to share certain information about the approved alternative methods of compliance to ensure that a consistent understanding of rapid-changing circumstances is happening in real-time. This could be accomplished, for example, by having the applicant include a draft statement for public release upon approval of an application or petition, which requires inclusion of equipment make and model, and other critical information such as airports where an approval will be effective.

The FAA should also be funded and charged to stay better informed and included as a key stakeholder in any national spectrum strategies, including mobile wireless (5G or future) radio spectrum strategies. The FAA should be empowered to interact directly with FCC when required and not be limited in coordination by relying on another federal agency that does not understand aviation's carefully designed and very robust safety risk mitigation strategy.

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[1] Japan Macro-cell limits are 63 watts (48 dBm/Mhz), while US rural power limits are 3280 watts (65 dBm/MHz). See ICAO Frequency Spectrum Management Panel paper FSMP–WG11–WP30.

Lastly, the FAA should be granted the authority to reject new or expanded FCC spectrum applications that affect aviation until safety can be ensured.

Mr. Chairman, we thank you and the committee for holding this timely and important hearing. The ongoing challenges that airline pilots are facing due to 5G interference with radar altimeters does not appear to be just a short-term issue, and there does not appear to be an end game defined, which means that your continuous monitoring of this situation is very much required and appreciated.

On behalf of the more than 62,000 ALPA pilots working every day to safely arrive at their destination with passengers and cargo, I thank you for the opportunity to share our perspectives with you today.

Mr. LARSEN. Thank you very much, Captain DePete, for your testimony.

And I now want to call on Faye Malarkey Black, you are recognized for 5 minutes.

Ms. BLACK. Thank you, Mr. Chair, Chair DeFazio, Ranking Member Graves and Graves and committee members. I appreciate the opportunity to speak today. RAA represents regional airlines that operate 44 percent of the Nation's flights and connect every corner of the country. Fully two-thirds of U.S. airports are served only by regional airlines.

RAA was among those, including this committee, called for safeguarding safety and operational integrity of the aviation system before 5G rollout, yet FAA issued thousands of NOTAMs prohibiting airport operations in low visibility where new 5G signals interfere with aircraft radio altimeters. Alternative methods of compliance, or AMOCs, are granted only if manufacturers can show their equipment withstands the new interference.

This patchwork of broad restrictions and case-by-case approvals has been disastrous. Airlines are uncertain when and what clearances they might get for which aircraft, if any. The impact on regional airlines has been particularly pronounced. Not one regional aircraft AMOC had been issued when 5G went live. Even now, because negotiated safeguards against 5G interference are insufficient for the typical regional altimeter, the FAA has issued far fewer of those compared with larger equipment. And more than half the fleet remains restricted at dozen of airports.

These restricted aircraft provide more than 130,000 monthly flights and provide the only source of air service to 27 airports. Passengers almost immediately experienced disruption. One carrier had 63 5G cancels the first week displacing 1,800 passengers, some of those at Paine Field. Yesterday morning, an airline's entire inbound operation to Houston was delayed, nine flights were cancelled when 5G barred low-visibility approaches. By mid-day, 1,400 passengers were displaced.

Earlier, an RAA member endured eight 5G cancels, not due to severe weather, just wet runways. Operational limitations have also caused denied boardings. One carrier was limited to using just 23 of its 50 seats as runway conditions changed. Even small reductions can make a 50-seat flight unprofitable and threaten the viability of the route.

I urge this committee not to view these disruptions as mere pockets of pain. The list of excluded airports is now at 70 and growing each time a new tower turns on. Consider that all three New York metropolitan airports are excluded now, and more than one-quarter of the flights operate there are on aircraft now prohibited weather.

The downstream consequences are vast. Regional airlines support the Nation's hub and spoke system. If 5G degrades their reliable schedules, then the integrity of the entire network is compromised. For smaller airports, fewer flights mean fewer options to recover displaced passengers and crew.

For communities served by aircraft now banned in weather, that specter of completely avoidable economic calamity is still very much at hand. FAA's NOTAMs and AMOCs were designed to protect aviation safety from the 5G hazard. Still, we must be careful that we do not trade one set of risks for another.

The entire industry must react, understand, and mitigate new risk each time a set of NOTAMs and AMOCs is offered. The introduction of more than 1,500 simultaneous NOTAMs is unprecedented. Each one complicates and increases the workload for dispatch, pilots, and ATC. For each approach, crews must determine if their aircraft is approved to utilize the approach being used for that airport, that runway, find and review the appropriate NOTAMs, and review the AMOC listing to determine what approach minimums apply before beginning the approach.

ATC also faces significant new airspace saturation with scores more flights holding, circling, and diverting even as mild weather rolls in. We enjoy an exceptionally high level of aviation safety in the United States, due in part to many layers of safety procedures and tools.

The radio altimeter is one such tool that enhances situational awareness. And 5G interference takes it away. In discussing risk, RAA doesn't wish to alarm passengers. Our members have taken every step to mitigate these risks and will not compromise safety. Flights will be grounded. Unfortunately, they have been. We must find a better and more sustainable path forward.

Today's patchwork of NOTAMs and unattainable regional AMOCs creates two tiers of reliability in our system. One for cities and another for everywhere else. I want to make this abundantly clear: Radio altimeters on regional aircraft aren't faulty or defective. These altimeters are operating as they should based on current regulatory and certification standards set by the FAA. Regional airlines have invested millions in these tools to allow safe, reliable air service in weather. Now we can't use them because the FAA auctioned C-band spectrum without fully considering the consequences.

We can't lose our sense of urgency. FAA must continue to refine data to determine if an aircraft can safely operate at airports. If they can't, better mitigations are needed. A roadmap may be found abroad where lower 5G power, down-tilted antennas, and wider exclusion zones protect more aircraft.

FAA must also improve its NOTAMs and AMOCs process to ensure cohesiveness, timeliness, and predictability. I spent my career advocating for small community service [inaudible] activity. For travelers that means air service. We support 5G too, but aviation safety and [inaudible] must be [inaudible].

I thank the committee for inviting me today. Thank you.

[Ms Black's prepared statement follows:]

Prepared Statement of Faye Malarkey Black, President and Chief Executive Officer, Regional Airline Association

OVERVIEW OF REGIONAL AIRLINE INDUSTRY AND RADIO ALTIMETERS

My name is Faye Malarkey Black. I am the President and CEO of the Regional Airline Association (RAA). Regional airlines play a critical role in the U.S. air transportation system, particularly for smaller communities. The safety of our passengers, crewmembers, and the public is and will remain our top priority. This safety cannot be compromised. RAA appreciates the opportunity to testify before the Committee today and share our experiences with 5G deployment and the impact that it has had on the operation of our aircraft and on small community air service.

RAA represents 17 regional airlines, which operate 44% of the U.S. scheduled passenger departures and directly employ over 65,000 individuals. Regional airlines specialize in operating smaller aircraft that are rightsized for markets with fewer passengers traveling at once. Regional airlines carried about 73 million passengers in 2020—reflecting COVID–19 impacts—and carried a more typical 165 million passengers in 2019. Regional airlines provide more than half of the air service in 30 states and more than 75% of the air service in 15 states. Most importantly, regional airlines offer the only source of scheduled, commercial air service at 66% of U.S. airports. In fact, major airlines directly operate at about 34% of US commercially served airports, while regional airlines operate at 94%. Because major airlines cannot serve smaller airports with larger, mainline aircraft, most partner with regional airlines to reach these customers. The goal of this arrangement is to bring air service connectivity and a seamless, reliable travel experience to passengers in every corner of the country. While regional airlines contribute significantly to civil aviation's overall $1.8 trillion economic footprint, air service at small communities (defined as small and non-hub airports) drove $152 billion in direct economic activity in 2019, supporting over one million jobs and $43 billion in local taxes and wages.

As this Committee knows, Radio Altimeters are critical sensors on board aircraft. This advanced technology enables and enhances numerous different safety and navigation functions throughout all phases of flight. On all types of aircraft, situational awareness of the flight crew is paramount to ensuring safe flight operations, especially flying in busy airspace, close to the ground, or in low visibility scenarios such as Instrument Meteorological Conditions (IMC). The radar altimeter plays a critical role in providing situational awareness in these operating conditions. Not only do radar altimeters provide a displayed indication of height above terrain to the flight crew, but they also form the basis of auditory altitude callouts during terminal landing procedures. Additionally, on commercial aircraft, the radar altimeter provides input to critical aircraft safety systems including, but not limited to, Traffic Alert and Collision Avoidance Systems (TCAS), Terrain Awareness Warning Systems (TAWS) Airborne Collision Avoidance Systems (ACAS), windshear detection systems, flight control systems and autolanding functions, including auto throttle and ground lift dump and thrust reversers. This usage by a wide variety of systems onboard the aircraft leads to the possibility of specific operational impacts that go beyond a general loss of situational awareness or risk of controlled flight into terrain.

BACKGROUND—RADIO ALTIMETER 5G SIGNAL INTERFERENCE

This Committee has been relentless in engaging with the Federal Aviation Administration (FAA), the Federal Communications Commission (FCC) and stakeholders in both aviation and telecommunications industry throughout the leadup to the deployment of 2.7–3.98 gigahertz (GHz) frequency band ("5G C-Band") services on January 19, 2022. We are grateful for this engagement, which has certainly helped to drive progress on this complex issue. We also appreciate the engagement of the FAA, along with the Agency's willingness to hear RAA's remaining concerns. RAA was among stakeholders who consistently warned that deployment of 5G technologies must proceed only after resolving clear and well-reasoned concerns that 5G transmissions would pose a threat to the safety and operational integrity of our aviation system, by interfering with radio altimeters.

Unfortunately, the FCC did not ensure sufficient mitigations to the root problems associated with 5G C-band interference and the FAA has concluded that interference with radio altimeters by wireless broadband operations presents an aviation safety hazard near airports. Consequently, the Agency issued an Airworthiness Directive days before the first anticipated rollout, warning that low-visibility operations would be restricted near 5G transmitters to mitigate the safety hazard. The Agency later issued an unprecedented 1,537 Notice to Air Missions (NOTAMs) specific to aerodromes, airspace, and instrument approach procedures. The FAA drew these NOTAMs according to its worst-case expectation of signal interference vulner-

ability and, accordingly, established a new baseline of vastly restricted operations when visibility drops below the established minimums.

The operational impact of these NOTAMs is extensive. At dozens of U.S. airports impacted by the first-tier rollout of 5G services, NOTAMs restrict operators from performing a vast array of approaches in low-visibility conditions. The primary impact of the NOTAMs serves to limit the use of the radio altimeters when flying instrument approaches in poor weather conditions. However, this is not the only operational impact as radio altimeters feed a wide range of additional, critical aircraft systems. Analysis by the aircraft manufacturers of the restrictions on the use of certain onboard systems has revealed additional landing and takeoff limitations that impact operations. The FAA acknowledges safety may also be upheld through Alternate Methods of Compliance (AMOCs), which the Agency approves when the AMOC provides an acceptable level of safety. Recognizing that some installed radio altimeters might be less impacted by 5G interference, the FAA directed aircraft original equipment manufacturers (OEMs) to submit data showing their radio altimeters are capable of functioning without interference by encroaching 5G signals to gain AMOC approval.

This process of allowing a patchwork of approvals, on a case-by-case basis, to clear some aircraft at some airports, has been tremendously challenging for the entire industry. Airlines face uncertainty over when and what clearances they might get for which aircraft at which airports, if any. The process and outcomes have been particularly troubling for regional airlines, which were initially excluded from consultation on mitigation agreements with the telecommunications industry that would make achieving AMOCs more feasible. Perhaps as a result, the narrow runway safety zones and buffer zone mitigations were not designed to protect the typical regional aircraft altimeter. Tellingly, an earlier agreement between the FAA and FCC focused exclusively on fifty so-called priority airports and ignored most regional airports altogether. When 5G was turned on January 19, most mainline aircraft had received at least partial AMOCs for their safe operation, but no regional OEM AMOCs had been issued at all.

This meant, when 5G went live, regional airlines remained restricted from operating during periods of low visibility at every airport with NOTAMs in place, even as headlines proclaimed the crisis was averted. Throughout the week, FAA continued to triage AMOC approvals according to its view of systemic impact, prioritizing regional airlines and aircraft last among commercial airlines. While the reasoning behind this prioritization may well have been aimed at relieving greater systemic pressure, we urge all stakeholders to consider that mitigating disruption at the aggregate-level does nothing for the tens of millions of passengers left vulnerable. Whether they are traveling for premium health care, to see a loved one, or just trying to get home to their families, passengers experience disruption as individuals and today's ever-changing NOTAMs and AMOCs expose regional airline passengers to more disruption. To this day, the FAA has been able to issue dramatically fewer AMOCs for regional aircraft compared with larger equipment and over half the regional fleet remains prohibited from operating in reduced visibility at dozens of key airports (See Appendix A). In many cases, the specific fleet types excluded from low visibility operations at hub airports operate more than a third of the airport's total departures. Regional airlines provide substantial support for the nation's intricate hub and spoke system; if 5G is allowed to degrade their reliable schedules then the integrity of the entire national air service network will be compromised. Put another way, the specter of "completely avoidable economic calamity" and vast disruption our major airline partners warned against last month remains very much in play for smaller communities who rely on aircraft that remain excluded from key airports in weather.

Two regional jets, the E135/145 (E145) and the E170/175/190 (E175), face particularly pronounced restrictions. The E145, a 50-seat aircraft scheduled for 31,383 departures (4.3% U.S. departures) in January, comprises 14% of the regional jet fleet and has no AMOC approved or pending for any operation that requires radio altimeters. The FAA has issued NOTAMs at 66 such airports used by regional airlines with low visibility approaches at the time of this writing, including 57 of the 189 U.S. airports the E145 serves today (Appendix B). Operating in 46 states, the E145 provides the only source of air service to 26 airports. (Appendix C). The E175 comprises 40% of the regional airline fleet, has a dual class configuration that can seat up to 76 passengers and was scheduled for 108,646 January departures (14.9% U.S. departures). Although this aircraft was granted an AMOC, that AMOC initially excluded 57 of the 69 NOTAM'd airports it serves. Overall, the E175 is used to provide air service to 167 U.S. airports, is used to provide the only source of air service to one airport (Paine Field) and supports more than 30% of the departures at 37 airports (Appendix C).

On Sunday, January 30, the FAA used a revised safety analysis model to issue new NOTAMs and AMOCs associated with current upcoming 5G deployments. Adjustments to the FAA's model brought 21 more airports into the E175 AMOC but left 33 airports excluded and newly excluded two more (JFK, ALB) for a current total of 35 excluded airports. The E145 remains excluded from all airports with NOTAMs. As more 5G towers are turned on and transmission signals are turned up and even as more high-speed internet users impact the signal, we expect even more airports to become excluded. This will almost certainly disadvantage more communities and passengers.

Despite relatively fair weather [1] in the first week of 5G deployment, regional airlines almost immediately experienced delays and cancelations due to weather that would not have restricted operations before the signal interference. Several notable examples occurred in the Pacific Northwest, including one RAA member with a total of 63 5G related cancelations or delays between the January 19 rollout and January 31st. As several members of this Committee can attest, lingering fog is a typical weather pattern in the area. When visibility drops below certain levels [2], no flights may operate. In other cases, the use of radio altimeters guides precision approaches to allow safe landings in certain categories of reduced visibility. Paine Field (PAE) in Everett, Washington, is served exclusively by the E175. Because of the proximity of the 5G tower to the runway, the E175's AMOC at the time did not cover approaches into the main runway. Because this is the runway authorized for low visibility approaches, all flights in and out of the airport were cancelled on Monday, January 24th, shutting down air service to the airport specifically and directly because of the 5G runway restrictions.

I urge this Committee not to view the disruptions in Pacific Northwest as merely pockets of pain and proof of a successful 5G roll out that has minimized disruptions; rather, they should be viewed as indicative of what awaits other parts of the country in the event of bad weather. The reality is that regional airlines operate in both large and small airports throughout the country; making considerable connections through the hubs to serve the spokes. Here are just a few a few examples of larger airports where the regional aircraft without an AMOC at the airport have a significant market presence:

- LGA has no AMOC for the E175. Of 20,293 scheduled flights in January, 7,395 were E175 aircraft equating to 36% (more than 1 of 3 flights).
- EWR has no AMOC for the E175. Of 15,764 scheduled flights in January, 2,853 were E175 aircraft equating to 18% (nearly 1 of 5 flights).
- JFK has no AMOC for the E175 or E145. Of 23,203 scheduled flights in January, 5,701 were E175 aircraft (no E145 ops) equating to 25% (1 in 4 flights).
- PHL has no AMOC for the E175 or the E145. Of 8,973 scheduled flights in January, 2,517 were E175 or E145 aircraft equating to 28% (more than 1 in 4 flights).
- RDU has no AMOC for the E175. Of 5,456 scheduled flights in January, 1,911 were E175 aircraft equating to 35% (more than 1 in 3 flights).
- IND has no AMOC for the E175 or the E145. Of 4,102 scheduled flights in January, 1,531 were E175 or E145 aircraft equating to 37%. (More than 1 in 3 flights)
- PDX has no AMOC for the E175. Of 5,039 scheduled flights in January, 822 were E175 aircraft equating to 16%.
- STL has no AMOC for the E175 or E145. Of 6,246 scheduled flights in January, 668 were E175 or E145 equating to 11%.
- MSP has no AMOC for the E175 or E145. Of 11,575 scheduled flights in January, 1,171 were E175 or E145 aircraft equating to 10%.

For smaller markets, where there are fewer total departures and a high percentage of departures on aircraft without an AMOC, the impacts carry a different type of systemic impact. With fewer flights overall, airports served by regional airlines have fewer options to recover passenger and crew disruptions when diversions, cancelations and delays occur. Here is a sampling of airports in this category, where one or both aircraft lack an AMOC for an airport have significant regional departures: CLE (32% regional) CVG (31%) JAX, (36%) RIC (35%) OKC (34%) ROC (42%), LIT (51%), GSO (43%), MDT (39%), HSV (40%), SBP (49%), STS (70%), ORH (81%).

Even at airports where service is permitted under certain AMOCs, many regional aircraft face other restrictions, such as limitations on runways. This is particularly troubling because regional airlines experience greater diversity in size, geography,

[1] The extent of 5G cancelations associated with the 1/28–29/22 weather event in the Northeastern U.S. is not yet known.

[2] The FAA denotes qualified U.S. airports and runways for Category I (CAT I), Category II (CAT II) and Category III (CAT III) Instrument Landing System (ILS) operations.

weather, and runway characteristics at airports they serve, relative to other operators. One RAA member endured eight 5G interference cancelations in a single morning the week 5G went live—not due to a snowstorm or intense thunderstorms—but rather, wet runways at the arrival airport. In other cases, airlines are taking weight penalties to mitigate against 5G impact on systems. Another RAA member, already restricted outright from operating at multiple airports during weather, incurred weight penalties at airports it could serve. This required a real-time reduction in payload that forced the denied boarding of eight passengers across two flights. In addition to burdening those displaced passengers, even small reductions to the seating capacity of a 50 seat passenger aircraft quickly make for an unprofitable flight. Long term, such impacts threaten the viability of small community routes.

Leaving dozens of airports and millions of passengers vulnerable to sweeping disruptions is unsustainable and unacceptable. Today's patchwork of NOTAMs and airport specific AMOCs that exclude regional aircraft is creating a two-tiered national aviation system where communities that rely on regional airline service are disadvantaged and subject to more disruption, while those served exclusively by larger aircraft are less vulnerable. It must be made abundantly clear that radio-altimeters on regional aircraft aren't faulty or defective; they are operating as they should, based on current regulatory and certification standards established by the FAA. Unfortunately, these standards became irrelevant when the FCC auctioned C-Band spectrum near the radio altimeter operating frequency without full consideration of the consequences.

Aviation Safety

Most importantly, FAA's extensive use of NOTAMs creates a massive differential in workload and procedures that itself introduces risk into the aviation system. Fundamentally, NOTAMs are Irregular Operations (IROPs). While the NOTAMs and their associated AMOCs are offered to protect aviation safety from the 5G hazard, we must be extremely careful that we do not trade one set of risks or another. Pilots in the airline industry are trained to a set of practices and procedures, which have changed abruptly. The introduction of more than 1,500 NOTAMs simultaneously is unprecedented. The entire industry must react, understand, and mitigate new risk each time a new set of NOTAMs and AMOCs is offered. Each NOTAM and AMOC complicates and increases the workload for aircraft dispatch professionals and pilots. Pilots performing short haul flights often fly to multiple destinations in a single day. Every approach requires the crew to determine if their aircraft is approved to utilize the approach being used currently for that airport and runway, then find and review the appropriate NOTAMs and review the AMOC listing to determine what approach minimums apply to the safely begin an approach. This workload shift will not be limited to airline crews. In cases where flights are dispatched before weather moves in, Air Traffic Control (ATC) will be required to handle significant airspace saturation associated with diversions and holdings. This in turn could spur ground stops and other systemic delays to allow ATC to safely handle the traffic flow.

One very important factor behind the extremely high level of safety the U.S. aviation system enjoys today lies with the many layers of procedures and safety tools it employs. The introduction of these NOTAMs removes one such tool, by limiting use of the radio altimeter to enhance situation awareness. In discussing these risks, RAA does not wish to alarm U.S. airline passengers. Our members have taken every step to mitigate these risks and will not compromise safety. Flights will be grounded, and unfortunately, they have been. We must find a better and more sustainable path forward.

Comprehensive and Permanent Solutions

Regional airlines have invested millions of dollars in advanced safety technologies like radio altimeters that allow safe and reliable air service for the traveling public during periods of poor weather. Without their use, flights will continue to be canceled, delayed and as necessary, diverted. This imposes a terrible burden on regional passengers. We should not be willing to accept two levels of reliability in this country and the FAA and FCC must not allow 5G interference to undermine and waste these investments by failing to ensure adequate protections for all aircraft. The FAA, the White House, FCC, telecommunication companies and aviation stakeholders must further commit to resolving underlying factors causing 5G C-Band interference near airports and mitigate those to protect safe operations at all airports—today and moving forward.

The FAA should continue to review its analysis and modeling of 5G interference and refine this based on updates from telecom companies related to tower location, signal strength, and positioning, to determine if aircraft can safely operate at cur-

rently excluded airports. If the FAA find that these aircraft cannot safely operate under the current mitigations, the Agency and the White House should engage directly with the telecommunication companies to pursue other mitigations to restore that safe operation. Potential tactics may include efforts that have worked well abroad, such as additional lowering of 5G C-band power levels, requiring a downward tilt on airport-proximate 5G antennas, and creating exclusion zones near airports that protect all aircraft from transmission interference if necessary. Based on the limitations associated with some current regional aircraft AMOCs, these exclusion zones may need to be larger at certain airports.

Continued and improved communications, including greater consultation of regional operators and stakeholders, will be central to the successful, safe deployment of 5G services. It is important that the FAA continue to work with the FCC and telecommunications stakeholders to ensure future communications are less hindered by Non-Disclosure Agreement-driven opacity and other factors, so that direct and clear data-sharing can expand between stakeholders. RAA also asks that the FAA improve upon its process of issuing NOTAMs and AMOCs to ensure better cohesiveness, timeliness, and predictability.

CONCLUSION

As an organization that supports air service to communities large and small, RAA believes in the power of connection. We are committed to working with all stakeholders, including this Committee, to ensure aviation safety is upheld and that an appropriate balance is struck between two important modes of connection: successful deployment of 5G services while preserving the integrity of the country's air transportation network. I thank the Committee for this opportunity to testify today and look forward to taking your questions at the conclusion of the panel.

Appendix A—Airports with NOTAMs Excluded from AMOCs—Select Regional Airline Fleet

Black † denotes airport excluded in first round but cleared 1/31. Gray † denotes newly excluded on 1/27.

Airport List	Name	CAT II/III Approach	NO AMOC E175 01.27.22	NO AMOC E175 01.31.22	NO AMOC E145	NO AMOC Q400
AFW	Fort Worth Alliance	Yes			X	
ALB	Albany International	Yes		X		
AUS	Austin Bergstrom	Yes			X	
BDL	Bradley Windsor Locks	Yes			X	
BFI	Boeing Field	Yes	X	X	X	
BFL	Bakersfield	Yes	X	X		
BHM	Birmingham	Yes	X	X	X	X
BLI	Bellingham	Yes	X	X	X	
BNA	Nashville	Yes			X	X
BOS	Boston Logan	Yes			X	
BUR	Burbank	Yes			X	
BWI	Baltimore	Yes			X	
CAE	Columbia	Yes			X	

Appendix A—Airports with NOTAMs Excluded from AMOCs—Select Regional Airline Fleet—Continued

Black† denotes airport excluded in first round but cleared 1/31. Gray† denotes newly excluded on 1/27.

Airport List	Name	CAT II/III Approach	NO AMOC E175 01.27.22	NO AMOC E175 01.31.22	NO AMOC E145	NO AMOC Q400
CHS	Charleston SC	Yes	X	X		
CLE	Cleveland	Yes			X	
CLT	Charlotte	Yes	X	[redacted]	X	
CVG	Cincinnati	Yes	X	[redacted]	X	
DAL	Dallas	Yes		X		
DAY	Dayton	Yes	X	X	X	
DFW	Dallas Fort Worth	Yes			X	
DTW	Detroit	Yes			X	
EWR	Newark	Yes	X	X	X	
FWA	Fort Wayne	Yes	X	[redacted]	X	
GSO	Greensboro	Yes	X	[redacted]	X	
GSP	Greenville Spartanburg	Yes			X	
HIO	Hillsboro OR	Yes	X	X	X	
HOU	Houston Hobby	Yes	X	[redacted]	X	X
HPN	White Plains	Yes	X	X		
HSV	Huntsville	Yes			X	
IAH	Houston George Bush	Yes			X	
IND	Indianapolis	Yes	X	X	X	
ISP	Islip	Yes	X	X		
JAX	Jacksonville	Yes	X	[redacted]	X	
JFK	New York JFK	Yes		X	X	
LAX	Los Angeles	Yes	X	X	X	
LGA	La Guardia	Yes	X	X		
LIT	Little Rock	Yes	X	X	X	
MCI	Kansas City	Yes	X	X	X	
MCO	Orlando	Yes			X	

Appendix A—Airports with NOTAMs Excluded from AMOCs—Select Regional Airline Fleet—Continued

Black† denotes airport excluded in first round but cleared 1/31. Gray† denotes newly excluded on 1/27.

Airport List	Name	CAT II/III Approach	NO AMOC E175 01.27.22	NO AMOC E175 01.31.22	NO AMOC E145	NO AMOC Q400
MDT	Harrisburg	Yes	X	[redacted]	X	
MEM	Memphis	Yes	X	X	X	
MHT	Manchester NH	Yes	X	X		
MKE	Milwaukee	Yes	X	[redacted]	X	
MOD	Modesto	Yes			X	
MRY	Monterey	Yes				X
MSN	Madison WI	Yes			X	
MSP	Minneapolis, St. Paul	Yes	X	X	X	
MSY	New Orleans	Yes	X	[redacted]	X	
OAK	Oakland	Yes	X	X	X	
OKC	Oklahoma City	Yes	X	X	X	
ORH	Worcester MA	Yes	X	X		
ORD	Chicago O'Hare	Yes	X	[redacted]	X	
PAE	Everett	Yes	X	[redacted]	X	
PDX	Portland OR	Yes	X	X		
PHL	Philadelphia	Yes	X	X	X	
PHX	Phoenix	Yes			X	
PIT	Pittsburgh	Yes			X	
PVD	Providence	Yes	X	X	X	
RDU	Raleigh Durham	Yes	X	X	X	
RIC	Richmond	Yes	X	X	X	
ROC	Rochester NY	Yes	X	X	X	
RST	Rochester MN	Yes	X	[redacted]	X	
SBP	South Bend	Yes	X	X		
SEA	Seattle Tacoma	Yes		[redacted]		
SJC	San Jose	Yes	X	X		

Appendix A—Airports with NOTAMs Excluded from AMOCs—Select Regional Airline Fleet—Continued

Black† denotes airport excluded in first round but cleared 1/31. Gray† denotes newly excluded on 1/27.

Airport List	Name	CAT II/III Approach	NO AMOC E175 01.27.22	NO AMOC E175 01.31.22	NO AMOC E145	NO AMOC Q400
SLC	Salt Lake City	Yes	X	[redacted]	X	
SNA	Orange County	Yes	X	X		
STL	St Louis	Yes	X	X	X	
STS	Sonoma County	Yes	X	X	X	
SWF	Stewart NY	Yes	X	[redacted]	X	X
SYR	Syracuse	Yes			X	
TPA	Tampa	Yes	X	X	X	

†Editor's note: Colors were changed from green and orange in the original testimony to black and gray, respectively, in order to display the denotations in a black and white format.

Appendix B—26 Airports Served Exclusively by the ERJ145

Jan–22		ERJ 135/145 Flights	Total Flights	Other Flights	% ERJ 135/140/145
ABI	Abilene, TX	213	213	0	100.0%
ALO	Waterloo, IA	58	58	0	100.0%
ART	Watertown, NY	45	45	0	100.0%
BKW	Beckley, WV	107	107	0	100.0%
BPT	Jack Brooks, TX	76	76	0	100.0%
CCR	Buchanan Field, CA	33	33	0	100.0%
CEC	Del Norte County, CA	30	30	0	100.0%
CLL	Easterwood, TX	193	193	0	100.0%
CMI	Willard, Il	151	151	0	100.0%
CVN	Clovis, NM	54	54	0	100.0%
DBQ	Dubuque, IA	46	46	0	100.0%
DIK	Dickinson, ND	53	53	0	100.0%
DRT	Del Rio, TX	59	59	0	100.0%
FLO	Florence, SC	80	80	0	100.0%
GCK	Garden City, KS	61	61	0	100.0%
GGG	East Texas Regional, TX	126	126	0	100.0%
GLH	Greenville, MS	52	52	0	100.0%
LAW	Lawton, OK	94	94	0	100.0%
MCN	Macon, GA	54	54	0	100.0%
PGA	Page, AZ	40	40	0	100.0%
PGV	Greenville, NC	93	93	0	100.0%
PKB	Mid-Ohio, WV	53	53	0	100.0%
SBY	Salisbury, MD	119	119	0	100.0%
SPS	Wichita Falls, TX	213	213	0	100.0%
TXK	Texarkana Regional, AR	95	95	0	100.0%
TYR	Tyler-Pounds, TX	211	211	0	100.0%

Appendix C—37 Airports with 30% or More Departures by E175

Jan–22		ERJ 170/195 Flights	Total Flights	Other Flights	% ERJ 170/195
PAE	Paine Field, WA	259	260	1	99.6%
ORH	Worcester Regional, MA	121	149	28	81.2%
SUN	Friedman Memorial, ID	203	260	57	78.1%
STS	Sonoma, CA	302	432	130	69.9%
ACV	Humbolt County, CA	153	220	67	69.5%
HHH	Hilton Head, SC	64	95	31	67.4%
XNA	Northwest Arkansas, AR	730	1,312	582	55.6%
RDM	Redmond, OR	375	687	312	54.6%
BOI	Boise, ID	1,149	2,247	1,098	51.1%
SBP	San Luis Obispo, CA	218	443	225	49.2%
CMH	Columbus, OH	1,866	3,873	2,007	48.2%
CHS	Charleston, SC	1,037	2,360	1,323	43.9%
PIT	Pittsburgh, PA	1,864	4,461	2,597	41.8%
MSO	Missoula, MT	150	372	222	40.3%
ILM	Wilmington, NC	228	585	357	39.0%
EYW	Key West, FL	497	1,276	779	38.9%
PSC	Pasco, WA	208	539	331	38.6%
GRK	Killeen-Fort Hood, TX	113	296	183	38.2%
LIT	Little Rock, AR	488	1,280	792	38.1%
ORF	Norfolk, VA	763	2,073	1,310	36.8%
LGA	New York, LaGuardia	7,395	20,293	12,898	36.4%
FCA	Kalispell, MT	102	280	178	36.4%
JAX	Jacksonville, FL	1,031	2,856	1,825	36.1%
IND	Indianapolis, IN	1,478	4,102	2,624	36.0%
RDU	Raleigh-Durham, NC	1,911	5,456	3,545	35.0%
HLN	Helena, MT	52	154	102	33.8%
SAV	Savannah, GA	525	1,555	1,030	33.8%
DCA	RR Washington National, DC	4,743	14,101	9,358	33.6%
SDF	Louisville, KY	731	2,185	1,454	33.5%
EUG	Eugene, OR	301	919	618	32.8%
SGF	Springfield, MO	261	797	536	32.7%
OKC	Oklahoma City, OK	680	2,111	1,431	32.2%
MTJ	Montrose, CO	137	428	291	32.0%
BOS	Boston, MA	6,082	19,476	13,394	31.2%
PSP	Palm Springs, CA	507	1,629	1,122	31.1%
BUF	Buffalo, NY	628	2,032	1,404	30.9%
MFR	Medford, OR	222	721	499	30.8%

Mr. LARSEN. Thank you very much.

The Chair recognizes Mr. James Viola, president and CEO of Helicopter Association International. You are recognized for 5 minutes.

Mr. VIOLA. Thank you. Chairman DeFazio, Chairman Larsen, Ranking Member Sam Graves, Ranking Member Garret Graves, and members of the subcommittee, thank you for your leadership and for holding this hearing. I appreciate the opportunity to provide testimony today. I have been involved in aviation for more than 35 years and began my aviation career in the U.S. Army with the majority of my flying done as a special operations helicopter pilot. I later joined the FAA where I most recently served as the director of general aviation safety assurance. I now serve as the president and CEO of Helicopter Association International.

Throughout my career, I have been dedicated to safety and the continued development and refinement of safe aviation operations. The unique capabilities of vertical flight means we can accomplish missions that no other aircraft can. And our industry is also expanding, bringing on to the flight deck exciting technologies such as advanced air mobility and eVTOL aircraft.

Our operations are conducted at lower altitudes and at lower speeds. Many flights are conducted from start to finish without the use of airports. Every day, vertical flight serves the public good. Our members do everything from air medical, law enforcement, firefighting, heavy construction to urban air mobility, and even more. Helicopter air ambulance operators transport roughly 1,000 injured or critically ill patients every day.

The FAA, in carrying out its mission to maintain aviation safety, put into place restrictions on helicopter flight operations through NOTAMs and airworthiness directives, or ADs, in order to mitigate the risk of 5G interference with aircraft radio altimeters. For helicopters, the AD prohibits certain operations requiring radio altimeters.

The restriction in the AD, which prohibits takeoff and landings, has significant far-reaching consequences for the rotorcraft industry. We may be unable to conduct certain missions and provide public services, especially when you consider that limitation applies to nearly 2,000 NOTAM designated locations.

To combat the impacts of 5G interference, the FAA implemented an alternative method of compliance, or AMOC. To date, the focus has been on part 121 air carriers and the FAA has done tremendous work there, but this is a Band-Aid approach to a permanent problem that is constantly changing. The rotorcraft AMOC procedures have not been formally released by the FAA. The process is still being fine-tuned.

We believe it is critical that the FAA continue the same level of urgency and commitment as they have had for commercial aviation to mitigate operational impacts on helicopter operations and the essential services they provide to save lives, protect communities, and support jobs. It must be recognized that rotorcraft's operational environment is vastly different than the airlines.

Helicopter operations which take place at much lower altitudes than airline flights could very well conduct their entire flight within the zones of this interference. Rotorcraft utilize airports, as well as unapproved locations such as streets, parking lots, or fields. The other avenue to combat the operational impact of 5G interference is the exemption process.

The FAA partially approved a HAI petition for exemption allowing helicopter air ambulance operators to continue flying with restrictions. This relief will also allow them to use night vision goggles in the helicopter air ambulance operations. Ninety-seven percent of the 1,250 helicopters used in helicopter air ambulance now have an HAI exemption.

I want to be very clear: HAI and our members are not against 5G. However, due to our mission profiles and operational parameters, 5G interference is a particular concern to the vertical flight sector. We want to ensure that 5G is deployed in such a way that it can safely coexist with aviation operations. The development of

new radio altimeters with filters that can withstand 5G interference will take time, and the cost for operators to purchase and install these new altimeters is of particular concern to the industry.

In the short term, HAI is focused on working with the FAA on AMOC process and additional exemptions with mitigations to allow operators to provide services to their communities. In the long term, we urge Congress to enact reforms to provide better transparency and coordination on the spectrum issues. The Department of Commerce and its Federal Advisory Committee have studied the issues of equitable access to spectrum and identified several recommendations.

The reason we are here today is clear: Misaligned spectrum policy has disadvantaged aerospace and aviation users. It is imperative we find a solution to address the currently failed system so that we are not in the same situation again.

I thank the committee again for the opportunity to provide the perspective of the vertical flight industry, and I look forward to continuing our work together in these important issues. My full comments are offered for the record. I welcome any questions.

[Mr. Viola's prepared statement follows:]

Prepared Statement of James Viola, President and Chief Executive Officer, Helicopter Association International

Chairman Larsen, Ranking Member Graves, and Members of the Subcommittee, I want to thank you for holding this hearing on the urgent issue of 5G interference with safety-critical aviation equipment. Thank you for your leadership in defending aviation safety. I also want to express my sincere appreciation for the opportunity to provide testimony today.

I have been involved in aviation for more than 35 years and have flown more than 70 types of aircraft, both helicopter and fixed-wing, military and civilian. I began my aviation career in the US Army, with the majority of my flying done as a special operations helicopter pilot. I later joined the Federal Aviation Administration (FAA), where I most recently served as director of General Aviation Safety Assurance.

I now serve as president and CEO of Helicopter Association International (HAI). As the professional trade association for the international helicopter industry, HAI represents more than 1,100 companies and over 16,000 industry professionals in more than 65 countries. Each year, HAI members safely operate more than 3,700 helicopters and remotely piloted aircraft approximately 2.9 million hours. HAI is dedicated to the promotion of the helicopter as a safe, effective method of commerce and to the advancement of the international helicopter community.

Throughout my career, I have been dedicated to safety and the continued development and refinement of safe aviation operations.

SERVING THE PUBLIC GOOD

The unique capabilities of vertical flight—the ability to land and take off from practically anywhere, the maneuverability, and the ability to hover or fly at very low speeds—means we can accomplish missions that no other aircraft can. Another way we differ from fixed-wing aircraft is that our operations are conducted at lower altitudes and at slower speeds.

Every day, vertical flight serves the public good. Our members do everything from air medical, law enforcement, firefighting, heavy construction, utility patrol and maintenance, urban air mobility, and more. And our industry is expanding, bringing onto the flight deck exciting technology such as advanced air mobility and electric vertical takeoff and landing (eVTOL) aircraft.

All over the country, from densely populated cities to oil rigs 200 miles offshore, helicopters are used to save lives, serve and protect American citizens, and support critical industries in demanding environments—and many of those missions are conducted from start to finish without the use of airports.

As just one example of how vertical flight serves the public good, consider air medicine. Helicopter air ambulance (HAA) operators transport roughly 1,000 injured or critically ill patients every day. Up to 50,000 of the more than 300,000 people transported by HAA operators during 2021 were transported from off-airport or unimproved areas—meaning the 5G mitigations proposed to maintain an equivalent level of safety at airports will have no effect on those operations. The loss of a single life because of misguided 5G-related policies would be reprehensible.

5G Flight Restrictions

In carrying out its mission to maintain safety in the US National Airspace System, the FAA has put into place restrictions on helicopter flight operations to mitigate the risk of 5G interference with aircraft radio altimeters. The FAA has communicated these restrictions via two channels: a series of Notices to Air Missions (NOTAMs) and Airworthiness Directive (AD) 2021–23–13.

The FAA uses NOTAMs to define the geographic locations where 5G interference occurs. As of Jan. 27, 2022, the agency has issued 5G-related NOTAMs for 1,904 locations around the country.

AD 2021–23–13 states that when operating in US airspace, the following operations requiring radio altimeters are prohibited in areas defined by the presence of 5G C band wireless broadband interference as identified by NOTAM:

- Performing approaches that require radio altimeter minimums for rotorcraft offshore operations. Barometric minimums must be used for these operations instead.
- Engaging hover autopilot modes that require radio altimeter data.
- Engaging search and rescue (SAR) autopilot modes that require radio altimeter data.
- Performing takeoffs and landings in accordance with any procedure (Category A, Category B, or by Performance Class in the Rotorcraft Flight Manual or Operations Specification) that requires the use of radio altimeter data.

For each mission, an operator must review their Rotorcraft Flight Manual and Operations Specification to determine if the use of radio altimeter data is required by provisions of Title 14 of the Code of Federal Regulations. If a radio altimeter is required and if the mission's flight path would overlap a geographic location identified by a 5G-related NOTAM, then the restrictions listed in the AD apply to that flight.

The first and third bullets impact specific segments of our industry. However, the fourth bullet, which prohibits takeoffs and landings in areas identified by 5G-related NOTAMs, has significant, far-reaching consequences for the rotorcraft industry's ability to conduct missions and provide public services, especially when you consider that prohibition applies to nearly 2,000 US locations.

The issue is not limited to radio altimeter performance alone. According to the FAA Safety Alert for Operators 21007 of Dec. 23, 2021, "a wide range of other automated safety systems rely on radio altimeter data." The agency goes on to note that 5G interference and the ensuing anomalous radio altimeter inputs could cause flight controls, including autopilots, to operate in an unexpected way, which pilots may not detect in time "to maintain continued safe flight and landing."

Alternative Methods of Compliance

To reduce these impacts of 5G interference, the FAA has implemented an Alternative Method of Compliance (AMOC) process. This process evaluates the installed radio altimeter aboard an aircraft and its ability to withstand spectrum interference.

To date, the focus has been on Part 121 carriers, and the FAA has done an outstanding job of streamlining the process to issue as many approvals as they have. We support these efforts for the airlines. The AMOC process is vital to ensure a healthy, viable US aviation industry. Currently the rotorcraft AMOC procedures have not been formally released by the FAA; the process is still being worked on and fine-tuned. We believe it is critical that FAA continue the same level of urgency and commitment, as they have had for commercial aviation, to mitigate operational impacts upon helicopter operations and the rest of general aviation, and the essential services they provide to save lives, protect communities, and support jobs.

The effects of 5G deployment are not limited to the nation's busiest airports, and mitigations by wireless carriers should not be limited to those locations either. As we start evaluating AMOCs for rotorcraft, we must recognize that the airlines' operational environment is vastly different than the one for rotorcraft. An airliner is only in the zone where it could potentially be impacted by 5G interference for a

short duration, generally during the critical period of takeoffs and landings. The vast majority of its flight is conducted at high altitudes, out of the range of 5G interference.

Conversely, helicopter operations, which generally take place at much lower altitudes than airline flights, could very well conduct their entire flight within the zones of interference. In addition, while airplanes must take off and land from airports, rotorcraft can utilize a much wider variety of sites, including heliports and unimproved locations such as streets, parking lots, or fields. The voluntary measures proposed by the wireless carriers would provide modest 5G limitations at the surface of public-use heliports, of which there are only 55 in the country. That number is dwarfed by the estimated 6,533 to 8,533 HAA landing sites in the United States, with more than 4,000 being private-use heliports co-located at hospitals.

HAI has partnered with the FAA to maximize the efficiency the AMOC process. Knowing that the FAA would be under immense pressure to approve a large amount of AMOCs, HAI took steps to ensure that critical helicopter operations could be prioritized. In cooperation with the FAA, HAI developed a 5G AMOC Portal, where operators can report how their operations are being impacted by 5G interference. These reports are shared with the FAA, providing the agency with additional intelligence on 5G impacts.

EXEMPTIONS

The other avenue to reduce the operational impact of 5G interference is the exemption process. HAI is pleased that the FAA partially approved a petition for exemption that HAI had submitted in anticipation of 5G C band deployment, seeking relief from regulations that require a normally functioning radio altimeter for certain operations.

This exemption allows Part 119 certificate holders authorized to conduct HAA operations under Part 135, subpart L, to continue Part 135 helicopter operations while employing radar altimeters that may not function normally due to 5G interference. The relief will also allow the use of night-vision goggles (NVGs) in HAA operations.

These exemptions are contingent on certain conditions and limitations. All pilots conducting operations under the exemption are required to receive and maintain a record of proper training. Additional conditions for NVG operations include the installation of a movable searchlight and a requirement for pilots or crew members to establish radio contact with ground personnel at a landing site so they can receive and confirm a description of the landing site.

To date, 40 HAA operators have submitted Letters of Intent to use the HAI Exemption. This accounts for 1,206 helicopters in operation, or 97% of the approximately 1,250 helicopters used in HAA operations.

This exemption provides a significant path for moving forward, not only for HAA operators but for the countless communities and hospital networks that would otherwise have been deprived of the critical life-saving support that can only be offered by helicopter operations. This exemption will allow HAA operators to continue to do what they do best—save lives.

THE PATH FORWARD

I want to be very clear: HAI and our members are not against 5G. However, due to our mission profiles and operational parameters, 5G interference is of particular concern to the vertical flight sector. We want to ensure that 5G is deployed in such a way that it can safely coexist with US aviation operations.

Under the exemption and with the proper mitigations in place, HAA missions can move forward. However, other rotorcraft industry sectors do not have similar exemptions that enable them to continue operations. Critical public-service missions, including firefighting, utility work, and law enforcement, and economically important ones, such as transportation and flight training, are severely constrained if operating in areas for which a 5G-related NOTAM has been issued. Additionally, emerging technologies such as advanced air mobility operations that are projected to begin operations in dense urban areas—the exact areas of 5G deployment—could face severe restrictions.

The development of new radar altimeters with filters that can withstand 5G interference is critical to the vertical flight industry's ability to continue flying and serving the public good. However, developing and certifying new radar altimeters will take time. Additionally, the cost for operators to purchase and install these new altimeters is of significant concern to the industry. My members ask why they should be financially responsible for installing new equipment to mitigate the safety risk imposed by another corporation's decision to deploy 5G wireless systems.

In the short term, HAI is focused on working with the FAA and the AMOC process to determine which radio altimeters and aircraft models can withstand 5G interference. Additionally, HAI will continue to explore for FAA approval exemptions and accompanying operational mitigations that will help operators to continue to provide aviation services to their communities.

In the long term, we urge Congress to enact the necessary reforms to provide better transparency, efficiency, and coordination on spectrum issues by the FCC and other government agencies. Various parties, including the Department of Commerce and its Federal Advisory Committee, have studied the issue of equitable access to spectrum in the U.S. and identified several recommendations. It seems clear that misaligned domestic spectrum policy, to the disadvantage of aerospace and aviation users, is what brings us here today. We do need to find a solution to address how a currently failed system can be fixed so that we are not in the same situation again. The deployment of 5G will not be the last spectrum issue to resolve. Let's begin to work now to ensure that the problems we faced with the 5G rollout will not occur in the future.

Ensuring the safety of those who fly—whether pilots, crews, or passengers—is always HAI's top priority. As such, we will continue to advocate for reasonable limitations on 5G deployment so that safety-critical equipment on helicopters is not compromised by harmful interference. HAI will also continue to work with regulators to develop solutions that maintain safety and preserve the helicopter community's ability to operate in a 5G environment.

I thank the Committee again for the opportunity to provide the perspective of the vertical flight industry and look forward to continuing our work together on these important issues. I welcome any questions.

Mr. LARSEN. Thank you very much for your testimony. And we will now turn to Ms. Baker from the CTIA. You are recognized for 5 minutes.

Ms. BAKER. Thank you, Mr. Chairman. And thank you for including the wireless industry in today's hearing. I am glad to be here together with the aviation leaders, and the keyword for me is "together." I am very happy to report that millions of Americans today are benefiting from next generation 5G service. Those same Americans are flying across the country and across the world safely. We got here thanks to a great deal of hard work in the past few years, particularly in the past few weeks.

We have shown that engineer to engineer there is a path forward together. As of today, 90 percent of commercial planes have been cleared demonstrating the successful coexistence of 5G and flights. We are committed to working to clear the remaining planes and being a good partner with aviation. I very much share the view expressed by American Airlines CEO Doug Parker that we are in the right spot.

Technical experts are encouraged and information sharing has been key. An agreement between CTIA, A4A, and AIA helped drive this breakthrough. I also share the confidence of Scott Kirby, the CEO of United, who said that we will get to a final resolution. Like him, I just wished it had happened earlier.

Rewind a few weeks and the press tried to pit the future of wireless versus aviation. That was always a false choice. We can and must have safe flights and robust 5G.

Nearly 40 countries around the world have shown us it can happen, and it is happening now in communities across our country. We have been preparing to bring C-band spectrum into service for years. A regulatory rulemaking, global study, this has been a bipartisan priority to drive our national wireless leadership and close the digital divide.

That extended process only reinforces how proud I am of AT&T, Verizon, and the U.S. wireless industry for being so responsive to aviation concerns.

After spending billions on spectrum license and billions more deploying networks, they hit pause. They took repeated steps to ensure that we are in the position we are today. They delayed, in the public interest, fully confident of our ability to coexist effectively. They first postponed their launch voluntarily for 30 days to give aviation more time to evaluate altimeter performance. They then took steps to reduce their power in the air to protect airports and heliports, all in response to aviation concerns.

Then they agreed to 2 additional weeks of delay. In doing so, they adopted even more temporary protections around airports. Still then, the carriers, the day before launch, agreed not to turn on cell towers in the immediate area around specific airports. The FCC called these the most comprehensive efforts in the world to safeguard aviation technologies. And they are.

This is the type of U.S. corporate leadership we need. These temporary steps are on top of the FCC's balanced rules that were the culmination of years of expert review, capturing the feedback of both aviation and wireless interests.

This hearing is rightfully focused on protecting aviation safety. We share that objective wholeheartedly and now have real-world evidence of it in the United States.

I wish to close by sharing how excited I am for our 5G future. Accenture just last week released a report noting that broadly deployed 5G will help us achieve up to 20 percent of the administration's climate goals.

5G will also create new home broadband competition and help close the digital divide in each of your districts. 5G is well worth the wait. That is why getting the full power 5G as envisioned by the FCC is so important, and it is why getting access to the next phase of C-band is so critical.

The enhanced collaboration between our industries will make that a reality. The last few weeks have given us a clear roadmap to do so. This is about our global competitiveness and creating new opportunities in towns, small and large. We will do all of that while ensuring safe flights. That is really great news, and we should celebrate that.

I look forward to your questions.

[Ms. Baker's prepared statement follows:]

Prepared Statement of Hon. Meredith Attwell Baker, President and Chief Executive Officer, CTIA

Chairman DeFazio, Ranking Member Graves, Subcommittee Chairman Larsen, Ranking Member Graves, and Members of the Subcommittee, on behalf of CTIA and the U.S. wireless industry, thank you for the opportunity to testify today.

Congress and this Committee have been laser focused on critical investments to our nation's infrastructure. The Infrastructure Investment and Jobs Act (IIJA) recognized the key role that 5G plays in closing the digital divide and supported low-income households so they can stay connected. These historic investments in both our physical and digital infrastructure are integral to our connected future across America.

Your leadership is also critical in supporting the safest air traffic system in the world. We can—and must—have both safe flights and robust and reliable C-Band 5G. I appreciate you holding this hearing.

THERE IS BROAD SUPPORT AND COMMITMENT TO ADVANCING C-BAND 5G AND AVIATION SAFETY

Last month, President Biden emphasized the U.S. Government's "commit[ment] to rapid 5G deployment" while ensuring that aviation will "safely co-exist."[1] The wireless industry fully endorses the President's statement and is committed to working collaboratively with altimeter vendors, aircraft manufacturers, the airlines, helicopters, airports, the Federal Communications Commission (FCC), the Federal Aviation Administration (FAA), the White House, and Congress—in sum, *all stakeholders*—to enable full-scale C-Band 5G deployments while maintaining air traffic safety.

The hard work over the last several weeks demonstrates that the United States can achieve the dual imperatives of air traffic safety and C-Band 5G. On January 19, 2022, AT&T and Verizon successfully launched 5G services in the initial tranche of C-Band 5G spectrum, the 3.7–3.8 GHz band, and Americans have continued to travel safely across the nation.

I am proud of how AT&T and Verizon responded in the face of concerns about C-Band 5G and the claims of potential interference to radio altimeters. Despite all available real-world evidence—including existing C-Band 5G networks operating abroad using the same frequencies with the same permitted power levels and with no reported incidents of interference to air traffic safety—AT&T and Verizon acted to allay public concern and to give the FAA and the aviation industry additional time to evaluate altimeter performance with 5G. Specifically, since the FAA issued its statement on 5G/altimeter co-existence on November 2, 2021, AT&T and Verizon delayed their launches twice and committed to three different sets of voluntary temporary measures.

I also want to thank the FAA for its actions in recent weeks to turn to an altimeter-by-altimeter review and keep Americans flying safely and with minimal disruption. As of January 28, 2022, the FAA has cleared 20 altimeter models and 90% of the U.S. commercial fleet for low visibility landings in the vicinity of C-Band 5G networks.[2] This clearance rate demonstrates co-existence is attainable.

With continued collaboration and enhanced transparency, and relying on sound science and good engineering, I firmly believe we will achieve an outcome that permits robust C-Band 5G and continued air traffic safety across the American skies. To that end, I am encouraged by recent statements from airline leaders. As United's CEO Scott Kirby said, "[w]hile I wish it happened earlier, the good news is we now have everyone engaged."[3] And American Airlines CEO Doug Parker noted that technical experts working on 5G and air traffic safety "seem encouraged that we'll be able to address this in a way that allows for full deployment of 5G, including near airports."[4] The wireless industry is committed to working with our aviation counterparts, the FCC, the FAA, and all of government to do the work necessary to achieve both robust C-Band 5G and safe skies.

THE PROMISE OF 5G AND THE IMPORTANCE OF C-BAND 5G

5G wireless broadband networks are transforming the way we live and work, with speeds up to 100 times faster than 4G networks, connectivity responsiveness that is five times quicker, and network capacity that can handle 100 times the number of devices. In the transportation sector alone, 5G is beginning to help foster driverless cars, increase the efficiency of public transportation, and improve roadway safety and save lives. 5G will help update and build the industries of the future, including healthcare, smart manufacturing, logistics, and agriculture. The Boston Consulting Group projects that 5G networks will add $1.5 trillion to America's economy and create 4.5 million new jobs over the next decade.[5]

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[1] Statement by President Joe Biden on 5G Deployment Agreement, The White House Briefing Room (Jan. 4, 2022) ("President Biden Jan. 4 Statement").

[2] FAA, 5G and Aviation Safety, https://www.faa.gov/5g (last updated Jan. 28, 2022).

[3] Chris Isidore, *Major airlines say the 5G doomsday scenario is over*, CNN Business (Jan. 21, 2022), https://www.cnn.com/2022/01/20/business/airlines-outlook-5g-truce/index.html.

[4] *Id.*

[5] Enrique Duarte Melo et al., *5G Promises Massive Job and GDP Growth in the US*, Boston Consulting Group (Feb. 2021), https://www.ctia.org/news/report-5g-promises-massive-job-and-gdp-growth-in-the-u-s. Conversely, delayed access to 5G spectrum has real impacts: every six-

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Further, a recently released Accenture study quantifies the importance of 5G wireless services to addressing climate change.[6] Accenture concluded that in the U.S., use cases on 5G networks are expected to enable a 20 percent contribution toward carbon emission reduction targets, helping the country meet its climate change goals. Accenture finds that 5G use cases will have the same effect as taking nearly 72 million cars off the road for a year.

Rapid deployment of the C-Band is key to the U.S.'s global leadership in this developing 5G ecosystem, with economic and national security implications. Our global competitors understand that wireless leadership means billions of dollars in economic growth and millions of jobs in the industries of tomorrow, such as Smart Cities and the Internet of Things. Unfortunately, other countries possess significant advantages in the availability of spectrum for wireless innovation—for example, China is freeing up hundreds of megahertz of mid-band spectrum for 5G.

Maintaining our global leadership in wireless and meeting the ever-growing demand for next-generation wireless requires access to spectrum, and the FCC on a bipartisan basis has made strides to open up new frequency bands that will power 5G. Mid-band spectrum is the "sweet spot" of spectrum innovation and is a key factor for 5G, as it provides high speeds over a broad coverage area, making sure no one gets left out of the New Economy. As a presidential candidate, Secretary Buttigieg committed to "[s]peed up next generation wireless expansion . . . support[ing] clearing more government and other spectrum (like the C-band)."[7]

But America is playing catch-up, as the U.S. has a limited amount of mid-band spectrum available to power 5G networks. Across the globe, the C-Band is the mid-band workhorse for 5G. Nearly 40 countries are already using this spectrum with no threat to air safety. In the U.S., policymakers and industry stakeholders alike have been working to open up the C-Band for 5G for years, including international review dating back as early as 2003 and more recently as part of a 2017 FCC inquiry and the 2018 bipartisan MOBILE NOW law.[8] In February 2020, the agency adopted a comprehensive order enabling 5G in the C-Band with carefully crafted technical rules to allow C-Band 5G to safely operate with altimeters. The FCC reviewed the concerns expressed by the aviation industry and concluded that "the technical rules on power and emission limits we set for the [C-Band 5G] Service and the spectral separation of 220 megahertz should offer all due protection to [altimeter] services in the 4.2–4.4 GHz band."[9]

In February 2021, the FCC completed an auction of 280 megahertz of C-Band spectrum that generated more than $81 billion for the U.S. Treasury—the largest spectrum auction in history. AT&T and Verizon won licenses in many of the most populated geographic areas in the 3.7–3.8 GHz band and, under the FCC's rules, paid incumbent users billions of dollars more to clear the spectrum by December 5, 2021. The remaining licenses, covering the full band from 3.7–3.98 GHz, are scheduled to become available for 5G by December 2023.

Following the auction, AT&T and Verizon sprang into action, investing billions of dollars to deploy C-Band 5G network infrastructure across the country, while thousands of employees worked to prepare the network, and thousands more were trained to engage with customers about C-Band 5G—all in the lead up to the scheduled launch, last December 5, 2021.[10]

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month delay in 5G deployment costs our nation's economy $25 billion in economic benefits over the next decade, risks America's competitiveness, and jeopardizes our ability to ensure global 5G leadership. *Id.*

[6] Monica Kuroki et al., *5G Connectivity: A Key Enabling Technology to Meet America's Climate Change Goals*, Accenture (Jan. 2022), https://newsroom.accenture.com/news/5g-enabled-technologies-could-solve-for-one-fifth-of-us-climate-change-target-by-2025-new-study-finds.htm.

[7] *Investing in an American Asset: Unleashing the Potential of Rural America*, Pete for America, Aug. 6, 2019, https://peteforamerica.com/policies/unleash-rural-opportunity/ [https://archive.ph/MiFF7].

[8] *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, 32 FCC Rcd 6373 (2017); MOBILE NOW Act, Pub. L. No. 115–141, Division P, Title VI, § 601 *et seq*. (2018).

[9] *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, Report and Order and Order of Proposed Modification, 35 FCC Rcd 2343, 2485 ¶ 395 (2020) ("*C-Band Order*").

[10] Letter from John Stankey, Chief Executive Officer, AT&T, Inc. & Hans Vestberg, Chairman and Chief Executive Officer, Verizon Communications, Inc., to Pete Buttigieg, Secretary, U.S. Department of Transportation & Steve Dickson, Administrator, FAA, at 2 (Jan. 2, 2022) ("AT&T Verizon Jan. 2 Letter"), https://www.politico.com/f/-?id=0000017e-1c36-dee4-a5ff-fe3e997f0000.

WIRELESS PROVIDERS' VOLUNTARY DELAYS AND STEPS TO PARE BACK THE C-BAND 5G LAUNCH HAVE ALLOWED AVIATION STAKEHOLDERS TO VERIFY 5G CAN CO-EXIST EFFECTIVELY

I am proud of AT&T and Verizon for their responsiveness to FAA and aviation concerns. The wireless providers have delayed launch twice, for a total of six weeks, and committed to voluntary measures restricting full-power C-Band 5G for six months in addition to the protections in the FCC's rules. The wireless industry remains confident that 5G poses no risk to air traffic safety but has taken these steps to allow the FAA time to evaluate altimeter performance with C-Band 5G.

On November 2, 2021, just over a month before AT&T and Verizon were set to launch the first C-Band 5G networks in the U.S., the FAA issued a pronouncement on C-Band 5G, a Special Airworthiness Information Bulletin (SAIB) identifying a potential risk of C-Band 5G resulting in adverse effects to altimeters.[11] The FAA sought information on altimeter design and deployment on aircraft, as well as testing results. The SAIB followed press reports a few days earlier suggesting there could be flight cancellations, delays or diversions if the FCC did not suspend C-Band operations.[12]

Although the FCC had conducted a rigorous analysis and found no harmful interference to altimeters, and the FAA's SAIB recognized that other nations' C-Band wireless networks have not resulted in any documented reports of interference, the FAA acted in large part based on a single, flawed industry study. In response, on November 4, AT&T and Verizon announced the first of what would become two delays in the launch of C-Band 5G. Specifically, the two wireless providers voluntarily postponed their C-Band launches for one month, from December 5 until January 5, 2022, as a show of good faith to help provide aviation stakeholders additional time.[13] The FCC and the FAA issued a joint statement, noting that "[a]viation safety and technology leadership are national priorities, and with today's announcement these companies have demonstrated their commitment to both." [14]

This first delay was followed by discussions with the government officials in which AT&T and Verizon provided vast and unprecedented access to their 5G network deployment designs, radiofrequency planning, and equipment performance.[15] On November 24, AT&T and Verizon announced they would supplement the FCC's restrictions with a set of voluntary precautionary measures that would last for six months, or until July 5, 2022, unless credible evidence exists that real-world interference would occur if the measures were relaxed.[16] The temporary measures took two forms: the wireless providers agreed to (1) lower the power of C-Band transmissions across America including nationwide limits on power projected to the sky (where altimeters are in use), and (2) effectively curtail C-Band operations in broadly defined areas near public airports and helipads. AT&T and Verizon certified these commitments, making them enforceable by the FCC.[17] The FCC recognized these new temporary measures as among "the most comprehensive efforts in the world to safeguard aviation technologies." [18]

On December 7, 2021, the FAA issued two Airworthiness Directives, stating that "radio altimeters cannot be relied upon to perform their intended function if they

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[11] FAA, *Special Airworthiness Information Bulletin; Risk of Potential Adverse Effects on Radio Altimeters*, AIR–21–18 (Nov. 2, 2021) ("SAIB AIR–21–18"), https://rgl.faa.gov/Regulatory_and_Guidance_Library-/rgSAIB.nsf/dc7bd4f27e5f107486257221005f069d/27ffcbb45e6157e9862587810044ad19/$FILE/AIR-21-18.pdf.

[12] Andrew Tangle & Ryan Tracy, FAA Plans Warnings to Pilots, Airlines Over New 5G Rollout, Wall St. J. (Oct. 29, 2021), https://www.wsj.com/articles/faa-plans-warnings-to-pilots-airlines-over-new-5g-rollout-11635524648.

[13] Cat Zakrzewski, AT&T and Verizon will delay 5G rollout over airplane interference concerns, Wash. Post (Nov. 4, 2021), https://www.washingtonpost.com/technology/2021/11/04/att-verizon-5g-delay/.

[14] Linda Hardesty, *AT&T, Verizon postpone C-Band rollouts until air safety review*, FierceWireless (Nov. 4, 2021), https://www.fiercewireless.com/operators/at-t-verizon-postpone-c-band-rollouts-until-air-safety-review#:~:text=-The%20FAA%20and%20the%20Federal,impact%20on%20aviation%20safety%20technologies.

[15] Letter from Joan Marsh, Executive Vice President of Federal Regulatory Relations, AT&T Services, Inc. & Kathleen M. Grillo, Senior Vice President—Public Policy & Government Affairs, Verizon, to Jessica Rosenworcel, Chairwoman, FCC, GN Docket No. 18–122, at 5 (filed Nov. 24, 2021).

[16] *Id.* at 6.

[17] Letter from Joan Marsh, Executive Vice President of Federal Regulatory Relations, AT&T Services, Inc. & William H. Johnson, Senior Vice President—Federal Regulatory & Legal Affairs, Verizon, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18–122, at 1 (filed Dec. 31, 2021) ("AT&T Verizon Dec. 31 Letter").

[18] *See* Matt Daneman, *AT&T, Verizon Limit C-Band Deployments Near Airports, Helipads Through July 6*, at 2, Commc'ns Daily (Nov. 26, 2021) (quoting FCC spokesperson).

experience interference from wireless broadband operations in the 3.7–3.98 GHz frequency band." [19] The wireless industry's temporary measures were not addressed at all in the directives. The Airworthiness Directives previewed restrictions that would be imposed on pilots with the release of Notices to Air Missions (NOTAMs) at a later date.

On January 2, 2022, following more discussions with the White House, the Department of Commerce, the FCC, the Department of Transportation, and the FAA, AT&T and Verizon announced a further set of additional voluntary precautionary measures for the same six month period, until July 5, 2022, again in the spirit of cooperation and good faith. The wireless providers adopted C-Band exclusion zones around runways at certain airports that mirror those that are already in use in France, one of the very few C-Band 5G nations with any airport mitigations, with slight adaptation to reflect the modest technical differences in how C-Band is being deployed in the two countries.[20] And on January 3, 2022, AT&T and Verizon agreed to a second delay for the C-Band 5G launch, from January 5 to January 19. President Biden praised the agreement and noted, "we're grateful to all parties for their cooperation and good faith." [21] Secretary Buttigieg and Administrator Dickson thanked AT&T and Verizon for these voluntary steps that "will give us additional time and space to reduce the impacts to commercial flights." [22]

U.S. providers have agreed to airport exclusions zones like France, large geographic protections for air traffic around airports, and a nationwide limit on power levels above the horizon for six months. No other country has such protections in place.

Beginning in early January 2022, the FAA issued nearly two thousand NOTAMs, restricting certain operations requiring altimeter data in the vicinity of airports and heliports.[23]

On January 18, a day prior to the C-Band 5G launch, AT&T and Verizon announced further voluntary temporary measures around airports.[24] Secretary Buttigieg noted, "[w]e recognize the economic importance of expanding 5G, and we appreciate the wireless companies working with us to protect the flying public and the country's supply chain." [25]

Secretary Buttigieg and Administrator Dickson also referred to the temporary measures as a better way forward, "while permanent fixes are rapidly put into place." [26] These voluntary delays and roll-backs of full-scale C-Band deployments have created economic burdens and disrupted network deployments, but AT&T and Verizon committed to these temporary measures in the public interest to give the FAA and aviation industry additional time to evaluate altimeter performance with C-Band 5G. And these steps put us in the position we are in today: the FAA has now cleared 20 altimeter models and approved 90% of the U.S. commercial fleet for landing in low-visibility approaches in areas with C-Band 5G.[27]

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[19] Airworthiness Directives; Transport and Commuter Category Airplanes, 86 Fed. Reg. 69984 (Dec. 9, 2021); Airworthiness Directives; Various Helicopters, 86 Fed. Reg. 69992 (Dec. 9, 2021).

[20] AT&T Verizon Jan. 2 Letter.

[21] President Biden Jan. 4 Statement.

[22] Letter from Pete Buttigieg, Secretary, U.S. Department of Transportation & Steve Dickson, Administrator, FAA, to John Stankey, Chief Executive Officer, AT&T, Inc. & Hans Vestberg, Chairman and Chief Executive Officer, Verizon Communications, Inc., at 1 (Jan. 3, 2022), https://www.faa.gov/sites/faa.gov/files/2022-01/USDOT%20Letter%20to%20ATT%20Verizon__20220103.pdf.

[23] FAA, FNS NOTAM Search, https://notams.aim.faa.gov/notamSearch/nsapp.html#/ (last visited Jan. 21, 2022).

[24] *See* Ian Duncan & Lori Aratani, Wireless carriers to limit 5G near airports after airlines warn of major disruptions, Wash. Post (Jan. 28, 2022) https://www.washingtonpost.com/transportation/2022/01/18/airlines-disruptions-5g-verizon-att/; Letter from Airlines for America, to Brian Deese, National Economic Council Director, Pete Buttigieg, Secretary, U.S. Department of Transportation, Steve Dickson, Administrator, FAA & Jessica Rosenworcel, Chairwoman, FCC, at 1 (Jan. 17, 2022), https://www.airlines.org/news/a4a-urges-immediate-action-to-address-5g-interference/.

[25] FAA, 5G and Aviation Safety, January 18, 2022 Statement from U.S. Transportation Secretary Pete Buttigieg (Jan. 18, 2022), https://www.faa.gov/5g.

[26] Letter from Pete Buttigieg, Secretary, U.S. Department of Transportation & Steve Dickson, Administrator, FAA to John Stankey, Chief Executive Officer, AT&T, Inc. & Hans Vestberg, Chairman and Chief Executive Officer, Verizon Communications, Inc., at 1 (Dec. 31, 2021), https://www.faa.gov/sites/faa.gov/files/2021-12/12.31.2021%20%20-DOT%20and%20FAA%20Letter%20to%20ATT%20and%20Verizon%20.pdf.

[27] FAA, 5G and Aviation Safety, https://www.faa.gov/5g.

WITH SOUND SCIENCE AND GOOD ENGINEERING, THE FCC SET STRONG RULES TO PROTECT ALTIMETERS

In the lead up to the 2020 *C-Band Order*, the FCC examined concerns raised about C-Band 5G/altimeter co-existence, taking into account comments by aviation interests, the nature of radio altimeters deployed on aircraft, and new C-Band 5G deployments. The FCC found—based on the record before it, global study of C-Band wireless dating back nearly two decades, and interagency dialogue—that "the technical rules on power and emission limits we set for the [C-Band 5G] Service and the spectral separation of 220 megahertz should offer all due protection to [altimeter] services in the 4.2–4.4 GHz band."[28]

These restrictions are rigorous and significant. The FCC adopted a substantial protective barrier, or guard band, that separates 5G C-band signals from aviation signals—a minimum of 220 megahertz from 3.98 GHz, the uppermost portion of C-Band 5G, to the 4.2–4.4 GHz altimeter band and, for the 3.7–3.8 GHz spectrum that AT&T and Verizon just launched, a separation of 400 megahertz. By way of reference, the *entire* FM radio band spans 20 megahertz. The 220 megahertz separation is more than twice the size of the separation requested by some aviation stakeholders in the FCC record.[29] And it is more than twice the size of the guard band in Japan, where 5G networks operate up to 4.1 GHz and down to 4.5 GHz, just 100 megahertz from the 4.2–4.4 GHz altimeter band, with no reports of interference to air traffic safety. The FCC rightly concluded that its large guard band and its carefully crafted technical rules on power and emission limits would fully "protect aeronautical services in the 4.2–4.4 GHz band."[30]

The FCC's technical rules mandate that wireless emissions beyond the C-Band 5G frequency border are *sixty million times lower* than the maximum power allowed for in-band C-Band 5G operations. And leading equipment vendors have confirmed that out-of-band C-Band 5G transmissions at the 4.2 GHz band, the edge of the radio altimeter band, are *one and one-half billion times lower* than the maximum power per megahertz allowed for C-Band operations.[31] The C-Band rules and systems are designed to be very good neighbors, greatly limiting the amount of signals that reach spectrum users in adjacent bands, let alone altimeter users operating hundreds of megahertz away.

To rebut the FCC's findings, aviation interests primarily rely on a single industry study,[32] but that study applied flawed methodology and implausible scenarios to claim interference. That study's flaws are now well documented.[33] And most notably, the study's assertions are contradicted by real-world deployments of C-Band 5G in nations around the world.

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[28] *C-Band Order*, 35 FCC Rcd at 2485 ¶ 395.

[29] *Id.* at 2484 ¶ 391 (citing Comments of The Boeing Company (Boeing Reply), GN Docket No. 18–122, at 5–6 (filed Dec. 11, 2018)).

[30] *Id.* at 2485 ¶ 395.

[31] *See* AT&T Verizon Dec. 31 Letter at 3 (citing Letter from Mark Racek, Sr. Director Spectrum Policy, Ericsson, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18–122, at 1–2 (filed Sept. 13, 2021); Letter from Jeffrey A. Marks, Vice President, Regulatory Affairs, Nokia, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18–122, at 1 (filed Sept. 21, 2021)).

[32] *See* RTCA, Inc., *Assessment of C-Band Mobile Telecommunications Interference Impact on Low Range Radar Altimeter Options*, RTCA Paper No. 274–20/PMC–2073, at 21 Table 6–4, 67 Figure 10–16, and 87 (Oct. 7, 2020), https://www.rtca.org/wp-content/uploads/-2020/10/SC-239-5G-Interference-Assessment-Report__274-20-PMC-2073__accepted__changes.pdf.

[33] *See, e.g.*, Letter from Kara Graves, Assistant Vice President, Regulatory Affairs, CTIA, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18–122, at 3 (filed Nov. 3, 2021) ("CTIA Nov. 3 Letter"); Letter from Kara Graves, Assistant Vice President, Regulatory Affairs, CTIA, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18–122 (filed Oct. 27, 2020); Letter from Kara Graves, Assistant Vice President, Regulatory Affairs, CTIA, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18–122 (filed Sept. 3, 2021); *see also, e.g.*, Letter from Doug Hyslop, Vice President, Technology and Spectrum Planning, CTIA to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18–122 (filed Aug. 26, 2020); Letter from Kara Graves, Assistant Vice President, Regulatory Affairs, CTIA to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18–122 (filed Oct. 30, 2020); Letter from Kara Graves, Assistant Vice President, Regulatory Affairs, CTIA to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18–122 (filed Nov. 17, 2020); Letter from Scott K. Bergmann, Senior Vice President, Regulatory Affairs, CTIA to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18–122 (filed Dec. 7, 2020); Letter from Kara Graves, Assistant Vice President, Regulatory Affairs, CTIA to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18–122 (filed Mar. 4, 2021). *See* Comments of CTIA, Docket Nos. FAA–2021–0953 & FAA–2021–0954 (filed Jan. 24, 2022) ("CTIA FAA Comments").

REAL-WORLD EVIDENCE FROM NEARLY 40 NATIONS CONFIRMS C-BAND 5G AND AIR TRAFFIC SAFETY

As stakeholders examine the possibility of interference to altimeters, it is important to account for the real-world experience of wireless broadband networks operating in C-Band spectrum in 38 countries in Europe and Asia with no reported impact on radio altimeters in the same 4.2–4.4 GHz band. The vast majority of these countries have no altimeter-specific restrictions on C-Band deployments. Many of these nations have C-Band 5G operations in the same band as AT&T and Verizon's Phase 1 spectrum (3.7 to 3.8 GHz) and with power limits that are the same or allow higher power than what the FCC adopted, including Czech Republic, Denmark, Finland, France, Ireland, Romania, and Spain and, overlapping part of the band, Greece and New Zealand.[34] The flawed aviation study would predict rampant interference to altimeters in these countries, but there has been none. While some nations authorize C-Band 5G at lower power levels than the U.S., those lower power levels would still cause widespread interference, according to the industry study that aviation interests rely on. That study invented a "safe" level of C-Band 5G dramatically lower than any C-Band 5G rules permit in any country; as but one example, the United Kingdom exceeds the aviation-purported "safe" level by 40,000x—with no reported incidents of interference to air traffic safety.[35]

Every day U.S.-registered aircraft, carrying thousands of U.S. citizens, land in these nations without incident. The FAA's SAIB recognized that no interference has been documented to date due to wireless broadband operations internationally.[36] And the European Union Aviation Safety Agency, the EU's authority for aviation safety, reported in 2021 that "[f]or the time being, EASA does not identify any conditions that compromise safety and reports no occurrences of interference from 5G base stations to aeronautical radio altimeters."[37] These real-world deployments, subject to regulation equivalent to or similar to the FCC *C-Band Order*'s spectral separation and technical limits, show that the U.S. framework for C-Band 5G "protect[s] aeronautical services in the 4.2–4.4 GHz band."[38] If interference were occurring, engineers would have seen it long before now across the globe.

NEXT STEPS: CHARTING A COURSE FOR RESOLUTION

The steps AT&T and Verizon have taken in the last few months have put the U.S. in the position we are in today: C-Band 5G deployments in the 3.7–3.8 GHz band, to the benefit of U.S. consumers and industry, with continued safe and secure air travel. The temporary measures have given time for the FAA to clear altimeter models and approve aircraft models without widespread, significant disruption to air travel. As noted above, these temporary measures halt in July, and by then we will be less than 18 months from the December 2023 deadline for incumbent relocation that will pave the way for launch of all 3.7–3.98 GHz C-Band 5G operations.

The wireless industry is committed to working as a good partner to resolve aviation concerns, and to do so promptly. These discussions must be guided by sound science and good engineering, and informed by real-world experience. Our track record shows we are committed to C-Band 5G and air traffic safety. We urge government agencies to engage collaboratively with industry, to be transparent in their analysis and their actions, and to identify the information they are relying on in their decisionmaking. With this framework, I am confident that we will continue to have the safest air traffic in the world and robust, full-scale C-Band 5G. I am hopeful that the positive collaboration in the past few weeks provides a clear path to resolution in timely fashion—well in advance of any deadlines—for the full-scale, nationwide launch of C-Band 5G across the 3.7–3.98 GHz band.

Thank you again for this opportunity to testify, and I look forward to your questions.

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[34] *See* CTIA FAA Comments at 9–10. *See also* CTIA Nov. 3 Letter (noting that at least two hundred thousand 5G base stations are already operating today with technical rules and proximity to radio altimeter operations that the aviation industry's modeling assumptions would suggest should be seeing harmful interference, yet no known reports of interference exist); Letter from Jennifer L. Oberhausen, Assistant Vice President, Regulatory Affairs, CTIA, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18–122, at 1 (filed Dec. 31, 2021).

[35] *See* CTIA FAA Comments at 11.

[36] *See* SAIB AIR–21–18 at 1.

[37] European Commission Directorate-General for Communications Networks, Content and Technology, *Commission Activities related to radio spectrum policy* at 5 (June 16, 2021), https://rspg-spectrum.eu/wp-content/uploads/-2021/06/RSPG21-018final__commission__activities.pdf.

[38] *C-Band Order*, 35 FCC Rcd at 2485 ¶ 395.

Mr. LARSEN. Thank you very much for the testimony.

I now turn to Dennis Roberson, president and CEO of Roberson and Associates, and I hope a proud Washington State University graduate. Dr. Roberson, you are recognized.

Mr. ROBERSON. Absolutely. Thank you. Good afternoon, Chairman DeFazio and Larsen, Ranking Members Graves and Graves, and members of the Aviation Subcommittee. Thank you for the opportunity to testify on this important topic. I am, as you have heard, Dennis Roberson, president and CEO of Roberson and Associates, the technology consulting firm serving both Government and commercial customers.

My testimony represents my personal views and is not provided on behalf of any other organization. As you know, on January 19th, high-speed 5G cellular service was launched by both AT&T and Verizon based on their spectrum auction wins last year. The aviation community fought this rollout over the last several months initially focusing on safety of life issues and more recently massive disruptions in the airline flight schedules.

This has been headline news with claims and counterclaims between AT&T and Verizon and the aviation industry. The cellular providers point to the nearly 40 nations who have successfully deployed 5G in the so-called C-band. While the aviation community countered and today included that many of these countries have significant restrictions on the spectrum use that did not exist in the United States.

All this has made for a very confusing and contentious situation marked by lack of information and the inability of the FCC and FAA to resolve the conflict in a timely manner. That is the top level state of play, but is there really a problem? And going forward, what should be done to resolve the current concerns?

First, the unfortunate truth is that there is a problem with the design of some of the aviation industries' older radar altimeters. Now to get a little technical, the altimeters are supposed to operate in their assigned spectrum bands between 4.2 and 4.4 gigahertz.

When these devices were originally designed, they had very low-power satellite neighbors. Since the altimeters operate on a radar principle looking for a signal reflected from the ground, their receivers couldn't detect the satellite signals. This led the altimeter designers to largely ignore their assigned spectrum boundaries and as a result, these receivers are sensitive to transmissions from far outside their assigned band.

For decades, this was not an issue, but with new neighbors moving in, these old altimeters now have a potential interference problem. Adding a little more technical information to the mix, the AT&T and Verizon 5G service operates from 3.7 to 3.8 gigahertz or 400 megahertz away from the altimeter band.

To put this into perspective, the whole FM radio band is only 20 megahertz wide. Because of the vast separation between the 5G cellular spectrum and the altimeter spectrum allocation, the FCC determined that there shouldn't be an issue. Unfortunately, this is not the case for old, technically wide-open altimeters.

Though the altimeters were once stand-alone instruments, today, as you have heard, they are highly integrated into the aircraft's avionics. If, for instance, the altimeters say the airplane is still in

the air when it is actually landed, the operation of the reverse thrusters and spoilers that rapidly reduce the airplane's speed on the ground will be blocked. I am told that on an icy runway, this failure could increase the landing distance by as much as four times, which for short runway airports, for example, Washington's Reagan National Airport, could be an enormous problem.

So, where do we go from here? First, my understanding and the good news is that most modern altimeters do not have a 5G interference problem. The FAA is currently determining both the robustness of various altimeter models and which altimeters are installed on which aircrafts, certifying those aircrafts that have altimeters that properly filter out 5G transmission.

Using this process, the FAA has cleared 20 altimeter models and certified 90 percent of the commercial fleet. Those aircraft that don't have appropriate altimeters should be required to replace their altimeters or suffer a significant reduction in the weather conditions in which they are allowed to fly. Given this straightforward, but critical set of steps, aircraft can be safely flown and landed in the presence of 5G technology. And importantly, AT&T and Verizon can fully deploy their high-performance 5G networks.

Thank you for the opportunity to testify before the committee this afternoon, and I, too, look forward to your questions.

[Mr. Roberson's prepared statement follows:]

Prepared Statement of Dennis A. Roberson, President and Chief Executive Officer, Roberson and Associates, LLC

Good morning Chairman Larsen, Ranking Member Graves, and Members of the Transportation and Infrastructure Committee's Aviation Subcommittee. By way of background, I am Dennis Roberson and I serve as the President and CEO of Roberson and Associates, LLC, a technology and management consulting firm serving government and commercial customers. In addition, I am a Research Professor at Illinois Institute of Technology and serve in advisory or board roles for several start-up companies in the technology space. Prior to my current roles I served as Executive Vice President and Chief Technology Officer of Motorola and over the years have held executive positions at AT&T, Digital Equipment Corporation (now part of HP), IBM and NCR. I also served as the Chairman of the FCC's Technological Advisory Council for the past eight years and serve on the Department of Commerce Spectrum Management Advisory Committee. My technical focus and personal passion through these roles has been to optimize the use of our nation's increasingly valuable spectrum resources through both technology enhancements and enhanced spectrum management policies and practices.

January 19th was the day that High Speed 5G Cellular service was launched by both AT&T and Verizon based on their very expensive Spectrum Auction wins at the FCC last year. The Aviation world including the FAA, commercial airline and private aircraft communities, airport authorities, and others have fought this roll-out for the last several months initially focusing on safety of life issues and more recently talking about massive disruptions in airline flight schedules. This has all been headline news with claims and counterclaims between the two major cellular providers operating in the contested spectrum band and the aviation industry. For their part, the cellular providers point to nearly 40 nations who have successfully deployed 5G in the so-called C-Band spectrum while the aviation community counters with the fact that these countries have significant restrictions on the use of the band which until recently did not exist in the U.S. All this has made for a very confusing and contentious situation created by the lack of information and the failures of the FCC and FAA to resolve their differences in a timely fashion while the cellular carriers have delayed their roll-out and altered their plans on an almost weekly basis. 19 January was the day when all the hoopla finally came to a head when AT&T and Verizon began to deploy their high speed 5G service minus any deployments within a few miles of a major U.S. airport.

That is the top-level state of play but is there really a problem and going forward what should be done now to eliminate the current concerns? First, the unfortunate truth is that there is a real problem, but it is what can be described as an "edge case" problem, that is, a problem that only occurs in unusual circumstances and for a very limited number of aircraft. So, what is the problem? Fundamentally, the problem is a design issue with the aviation industry's radar altimeters. These are the devices that sense how high the aircraft is above the ground and especially in bad weather when ground visibility is limited and runway conditions are suboptimal, this is a crucial component of an aircraft's ability to safely land. Now to get a little technical. The altimeters are supposed to operate in their assigned spectrum band between 4.2 and 4.4 GHz. Unfortunately, when these devices were originally designed, they had very low power neighbors, i.e., satellites beaming their information to the earth from very distant orbits. Since the altimeters operate on a radar principle looking for a signal reflected from the ground their receivers couldn't detect the very low power neighboring satellite signals. This led the early designers of the altimeters to decide they really could ignore their assigned spectrum boundaries and as result they allow transmitted energy far outside their band into the receiver. For decades this was not an issue given their quiet neighborhood, but with new neighbors now moving in (AT&T and Verizon), the spectral space that they were allowing into the receiver is now a potential problem.

Adding a little more technical information to the mix, AT&T and Verizon have now commenced operation in the spectrum range from 3.7 GHz to 3.8 GHz, i.e., 400 MHz away from the altimeter band. To put this in perspective, the whole FM radio band (all stations) is only 20 MHz wide, so the spectral separation between the new 5G cellular band and the altimeter band is very, very large. The FCC for its part when granting the use of the band (which will ultimately be expanded to cover 3.7 to 3.98 GHz) determined that there shouldn't be an issue because of the vast separation between the 5G cellular use of the new spectrum and the altimeter spectrum allocation. Unfortunately, this is not the case for old, technically "wide open" altimeters. These radar altimeters may send out a signal and be unable to discern the reflected signal because of energy from the far away 5G towers entering the receiver, causing the radar altimeter to either fail to function or possibly provide a false reading.

To make matters worse, though the altimeters were once only a standalone instrument that had an altitude indicator on the pilot's panel, today the altimeter is highly integrated into the avionics for modern aircraft. If for instance the altimeter says the aircraft is still in the air when it has actually landed, it will cause the reverse thrusters and spoilers that normally create a rapid reduction in the airplane's speed on the ground to not operate. I am told that in icy runway conditions the lack of reverse thrusters and spoilers could increase the landing distance by as much as four times which for short runway airports (e.g., Washington's Reagan National Airport or even worse Chicago's Midway Airport) with the potential for poor landing and runway conditions could be an enormous problem.

So how do we get out of this mess? First, most of the time the situation is not nearly as bad as the dire challenges the worst-case scenarios would suggest. Modern altimeters are well designed and do not have the problem of looking far outside their assigned band. The addition of a very low-cost component, historically a small piece of ceramic, called a filter at the antenna input to the altimeter receiver eliminates the issue of looking outside the altimeters assigned band. Of course, retrofitting and certifying a new radar altimeter in an aircraft is a non-trivial expense in both time and dollars. Happily, most modern altimeters have filters and will not experience any 5G interference problem. The FAA is currently determining both the robustness of various altimeter models, having currently cleared some 20 altimeter models, and which altimeters are installed on various aircraft, certifying those aircraft that have altimeters that properly filter out 5G transmissions. Those aircraft that don't have appropriate altimeters should be required to replace their altimeter or suffer a significant reduction in the weather conditions in which they are allowed to fly. Using this process, the FAA has reported that approximately 90% of commercial aircraft have been certified for safe operation in the presence of 5G transmissions.

Given this straightforward, but critical set of steps, the aviation world can be returned to a safe environment in the presence of 5G technology and AT&T and Verizon can fully deploy their new C-Band systems including deployments around airports. As an important aside, while all of this turmoil has been proceeding, it should be noted that T-Mobile's deployment of high speed 5G is currently unimpeded by these concerns since it operates in spectrum that is even further away from the altimeter band at 2.5 GHz.

Hopefully this Testimony will help clarify the technical aspects of this high-profile issue and the way forward. I look forward to hearing the questions or comments that this testimony inspires.

Mr. LARSEN. Thank you very much for your testimony. I appreciate the technical descriptions in language we can understand here on the committee. I appreciate that.

And with that, I will turn to the chair of the full committee, Chair DeFazio, for 5 minutes.

Mr. DEFAZIO. Thank you, Mr. Chairman. I will go back to a question I put to the Administrator, which is, what happens at the end of 6 months?

Right now, yes, we have cleared 90 percent of the planes, but that is with exclusion zones and lower power in proximity to the airports. In the testimony of CTIA, they say that they will last for 6 months or until July 5th unless credible evidence exists that real-world interference would occur.

Well, the British aviation CAA found that, in fact, there is a viable interference threat to radio altimeters. France was cited by CTIA as well. We are doing exactly like France. Well, not exactly. They also have to deflect their antennas down and they have exclusion zones. Czech Republic has exclusion zones. They aren't doing those things for fun; they are doing those things because they think there is a real and credible threat to aviation.

So, then other places—well, the Canadians also are now adopting exclusion zones around 26 airports where base towers might be deployed. And then other nations, Japan, 5 percent of the power here—no. 90 percent below here. Australia, 76 below here.

We have the strongest signals and as initially deployed, no protections for aviation or airports. And we are saying, well, there are just a few old obsolete altimeters. Well, there is a NOTAM out on the 787, I think that is the most modern airplane in America's fleet, that their thrust reversers might not work in presence of 5G.

And I don't think they went out and bought an old altimeter for the 787. So, this is real. So, the question I would have to the CTIA—I mean, I think that the companies have come around, but I know you are running an organization, the associations are generally run by the lowest common denominator member, and I think both Verizon and AT&T have recognized the real problems and we are trying to work through it, but I don't think that that is reflected in your testimony.

So, What do you think is going to happen after 6 months, Ms. Baker?

Ms. BAKER. Well, thank you for your question, Mr. Chairman. I would say that we are working cooperatively, as Administrator Dickson said, and that we have made a great deal of progress, and the cooperation continues. And so, it is my firm belief that the aviation industry is going to get comfortable with the idea that these guard bands that Dennis Roberson just mentioned are so significant that there will not be interference in the altimeter proceedings.

We feel confident that France is the outlier, and that most countries have not required any air support-specific protections. And the reason we keep mentioning France is because that is what AT&T and Verizon adopted in this temporary protections to give

the FAA time to address the altimeters. And as we can see, the FAA is rolling off of these altimeter restrictions as quickly as they can.

Mr. DEFAZIO. But—excuse me. But France is permanent. I am not aware that it goes away in 6 months. Czechoslovakia exclusion zones are permanent; they don't go away in 6 months. Canada, the exclusion zones are permanent; they don't go away in 6 months. And we are talking about, in 6 months, we are not going to have exclusion zones anymore, and we are going to be just so much more comfortable than France, Czechoslovakia, Great Britain, and Canada, that we are like, yeah, it is OK. Because then as soon as I land, my God, I am going to be able to stream 5G while I am still sitting on the airplane. Wow. That is great. I would rather know that I am going to land safely than being able to do that.

Ms. BAKER. Mr. Chairman, with due respect, I think the chart that you are working on doesn't fairly capture the most recent conditions. 5G is deployed in France in the same band, and the authorized power in France is higher than the FCC rules. France is only one of three nations with airport-specific specifications today. And we applied that protection temporarily to help the FAA process.

Given our nationwide limits skyward and the airport protections, the U.S. provides more protection today than France does for aircrafts. Again, France is an outlier, and there are at least——

Mr. DEFAZIO. And Canada——

Ms. BAKER [continuing]. To have——

Mr. DEFAZIO. And Canada and Czechoslovakia and many other nations that operate at a fraction of the power here in the United States who haven't seen fit to have to have exclusion zones because they are not worried about extraordinarily large high signals, strong signals interfering.

Thank you, Mr. Chairman. My time has expired.

Mr. LARSEN. The Chair recognizes Representative Graves of Louisiana.

Mr. GRAVES OF LOUISIANA. Thank you, Mr. Chairman.

Under the current 5G rollout plan, telecom providers are going to be, I guess, using the space in the vicinity of airports in a 3.7 to 3.8 band. They are going to temporarily delay the 3.8 to 4.0 as a cushion in the interim period.

Mr. Roberson, I am curious, could you talk about whether you believe that current 3.7 to 3.8 is going to cause interference with radio altimeters? Do you think that the cushion of 3.8 to 4.0 is sufficient at this time?

Mr. ROBERSON. Yes. As I testified, it is a very large cushion. It is really an unprecedented amount of spectrum that separates the 3.7 to 3.8 to the 4.2 to 4.4.

Mr. GRAVES OF LOUISIANA. And so, at this point, you don't anticipate that there will be conflicts with radio altimeters with that type of cushion in place?

Mr. ROBERSON. There should not be. It is possible to create it. And as I testified, in early days, because there was no strong signal anywhere in the vicinity, radar altimeters were designed without any filtering at all. So, they saw anything in a very, very large area. But with filters—and we should identify that filters are little

pieces of ceramic, historically, that cost nickels and dimes. I have actually personally made them in Motorola, as their executive vice president/chief technology officer. So, it is a very small thing.

But I do understand why, in the earlier timeframes, since there was no interference outside the band, that the designers chose to eliminate those because there was no reason for them. But now there is, and now these altimeters do have a problem. But those are old altimeters. My understanding is that new altimeters do have the filtering, which is appropriate, and therefore, don't have a problem.

Mr. GRAVES OF LOUISIANA. Which is why when I spoke earlier that I think that engagement with RTCA to make sure that appropriate technological sort of protocols in manufacturing moves in a direction to ensure consistency there.

Ms. Baker, thank you for being here today. I appreciate your testimony. As we noted in opening statements, I think you heard a lot of frustration across the panel with just how we found ourselves in this situation. Certainly, 5G is not the latest—or, excuse me, going to be the end all/be all in regard to technology. We are certainly going to be moving, in fact, already are moving in the direction of 6G and 7G.

Can you share a little bit about your lessons learned in this process and how we prevent, moving forward, these types of conflicts from happening again?

Ms. BAKER. Well, thank you so much for your question. And I think we share your frustration, because we followed the FCC rules. The FCC came out with their rules in March of 2020. And, how this didn't get resolved before—certainly before the auction in December of 2020, I don't understand. I have worked at NTIA. I know the Government's IRAC process, that is the interagency coordinating process, should have driven a resolution. I have seen that process work on really hairy spectrum issues from broadcasters to DoD to FBI surveillance.

I wasn't there, so I can't speak to why it didn't work here. But we need to get the agency input early, and let the spectrum engineers do their job. Because this is a technical engineer issue, and we have the best engineers, certainly the best spectrum engineers in the world.

I think now that we have a permanent head of NTIA in Alan Davidson and Jessica Rosenworcel as Chairman of the FCC, they have an opportunity now to take a fresh look at what is working and what is not, and we certainly hope that they will.

Mr. GRAVES OF LOUISIANA. Thank you. I appreciate it.

I want to make note there was an article in Politico today, I think, indicating that my friends over here had a meeting with the FCC. And I do just want to urge—I am very disappointed FCC is not here today. I heard there was a scheduling conflict, which I think, as important as this issue is, that this should have been the priority as opposed to other things. But I do want to make sure that we all acknowledge this is a bipartisan issue; we should be working together on it.

And in addition to frustration with the FCC not being here, I want to remind my friends next to me and down the aisle there

that we would be happy to join them in future meetings with the FCC.

I yield back.

Mr. LARSEN. Thank you.

I will recognize myself for 5 minutes.

Mr. Fanning, in my opening testimony, I talked about the process moving forward, in part, the technical process moving forward. We have a rollout that will continue in the 3.7 to 3.8. Then we have a rollout from 3.8 to 3.98. And then there is the future of 5G, and then there is 6G, and there are options in the future as well. And I said, well, I thought maybe we could create an informal technical process. And maybe it is not the RTCA process, but something that is more informal that can begin to inform some of these technical issues before they get formalized and then passed up to the process.

Have you all at AIA thought about this type of new process or a different process so that we are helping to get ahead of these issues in the future?

Mr. FANNING. Thank you, Mr. Chairman. We have. The groundwork for that is starting, even as we speak really, in the last month, the great work that is being done between the aviation industry and the telecom industry. There is a lot of sharing of data, a lot of coming together, a lot of understanding of each other's sides, as you and Ranking Member Graves talked about in your opening comments. And we need to build on that, not just to answer Chairman DeFazio's question about what happens at the 6-month point, what happens between that point and when we solve and implement the issue that we are faced with now, but that we continue going forward, so we don't find ourselves in the place we are now, and we can avoid what Dr. Roberson talked about, which is making sure that everybody who is in spectrum is cognizant of how spectrum is being used elsewhere and all new entrants are as well.

So, I think part of what we would suggest for a new process going forward is that we expand the definition of "stakeholder" to be more exclusive. Other Government agencies like the Department of Defense, industries that aren't just in the band that is being discussed but are adjacent to it, because we have been building out spectrum and utilizing spectrum, increasing how we utilize spectrum over decades. And so, it has become more complex in many ways.

What we saw here was, we are regulating spectrum in the 21st century using a 20th-century model. But I do think that there are indicators that we are already doing this informally, because a lot of important work is being shared.

Mr. LARSEN. Yeah. Thank you. I will explore that later after the hearing with you all. I need to move on to Captain DePete.

And, Captain DePete, in your testimony, you discussed added workload about 5G deployment that has been created for pilots and a level of uncertainty. Can you expand a little bit on what added workload, how that has been put on pilots as a result of the 5G rollout?

Mr. DEPETE. Certainly. And thank you for the question, Mr. Chairman. And also, Nick, I know you referred to this in terms of

the human factors that are involved with this. We operate the safest air transportation system in the world here, and that has been through collaboration. And I do find it somewhat ironic, if I might just begin by saying that we have—and this is not to be funny, but in the "Cool Hand Luke" movie—the failure to communicate. These are communication companies that we have been asking a long time to collaborate with that have rejected those offers.

So, having said that, our pilots are really becoming quite saturated by the number of NOTAMs that are outdated. A lot of work goes into preparation for a flight. And I know Representative Stauber has spoken on many occasions about the conditions of the NOTAM system. And I know the work in this committee has been extraordinary to try to push that along to improve that process.

But you can imagine, in a busy cockpit, in a situation where an airline may need to divert into an alternative airport, the amount of work involved in that, especially since the AMOCs could be changed regularly, right? They are specific to runways, they are specific to airports. Now our crews also have to know what particular equipment they have on their airplanes, what the configuration is. And as Administrator Dickson had pointed out earlier, that is very dependent on a lot of different things, including how those systems are connected to the other safety systems on the airplane.

So, yeah, I am not as sanguine about this at the moment as I have heard some others. In fact, I am concerned very much. And I think Chairman DeFazio, I think, articulated it very well. What is going to happen in 6 months, right? We are going to have to continue to work this.

Thankfully, we have on every airplane a minimum of two well-trained, well-qualified, adequately rested pilots; the most highly trained pilots in the world. But this is on their shoulders. They have to sign for the airplane every day. I am not sure the telecommunications CEOs have to sign and say, this should not be a problem. That doesn't work in aviation. And all the people on this committee know that, right? You have all worked together. That is why we have achieved the greatest, I mean, I think in the history of humankind, the safest form of transportation. And when you consider the conveyance, it is remarkable.

So, I know I ran out of time, but I think that answers your question.

Mr. LARSEN. That does answer my question, and——

Mr. DEPETE. Thank you, sir.

Mr. LARSEN. Thank you. I will be able to maybe return to a second round.

Mr. DEPETE. Sure.

Mr. LARSEN. With that, I will recognize Representative Balderson of Ohio for 5 minutes.

Mr. BALDERSON. Thank you, Mr. Chairman. Sorry about that. I hit the button with my notebook.

Thank you all for being here, the witnesses being here for our second panel today.

My first question is for Ms. Baker. CTIA has been deeply involved in spectrum allocations for broadband services, including many instances where spectrum was relocated from Federal use or

where specialized sharing and coexistence issues have to be worked out between commercial users and Federal institutions.

Can you discuss the FCC's role, as the expert agency in radio interference matters, how Federal agencies typically resolve such matters with commercial users through the NTIA, and whether the FAA followed these processes in this case?

Ms. BAKER. Well, thank you very much for the question. And I can't speak to the specific whether the FAA followed this or not, because I would not have been in the room. I will say, typically, there is a Government agency called the IRAC at NTIA. They are congressionally mandated to advocate for Federal Government users.

As I think maybe you mentioned earlier, spectrum is at a premium, and the using of spectrum efficiently is allowing us to continue to lead the world in many, many of, you know, automated transportation, wireless, broadcasting, you name it.

So, I do think the FCC and the NTIA coordinate on the Federal and the commercial spectrum, and they have been able to work out multiple really complex deals, such as moving broadcasters, such as relocating DoD radars. I think I mentioned AWS–3, which was a DOJ and FBI surveillance.

So, when they say that we haven't shared data, we are competitively sensitive in where we roll out and what the individual launching of cell sites are. So, this is not something that the FCC considers. They consider back to the guard bands. They consider whether the spectrum that they are allocating, which typically a guard band is 5 megahertz, here it is going to be 200, whether that causes interference.

So, there is a very complex process, and Congress has weighed in multiple times on how to relocate and what gets paid for, frankly. That is the Government's job.

Mr. BALDERSON. OK. Thank you very much for that answer.

My next question is for Mr. Roberson. Thank you, Mr. Roberson, for being here. You were on the FCC's Technical Advisory Board for the C-band order. Can you provide some insight on how the FCC came to the conclusion that the mitigation measures adopted in the order would be enough to protect aviation safety?

Mr. ROBERSON. Yes. Unfortunately, a little correction. The Technological Advisory Council specifically is precluded from weighing in on any issue that is before the FCC. So, the Technological Advisory Council serves as the headlights, looking out into the future.

Now, having said that, the Technological Advisory Council, along with many Government agencies, identified that mid-band spectrum was crucial for 5G competitiveness, and, therefore, it is something truly important for the United States for competitiveness with the rest of the world to have capabilities in that spectral area. And, in fact, Congress dictated that that area of spectrum should be considered.

As to the specific details of what were done, that is beyond my purview of the details. But I will note that how FCC works on these kinds of issues is to secure information from all available sources, and then based on what has been input into the docket, for their engineers to carefully review that material and then render a decision. So, that is how the process is supposed to work.

Mr. BALDERSON. OK. My followup—and thank you for clarifying that. My followup—and we are short on time, because I always like to give the chairman back extra time—can you expand on Ms. Baker's insight regarding the FCC's role as the expert agency on radio interference matters?

Mr. ROBERSON. Not really. I thought she provided an excellent answer. There is a process through the NTIA as the agency that provides the information to the FCC's docket, representing all groups, FAA, DoD, all the rest. And that process, no involvement, but as has been reported, there was apparently a breakdown in that link of getting information from the FAA into the FCC docket.

Mr. BALDERSON. Thank you very much. I appreciate that.

Mr. Chairman, sorry. I almost tried.

Mr. LARSEN. You were so, so close, Representative Balderson.

I will say it is pretty clear there was a big breakdown in NTIA delivering that information to the FCC.

All right. Next up is Representative Kahele of Hawaii.

Mr. KAHELE. Aloha, Mr. Chairman. And thank you so much for the second half of this hearing.

My question is for Captain DePete. Captain DePete, you know as well as I do that safety is nonnegotiable. Pilots will fly when it is safe to fly. And we must not and cannot put profits above the safety of our pilots, our flightcrews in the back, and our passengers. This process between the selling of the C-band to wireless companies through the FAA airworthiness directive has forced pilots, especially our regional pilots and general aviation pilots, to perform extensive maneuvers to ensure the safety of the flight due to the potential for radar altimeter interference.

Captain DePete, you stated in your testimony that the FCC proceeded with the spectrum action without acknowledging ALPA's concerns. When did and how did ALPA first raise these concerns? And as the arbiters of safety, how can we ensure in the future that pilots' concerns, like ALPA's, are taken more seriously?

Mr. DEPETE. Representative Kahele, thanks a lot for that question. Very important one obviously.

So, it just so happens I have a document here that is six pages of single-spaced. For us it began, actually, prior to 2018. But in 2018, we made an official request to the FCC expressing our concern about this. And then I would gladly provide this into the record for the committee to just see what ALPA had done since that time.

And we have pretty much tried to go everywhere we could go to—including FAA and other—with DOT, everybody, to bring this to everyone's attention. And it was ignored. It was ignored by the FCC, and it was also ignored by the telecom industry. And I think they need to understand too, Representative Kahele, how we created this safe system that is not a forensic model anymore. It is a risk-predictive model where it is 1 billion to the chance of something going wrong, and that is why it is such an amazingly safe system. And our pilots planned and took a role in it. Our pilots are the essential workers, right? They are frontline workers who took us through COVID. And now we are looking at these kinds of human factors concerns which really were unnecessary. It is an introduction of risk that was completely unnecessary.

So, we are doing all we can. We are not going to let work let up. I mean, thankfully, Administrator Dickson has been highly accessible. I speak to him probably every other day. He has been holding briefings regularly to inform us all, so that has been good.

And then on our aircraft itself, it is always a challenge too, as you know, to be able to discern how you are having an interruption, right? We don't have a 5G light on the cab. Now, if it is an inoperative radio altimeter, obviously we could spot that quickly. However, if it is false or erroneous information, that is where the problem comes.

But what I can say is this: By representing 62,000 pilots who are doing an incredible job handling this situation, we are the last arbiters of safety, and the airplane never leaves the gate unless it is safe to do so. If they don't continue to share the information, the airplanes won't fly. They will make a decision. No airplane will ever leave the gate unless the pilots understand it to be safe because they are the ones that sign for the aircraft. I hope I answered some of those questions.

Mr. KAHELE. Yeah, you bet. And just I will use the remaining 1½ minutes for a followup.

Mr. DEPETE. Sure.

Mr. KAHELE. I know ALPA probably has and is having to track—this is a lot of information—a spreadsheet with aircraft——

Mr. DEPETE. Uh-huh.

Mr. KAHELE [continuing]. Height, equipment, AMOCs, expiration dates. I talked earlier to Administrator Dickson about how the State's flagship carrier Hawaiian Airlines has AMOCs for all their airfields that they travel to, but they are going to expire in 25 days, and why this AMOC exemption is really important. Because if we don't have this, then pilots are forced into this bracket where, if the weather was zero-zero at a destination, and they can't get into that airfield, they are going to have to divert to their destination ultimately. And if they can't get in, everyone else can't get in either. So, now you have 36 planes lined up at a destination alternate, you have fuel issues, you are number 27 in line. Can you speak to that from our pilots in the flight deck that have to deal with that?

Mr. DEPETE. Absolutely. As an instructor pilot myself too, I have seen the workload rise in a cockpit pretty dramatically at times, right, when we are handling a situation. But in a divert situation in particular, right, you know as well as I do how busy it can get. But imagine now to have to consider all these other possibilities, knowing the configuration of the aircraft, ensuring that you have the data so the dispatch of our company's—the company's dispatch offices are going to be really, really tasked in ensuring that they are feeding us really good information. If we make the—if it is not accurate, up-to-date information, obviously it could lead us down a rabbit hole we don't ever want to go in.

So, it is challenging, and it is really falling on the shoulders of our pilots. But, thankfully, we are the most well-trained pilots in the world.

Mr. KAHELE. Thank you, Captain DePete. And mahalo.

Mr. Chair, I yield back.

Mr. LARSEN. Thank you. The Chair recognizes Representative Fitzpatrick of Pennsylvania for 5 minutes.

Mr. FITZPATRICK. Thank you, Mr. Chairman.

Captain DePete, good to see you, sir. Two very brief questions, revisiting the altimeter issue. Radio altimeters are one of the most important instrument a pilot has. Any interference, obviously, is unacceptable. Two questions. Could you tell us what warning signs or ways to tell if a radio altimeter is experiencing interference while in flight? And second, regarding your opening statement about the anomalies, could you explain these instances and describe how common altimeter irregularities are in general?

Mr. DEPETE. Representative Fitzpatrick, great to see you again. Thank you for those two questions.

As I indicated it from Representative Kahele, it is very difficult to tell, right? If it is an inoperative radio altimeter, we have that occasionally happen, although they are hugely reliable, we have been doing fine landing in airports all over the world, right, without this problem. 5G introduced a new risk. But if it is inoperative, we can probably put that together pretty accurately. However, if it is erroneous information, that is where the key is, in that you don't know it is erroneous. You are going to rely on a lot of [inaudible] with these integrated systems on more modern airplanes.

We are talking about connections to terrain awareness, EGPWS, throttles, our throttles, right? An uncommanded reduction in our throttles to idle while we are on close final in a wide-bodied airplane can create a rapid sink rate. So, our pilots are going to really Johnny-on-the-spot on this and really be ready to react and, thankfully, they are well-trained and they can do that. But it is unfortunate we put them in that situation.

So, did that answer that part of that question? What was the second part, again, I am sorry?

Mr. FITZPATRICK. Just explaining, regarding your opening statement——

Mr. DEPETE. Yeah.

Mr. FITZPATRICK [continuing]. Some of the instances and describe how common altimeter irregularities are in general.

Mr. DEPETE. Yeah. No, they are very reliable systems, and we have more than one, so, it has been really good. And it depends, like, in terms of the particular configuration on the airplane and the way they are wired into the systems as to how those anomalies would be shown to the flightcrews. So, that is where the complexities really begin. And throw on top of that the issues that we talked about before with the number of NOTAMs that have been put into the system now makes for a very challenging environment.

So, along with flying the airplane, we are having to manage this 5G situation, which from a human-factor standpoint, not the best.

Mr. FITZPATRICK. Thank you, Captain. Good to see you.

Mr. DEPETE. Thank you. You too.

Mr. FITZPATRICK. I yield the balance of my time to Representative Graves of Louisiana.

Mr. GRAVES OF LOUISIANA. Thank you, Mr. Fitzpatrick, I appreciate that.

I want to ask, following up, Ms. Baker, a quick yes or no question. Do the telecoms have any type of shield from liability? Are you held harmless if there is an interference issue that leads to an accident?

Ms. BAKER. I don't know. I would say we take our—we take our mission so seriously. We also have 911 delivery. And I would have to defer to lawyers as to any sort of safe harbor, but I would say no harmful interference is, in fact, what we do for a living and take it very seriously.

Mr. GRAVES OF LOUISIANA. Thank you.

Mr. Calio, the AMOC process, the alternatives that we discussed earlier, do you have concerns about the ability for the airlines to safely and, I guess, efficiently operate under this process?

Mr. CALIO. Yes, we do. Right now, it is, like I said during my oral testimony, it is a constant ebb and flow. And Joe just referenced the pilots. It is ever-changing.

And I would like to clarify one thing. Ninety percent of aircraft have been cleared, but they haven't been cleared to land everywhere. That has a particular impact on the regional carriers, which I think needs to be looked at. But this constant churn of AMOCs once every month is something we can't continue to live by because we can't do a 30-day rolling operational planning process.

So, we are working together very carefully right now. Our engineers are talking to the engineers from the telecom camp, from the FAA and the manufacturer. So, that is producing good results for right now. We need to come up with a better process long term, because this can't be kept in place where every 30 days it changes where you can fly, when you can fly, how you can fly, which runway you can fly into.

Mr. GRAVES OF LOUISIANA. Yeah, I agree. Thank you very much.

Ms. Baker, coming back to you, look, the telecom industry, the FCC deals with deconfliction across technology all the over the place. This one dealing with aviation shouldn't be the first time we tread into this category. Is there a process that other administrations have used to help with deconfliction that result in a better outcome?

Ms. BAKER. This was option No. 107, and I have never seen anything like this before. So, I would say this is an anomaly. And, hopefully, we have got all the processes in place now to make sure that we are working with the aviation industry as cooperatively as possible. But, yes, the FCC takes comments, and they have spectrum experts that handle these issues all the time.

Mr. LARSEN. Thank you.

The Chair recognizes Representative Johnson of Texas for 5 minutes.

Ms. JOHNSON OF TEXAS. Thank you very much, Mr. Chairman.

I would like to ask Ms. Black——

Mr. LARSEN. Representative Johnson, do you have a radio or something on in your office? Otherwise, if everyone can please mute.

Ms. JOHNSON OF TEXAS. Hold on. I am sorry. That is a meeting with me in the White House.

Mr. LARSEN. Well, you will need to mute whatever meeting is taking place in order to ask questions.

Ms. JOHNSON OF TEXAS. I am getting rid of it. Thank you. I am sorry. I am multitasking.

But, Ms. Black, both DFW and Love Field Airport have numerous regional flights from Dallas to smaller cities throughout the

southwest region in the State of Texas. And I am concerned about 5G technology's possible effect on small groups and smaller airports. Would you be able to elaborate on that concern?

Ms. BLACK. Yes. And thank you very much for that question, Congresswoman. And that is exactly the point. You are right to be concerned about that. I want to say again, these are aircraft that were perfectly fine and certificated appropriately, but they now need AMOCs to operate in an environment that has been compromised by the 5G signal.

About 14 percent of the regional fleet have no AMOC at all and no AMOC pact pending. Another 40 percent of the fleet, as Nick said just before, has a very limited AMOC, excludes dozens of airports. So, altogether, one or both of these fleet types are still restricted for 70 airports in weather.

So, if you are in a hub, you might get restricted right there, but if you are traveling through that hub, then you don't get to your spokes. And in some cases, you might not have an AMOC at the hub or the spokes. These are aircraft—they are the only source of air service to smaller communities. With half of them sat down in weather at key airports, that is a big problem for smaller communities.

Ms. JOHNSON OF TEXAS. Thank you very much.

Now, Mr. Calio, I understand that 5G technology has been successfully implemented throughout Europe and in many Asian nations. What do you think is the difference here in the United States that makes us believe that we have got to do so much to mitigate this issue for how long?

Mr. CALIO. Thank you, Congresswoman. In our view, which is not Ms. Baker's view, there is a difference between what has been implemented overseas as to what is being implemented here. I think it points out, in fact, the divergence of facts, if you listen to the testimony, suggest again we need a better, more transparent, long-term process. These all should have been worked out ahead of time. We should not be arguing about this right now.

And this is not really an argument between us and the telecom. We take a very different view. We rely on the FAA as our safety regulator. They have engineers. They believe that there was a possibility of interference.

So, I would say, you have got different testimony on what happens overseas and what happens here. What we need to be looking for long term is an answer to not only why it happened, but more importantly, how we do not let it happen again and how we will resolve things going forward.

Ms. JOHNSON OF TEXAS. Thank you very much.

Now, perhaps both of you can comment on this. The altimeter plays an important role in airline flight. What would be the cost to replace the old altimeters on an average per plane?

Mr. CALIO. I will be happy to start. I do not know the answer to that at this point. What I do know, and Mr. Fanning can probably jump in here if you would like, but it is a very long-term process. Even to modify a current altimeter has to go through a certification process.

Again, the difference in culture between the FAA and the FCC, for example, is always—our imperative is safety. You cannot com-

promise safety under any circumstance. So, we are talking—that is why I said earlier in my oral testimony, this is a matter of years, not days and not weeks. Is it something that is being looked at? Yes. As the Administrator pointed out, yes, it is, but it is just getting underway, and it is going to take time.

Ms. JOHNSON OF TEXAS. Thank you very much.

Ms. Black, did you have—or anyone else like to comment on that?

Ms. BLACK. I would just add that this issue is going to be with us for years and years. So, we have already talked about rolling out 6G, 7G. So, will we need to go out and buy new altimeters every time we roll out at 6G or 7G?

Now, I don't have the exact cost either. I don't think they are nickels or dimes. But I do know that airlines spend millions of dollars investing in new safety tools, and so did airports, as Chairman DeFazio said earlier in the first panel, spent billions to become all-weather airports. So, we just want to make sure that all of these airports can use that technology.

Mr. LARSEN. Thank you very much.

Ms. BAKER. If I may, I would just like to——

Mr. LARSEN. I am sorry. No. I am sorry. The gentlewoman's time has expired.

And we will now go to Mr. Van Drew, Representative Van Drew from New Jersey for 5 minutes.

Dr. VAN DREW. Thank you, Chairman.

I want to thank everybody for being here today and their wonderful testimony. This is important stuff. Your organizations actually represent essentially the entire aviation and telecommunications industries, and it is a massive part of the United States economy.

Earlier today, I asked the FAA Administrator, Mr. Dickson, about how new entrants to the airspace, like drones, will complicate spectrum management into the future. I do not believe the FAA is currently equipped for the future of aviation spectrum management.

The current 5G crisis was foreseeable. Individuals within the FAA Spectrum Engineering Office have been sounding the alarm for nearly a year. The spectrum office did not have the authority to make this issue a priority until it was too late.

I believe that we must empower the Spectrum Engineering Office within the FAA. It must be provided greater procedural authority and voice so that our country is able to handle the spectrum challenges into the future.

So, I direct my question to Eric Fanning, president and CEO of Aerospace Industries Association, and Meredith Attwell Baker, president and CEO of CTIA. Do you think the current situation shows us that the FAA is not properly equipped to meet the spectrum challenge of the future, such as drone integration? Further, do you believe that the FAA Spectrum Engineering Office must be empowered with authority to better manage spectrum resources, get spectrum to market faster, ensure capability and compatibility, and prevent conflicts like the ones we are experiencing right now?

And if any other witnesses concur with this sentiment, feel free to make that known. Thank you. I will wait for your answer.

Mr. FANNING. Congressman, thank you. I will start and say that I think it is an issue of empowering for the FAA. And what I was saying earlier that all stakeholders, we need to think of this more broadly as we move forward as we use spectrum, its limited bandwidth, as we use it for more complex technology, stronger signals, we need to have all the stakeholders that are in spectrum empowered to be a part of the conversation. Some formalized new process that brings all of us together rather than just thinking of spectrum in stovepiped bands, to think about it in its entirety. Because, clearly, that is part of what the issue was here.

This was an FCC-controlled process, and the FAA raised concerns but wasn't empowered to do anything about it other than raise it. They have great engineers. They cooperate with industry which has world-class engineers. And so, I think we have to look across all the stakeholders in spectrum, certainly the FAA when it comes to aviation safety, and make sure that they are a part of the process in anything that we do as we expand what we use spectrum for going forward.

Dr. VAN DREW. Thank you.

Ms. BAKER. So, thank you so much for the question. And I would say the FAA is the safety regulator, and FCC and NTIA are the spectrum regulators. I fully support FAA having more engineering resources. I think many of the agencies that use spectrum could use more engineering resources, whether it is the Department of Energy, who regulates nuclear, or the Department of the Interior, who use spectrum to measure the height of rivers. I think everybody could use more spectrum knowledge now that we are using spectrum for so many different things.

I think that we need to take another look at the consultive process, because this is an NTIA issue that they should be able to raise the FAA's issues with the FCC and advocate for the FCC. We can't have everyone have their own special regulator of spectrum. We need to speak with one voice.

And so, I fully support the concept. I just want to be clear that the FCC and NTIA are the spectrum regulators who need to be fully informed, and agencies like the FCC—the FAA, excuse me, really do need to be part of this process and——

Dr. VAN DREW. Absolutely. I agree with you. And I think you hit it on the head. And we need the leadership. So, as all those voices come together, you also need the leadership so we are on the same page and we have the regulation that we need. I think we would do so much better. You can't have people in different spots doing different things not knowing, which is kind of what happened here, what the other fellow was doing. So, I think you really made a good point, and I agree with you on that.

And I yield back.

Mr. LARSEN. Thank you.

The Chair recognizes Representative Payne of New Jersey for 5 minutes.

Mr. PAYNE. Thank you, Mr. Chairman.

Let's see. I understand that aerospace companies are responding to 5G deployment concerns by utilizing filters on existing equipment as stopgap measures to compensate for signal interference. This would not have been necessary if there was proper commu-

nication across the Federal Government regarding the potential issues with 5G signals and technical concerns reached the appropriate parties. Inevitably, there will be a new technology to replace 5G.

Mr. Fanning, how would proper communication of technical concerns make future rollouts of new technologies less chaotic?

Mr. FANNING. Well, first and foremost, which I think all of the panelists agree with, is that the process starts earlier. So, there is something that we need to amend or modify to the process to make sure these concerns are surfaced earlier.

As was stated at the beginning of this hearing by the chair and the ranking member, there are different cultures, different goals, different agendas on these industries. And as a country, we need them both to succeed. And so, making sure that dialogue starts earlier and perhaps never stops, because we know there are going to be future auctions, future technologies introduced into spectrum, to make sure that all of the relevant players, the stakeholders, and those who are affected by it are at the table and can voice their concerns and have them acted upon earlier. Because we certainly have been—the airlines, the pilots, the manufacturers—have been talking about this for a very long time.

So, we need to make sure that there is not just dialogue but that there is a process in place to act on those concerns from an earlier point. Because we do have amazing engineers in all of our companies, but to reach the certification standards, the safety standards that aviation is held to for justifiable and important reasons, takes a lot of time. It is a very high bar to prove something won't happen, as Congressman Graves said, than to try and prove that it will happen.

Mr. PAYNE. Thank you, sir.

I am glad we are having this hearing, and all are coming to the same conclusions, and everybody is hearing the same information from each other across the whole gamut.

Ms. Baker, I am grateful that telecommunications companies and the Biden administration were able to reach a deal to delay 5G deployment near airports, including Newark Liberty International Airport. However, these exclusion zones will expire, and 5G service will be fully deployed. How will telecommunications companies work with the Biden administration to ensure that full deployment of 5G will not cause any additional safety concerns?

Ms. BAKER. Well, thank you so much for your question. The process now, everyone is at the table. We are working with the FAA to give them the information they need. They asked for it in November, we got it to them in December. We are every day making progress. I feel confident we will continue to make this progress.

So, in July, when the temporary restrictions, if they don't go way before—because I am hopeful that the FAA will understand that they are—and find and feel comfortable 100 percent that there is not interference here, that there are plenty of countries around the world, such as Denmark to Spain to Ireland, who are using the same spectrum with the same power levels, and there is no interference.

So, I am hopeful the FAA will be comfortable enough so when we reach—they roll off these temporary restrictions, and then when we

roll out in phase 2, which is December of 2023, we will already have the process in place to make everyone comfortable that there is no interference here.

Mr. PAYNE. OK. Well, thank you.

And, with that, Mr. Chairman, I will yield back.

Mr. LARSEN. Thank you.

I now recognize Representative Nehls for 5 minutes.

Mr. NEHLS. Thank you, Chairman Larsen and Ranking Member Graves. And thank you for having this hearing. I am truly glad that Administrator Dickson testified, but I am truly disappointed the FCC refused to be here today.

Both industries represented here today and their customers, the American people, have been failed by how the Government handled the spectrum auction and the concerns with altimeters. Just yesterday, on the Highways and Transit Subcommittee autonomous vehicle hearing, we heard about the FCC was looking into C-band for AVs in the nineties. That was 30 years ago, and we still don't have AVs on the road. It is mind-boggling that they had the foresight for that but auctioned off C-band for 5G without fully examining how it would impact the companies involved.

I definitely would have liked an explanation from the FCC so we could prevent this from happening again. And I am truly disappointed the Chairwoman refused to testify here.

I do thank our industry witnesses for being here. And my first question is for good Captain DePete. When operating an aircraft, how do pilots know if there is an interference problem with a radar altimeter in their aircraft?

Mr. DEPETE. All right. Thank you for that question, Representative Nehls. And in regards to your FCC complaint, you are getting the same silent treatment, the committee is getting the same silent treatment that we have gotten over the years. So, I certainly can commiserate with you on that.

In terms of trying to see and understand what is going on in an airplane, in the old airplane styles where we had federated systems, meaning that all the instruments were not digital and they were all spread out, we can kind of do checks and balances, see if one conformed with the other and make a decision on that and begin to go down a decision tree. In these new modern airplanes where the systems are integrated, which takes a great deal of understanding to understand how they are integrated because they are all different, it is a little difficult to discern sometimes what is actually happening in the airplane when there is a malfunction.

If it is just a malfunction, if it is broke, if the system just stopped working, there are warnings that will be alerted to the crew. However, if it is false information, that is the tricky one, right? And how it affects other systems. We might see that first manifested in itself with some unusual throttle activity. We might see it—unfortunately, you would think terrain avoidance would be pretty important. Imagine if we didn't get the warnings that we were approaching terrain that we should, right? Or we got them when we shouldn't, and that creates another problem as well.

So, that is a really outstanding question. I think that is the one I get the most of, and it is challenging.

Mr. NEHLS. Thank you, Captain.

And I have a couple of questions for Ms. Baker. Given that 5G is already being delivered to the U.S. public using other spectrum bands, what is the importance of rapidly launching C-band spectrum for 5G?

Ms. BAKER. Thank you so much. I am glad you asked that question. It is a really important one. 5G is—C-band is the background of 5G across the country. It is because it has unique characteristics, it goes very far, it carries a lot of data. And for this, it really will bring us—it is going to change. I think it is the most transformative technology that we have seen in decades. And it is going to happen to our economy, our education, our health, even our transportation.

I mentioned Accenture put out a report last week that said if we deploy 5G, we will be 20 percent on our way to achieving the administration's climate goals. So, it is really important not to delay for full power. If we do, we are just going to harm America and your constituents.

Mr. NEHLS. Thank you.

And my last question, a little lengthy here, but the volunteer precautionary measures agreed to by AT&T and Verizon will last for roughly 6 months from launch. Yet both have emphasized they anticipate efforts to reduce or eliminate those precautionary measures even before that 6-month period ends. Why is allowing full utilization of the C-band spectrum for 5G, i.e., used without the precautionary measures under the FCC's originally adopted technical rules, so time-critical? Do you understand that?

Ms. BAKER. I did. And thank you for that question, too. I think it is important to take a look at the temporary restrictions. Let's take the 2 miles, 2 miles within an airport. If you are in Rayburn—which I can't tell if you are—if you are in Rayburn and you go to National Airport, that is approximately 2 miles. If you are in Boston Logan and you go to Boston Common, that is 2 miles. So, that exclusion area is going to put large swaths of metropolitan areas and, frankly, a lot of underserved areas not being able to have 5G and just going to enhance the digital divide and leave people behind in a way that we just don't want to do.

Mr. LARSEN. The gentleman's time has expired.

Mr. NEHLS. Thank you both.

Mr. LARSEN. I will turn to—yeah, thank you—Representative Brownley of California for 5 minutes.

Ms. Brownley, no?

OK. Representative—OK. Congresswoman Holmes Norton for 5 minutes.

Ms. NORTON. Thank you, Mr. Chairman.

Now, my first question is for Mr. Viola, president of the Helicopter Association. I represent the Nation's Capital and, as you know, the President and Congress are located here. In your testimony, you noted increased risks of 5G interference to helicopters, given that helicopter operations generally take place at much lower altitudes than airline flights and could conduct their entire flight within zones of 5G interference.

The development of new radio altimeters with filters that can withstand 5G interference is, therefore, critical to helicopter and rotorcraft safety. But the cost for operators to purchase and install

these new altimeters is of significant concern. Could you estimate the cost to helicopter operators to upgrade to newer, more resilient radio altimeters, and how do helicopter operators plan to cover this cost?

Mr. VIOLA. So, thank you very much, Congresswoman Holmes Norton. I appreciate that question.

Helicopters are just so much different from what we have been hearing today, as far as when the radar altimeter actually kicks in. You heard a lot about the 121 in airlines where most of their flight will be without that radar altimeter because it actually turns off once you get so high above the terrain.

The helicopters use a radar altimeter a lot of times for—where it is actually known about is because of reduced visibility. So, when we have good visibility, the radar altimeter is a safety aspect that gives us additional, not only our eyes telling us how far we are off the ground, because normally—especially if you are talking about coming in to get the President or yourself or someone flying around the DC area, you are actually deconflicting with the airliners that are over the top of you, you are coming up the river. So, over the water, that is where the pilot will glance over to make sure that he has maintaining the proper altitude above the ground.

So, the importance of that and being able to not be affected by 5G in the filtering, you asked about the cost, I don't actually have the cost for those. And, of course, a lot of those aircraft are going to be on the military side, too. And I haven't been read into how much work they have been doing with the military aircraft to try to upgrade their radar altimeters. A lot of this——

Ms. NORTON. Could the cost impact the timeline for upgrading rotorcraft fleets?

Mr. VIOLA. Well, what our problem right now with the rotorcraft fleet is that the AD, the airworthiness directive, and the NOTAMs—we are still having conversations with the FAA to determine what that actually means for the vertical flight community. Because the AD, the airworthiness directive, actually says that the radar altimeter is unairworthy. And then the NOTAM there supposedly says those are the areas where it may be unairworthy.

And so, we have no AMOCs yet for the rotorcraft or the vertical flight community. And we are working very closely with the FAA to get there. And so, we are actually held back by regulations. And a lot of times you will hear me talk about regulations shouldn't apply to just helicopters, it should be a mission set. And so, right now, the FAA has told us helicopters—and that is why we specifically went in and we have made sure we got an exemption for the air ambulance missions because we want to make sure they can deploy.

So, what they did for the air ambulance mission is the FAA says, OK, you can fly without the radar altimeter, even though it is required by rule, if you do additional training for all your pilots and you have a movable search light. So, it is things like that that they are trying to come up with, that equivalent level of safety. And that is why, until we get AMOCs, we really can't even get a cost estimate.

Ms. NORTON. Mr. Fanning, I would like to ask you about the logistics of upgrading radio altimeters for the U.S. air flight fleet.

What steps are involved in that process? How long would it take to upgrade the altimeters for the entire fleet, and how much would that cost? And who currently bears the burden of that cost? Mr. Fanning.

Mr. FANNING. Thanks for that question. There is a lot in there. The first thing we need to know is the operating environment that we will find ourselves in. So, what will be the standards based on that operating environment. So, what is the worst-case scenario for interference when 5G is fully rolled out. Then, as Administrator Dickson said earlier, we have to set the standards to that, and that could take easily into 2023 for the manufacturers to start designing, building for the certification process. So, there is testing certification. Once the FAA certifies something, then the manufacturers can build it at scale.

Rolling it out to the whole fleet is another timeline altogether, because, also as Administrator Dickson said, these airplanes are designed to fly people for 35, 40 years. And so, it can take a long time to rotate a next generation of technology unless you are doing it inside of the lifespan of the aircraft.

So, we are talking about a lengthy process to get next-generation new radio altimeters into the entire fleet. And that creates a lot of variables with the cost for what that could be. We just don't have an answer for that right now. And who pays for it is another question also. Historically, when a part of spectrum is auctioned off, there are proceeds set aside to mitigate the impact of those people inside that bandwidth, but it hasn't taken into account adjacent bandwidth. So, it is a——

Mr. LARSEN. Thank you. You have to wrap up your answer. It is a great question, but we need to move on the timeframe of the committee. But we would appreciate a followup written answer to that.

The Chair recognizes Representative Perry of Pennsylvania for 5 minutes.

Mr. PERRY. Thank you, Mr. Chairman.

Mr. Roberson, in your testimony you state, quote, "All this made for a very confusing and contentious situation created by the lack of information and the failures of the FCC and FAA to resolve their differences in a timely fashion while the cellular carriers have delayed their rollout and altered their plans on an almost weekly basis," unquote.

I think we can all agree that this is confusing and contentious. The situation should have been and could have been avoided had the administration had the foresight to bring folks together and figure this out prior to the deadline. Unfortunately, Secretary Buttigieg was asleep at the wheel with yet another crisis under his watch. And as you pointed out, quote, "there is a real problem, but it is what can best can be described as an 'edge case' problem, that is, a problem that only occurs in unusual circumstances and for a very limited number of aircraft," unquote.

So, if I can ask you this: What do you think prevented the FAA, the FCC, and both industries from coming together and addressing these edge cases before it became a crisis.

Mr. ROBERSON. I think a big part of it has been discussed already, and that is the way in which the process works. The FCC

makes their decisions. They are the authorized body to make decisions on spectrum. And they make those decisions exclusively on the basis of the information that is provided to them in their docket.

In this case, the information that the FAA had and the concerns weren't communicated through the NTIA to the FCC. So, they didn't have that information to act upon. So, that is a process miss that exists.

In terms of other inputs—and there were a variety of those who communicated that they did provide information to the docket. The FCC is always looking for technical information that they can act upon. And so, while there were considerable worries that were expressed about radar altimeters and operation in general, those weren't quantified in a way that the FCC could act upon that. So, this is a process that needs to be improved.

If I might, there is a fundamental one, too, that I suggested but didn't fully address, and that is that FCC itself doesn't regulate receivers. It regulates transmitters. So, as I described, for the altimeter designers, they felt free to design an altimeter that looked well outside their authorized band. And there is no prohibition, legal prohibition for them to not do that. The view historically was the market forces with——

Mr. PERRY. And the FCC didn't—the FCC didn't realize that or consider that or didn't know that?

Mr. ROBERSON. This has been an item that has been under discussion for more than 40 years about receiver standards and the need for some form of regulation or guideline around receivers, but it is more complex probably than time would permit right now.

Mr. PERRY. All right. If I can ask you another question here. You also pointed out that the aviation world, including the FAA commercial airline and private aircraft communities, airport authorities and others, have fought this rollout for the last several months, initially focusing on safety of life issues and, more recently, talking about massive disruption in airline flight schedules.

And that is what you said. Much of this, I believe, is primarily based on a study by RTCA filed with the FCC in November of 2020.

The question is: Have you reviewed the study? And, if so, do you find that the RTCA study provides credible evidence that 5G will cause problems with radio altimeters, and can you explain the basis for your response? And also, have there been instances of 5G interference with radio altimeters to date anywhere in the world where 5G has been implemented?

Mr. ROBERSON. Yeah. Two-part questions. First part, I have reviewed and my team—40 people in the company—we have reviewed the RTCA study and do find that there are some significant flaws in the study where very worst, worst-case assumptions were made. And this is one of the things that was discussed earlier. It would be very helpful if RTCA and telecommunications engineers could have gotten together in a more timely way to review those studies and to hash out the inconsistencies in the ways that the study was conducted.

On the question of recorded incidents where there have been difficulties with radar altimeters, this is probably a question better

asked of Meredith, but, to my knowledge, there is no instance in the world that there has been a problem with radar altimeters at this point.

Mr. PERRY. Thank you. Thank you, Mr. Chairman. I yield.

Mr. LARSEN. Thank you very much.

I now turn to Representative García of Illinois for 5 minutes.

Mr. GARCÍA OF ILLINOIS. Thank you, Chairman Larsen and Chairman DeFazio, for holding this hearing on aviation safety and the impact of 5G. Thanks to all the witnesses.

As many of our witnesses have alluded to today, there is currently a 2-mile restriction on deploying 5G around most major public airports in this country, including Midway Airport in Chicago.

Let me be clear. I support the FAA's interim orders to preserve aviation safety, including the 2-mile restriction on 5G deployment, but there are certain tradeoffs to these orders. Midway Airport is unusual because there are a lot of residents that live right around the airport. The airport is about 1 square mile and is surrounded by working-class neighborhoods directly across the street, as this map shows.

Many of you might have experienced this fact flying into Midway where planes go pretty close over homes. It is always an exciting landing experience. This poster behind me shows the 2-mile radius that constituents of mine live around. They are primarily Latino and Black, and lack access to quality broadband.

In fact, my own district office, which is 3 miles away, just outside the circle, has very poor broadband. For these residents and my district office, cellphone service is the primary way of accessing the internet. So, the potential lack of 5G in the long term, combined with the fact that telecom carriers are planning to shut down their 3G networks at the end of the year, is potentially devastating for these communities and residents around Midway Airport.

We cannot permanently prevent these residents from using 5G. We must expeditiously find a way to fully deploy 5G while keeping the same level of aviation safety that we all achieve under the FAA's interim orders.

For Ms. Baker and Mr. Fanning, a question. I am deeply concerned about how long 5G access may be restricted in the neighborhoods adjacent to airports, especially when these are almost always working-class Latino and Black neighborhoods who already face significant barriers to broadband access. In your opinion, what is the long-term solution that will allow residents around airports to fully have 5G while maintaining the necessary level of aviation safety? And roughly, how long will it take us to get there?

Ms. BAKER. So, thank you so much for your question. I think that is a really, really important one. I am going to first answer the previous question, but there has been no reported interference from 5G in the areas in the almost 40 countries that rolled out 5G. But to your point, we have agreed voluntarily and temporarily to exclusion zones around these airports.

And I think you raise such an interesting and important thing that we cannot exacerbate this digital divide. And so, what we are doing is working as cooperatively as we possibly can with the aviation industry and with the FAA to clear these zones as quickly as

possible. And we have agreed to do this until July 5. And at that point—we hope we will be done sooner than that.

We have made tremendous progress and we really have been cooperating well, and I am proud of our industry and I am proud of your industry. And it took too long to get here, but I am glad we are there.

Mr. GARCÍA OF ILLINOIS. Well, thank you for that.

And as you noted in your testimony, telecom companies have in the past paid other spectrum users to vacate parts of the spectrum or upgrade their equipment so that telecom companies can fully use that spectrum.

Would telecom companies be willing to pay some of the cost for airlines to upgrade their planes' altimeters that are at risk of interference so that we do not have these restrictions in place?

Ms. BAKER. So, I actually think it is premature to go there, because this hearing seems to presuppose that there is interference, where we don't believe that there is. So, I think we need to let the engineers do their job. And as far as who pays, yes, there have been all sorts of instances where, through a spectrum relocation fund or through a designation from Congress, there has been use—Congress can use the proceeds of this, you know, of an $80 billion auction as they wish.

And so, that part is really up to the Government, but I don't accept the premise that there is actually interference at this point.

Mr. GARCÍA OF ILLINOIS. And before I run out of time, if your members aren't considering a plan, are they considering any cellphone plan pricing compensation for residents who are paying for 5G but cannot access 5G networks?

Ms. BAKER. Well, we are doing what we can to close the digital divide, and we are encouraged that in the infrastructure bill, Congress actually has helped us do that. So, I think there will be longer support to low-income families to help pay for their cellphone and broadband service, particularly as it becomes the competitive choice of many, especially low-income folks.

Mr. GARCÍA OF ILLINOIS. Looking forward to that conversation. Thank you.

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

Mr. LARSEN. Thank you, Mr. García.

We are going to do a second round. I recognize the chair of the full committee for 5 minutes.

Mr. DEFAZIO. Thank you, Mr. Chairman.

I did hear a couple of very disturbing assertions. Mr. Roberson said, oh, well, RTCA was based on the worst, worst case. Tell that to the 346 families of the people who died on the MAX. That was supposed to be a worst case, worst, worst case. Very improbable. We don't run aviation that way in this Nation.

And then I heard also—I think it was Ms. Baker—that while the FCC auctioned it with Ajit Pai blowing off all concerns and not putting in any restrictions, but they followed the rules. Well, that was the other thing, the conclusion of our investigation, that both the FAA and Boeing said, well, we followed the rules, just 346 people died.

We changed the damn rules. And, that is a question that needs to be raised about this, about this issue, and the lack of cooperation

and coordination. I mean, there is a lot of talk about the NTIA run by the fifth political hack in a role under the Trump administration didn't forward the concerns of the FAA, but they had been directly communicated to Ajit Pai by everybody—by the pilots, by the airlines, by this committee, by the RTCA and others. And Ajit Pai just blew it all off because they were in a hurry to get it out there, and I am sure they were under a lot of pressure from the telecoms to get it out there. And we don't want to have any mitigations. We want to be able to have the most powerful towers in the world.

We have got to get some facts straight. My staff checked again with the FAA on the strength of the signals in France, and they say it is 15 to 85 watts, and Ms. Baker says it is more powerful in France, but they had France at 631 watts. So, I guess I don't understand watts. I always thought higher wattage, more powerful. I don't know. Plus, they deflect the antennas down. And that is permanent.

So, to say, oh, we might not need any measures, it is like, we don't think there is interference. There is another. Oh, we don't think there is interference? Think?

We have to absolutely—100 percent to the minus nine power—know. That is the risk in aviation. One in one billion. And I don't think we know that yet, because you have got the Civil Aviation Authority of the United Kingdom saying that they pose a viable interference threat to radio altimeters. Canada has just adopted exclusion zones around 26 airports. These are not insignificant countries, and they are much more similar to ours than Slovenia or whatever ones you are quoting out there that fly four airplanes a day.

So, I am just not happy with the way that—like I said, I think the telecoms are getting it now, at least Verizon and AT&T. I don't think CTIA is getting it. And, I want to make sure that others get it. I mean, the RTCA report, worst, worst case—well, that is what we plan for is the worst, worst case.

To Ms. Stephens, and this is a concern about the FAA. I don't think the FAA has been particularly transparent with airports. Can you comment on that?

I mean, for instance, I was told by the Administrator on Thursday, Eugene wouldn't be impacted, and on Thursday, Portland was on their list, and then on Friday it wasn't, but no one seems to understand how that all worked.

Ms. STEPHENS. Thank you, Chair DeFazio, for that question, and, yes, it is very true. The information has not been free flowing and transparent, and that has been a real challenge for airports to be able to plan and understand why we are being impacted in the way we are being impacted.

Eugene wasn't even supposed to be in the first rollout, and then we got the surprise NOTAM on the day of the 5G rollout and needed to try to understand very quickly why we were on the list and how we were going to be impacted. We never truly understood, we still don't know why we are on that list and have the NOTAM in place, and now the majority of our carriers have needed to be operating under AMOCs during low-visibility operations and, in fact, we still have one aircraft type that is not cleared with an AMOC to be able to operate at Eugene.

That impacts our passengers. Aside from the headaches that it causes for people trying to run airports, it really does impact our passengers. I was flying back to Eugene on Tuesday with a layover in Salt Lake City waiting at the gate for the Eugene flight, and I heard two passengers talking about how 2 weeks prior they had taken the same flight back into Eugene and then they were diverted to Portland because of fog in Eugene and they were not able to land. That just goes to what we have been battling all these years, Congressman, is making sure that people can use their local air service.

Mr. DEFAZIO. Thank you. Thank you, Mr. Chair.

Mr. LARSEN. Thank you. Just a few followups.

I want to underscore a point that the chair made about the language being used. Ms. Baker's comments or testimony said—you state the Radio Technical Commission for Aeronautics, RTCA, study applied flawed methodology and implausible scenarios.

The actions of the Maneuvering Characteristics Augmentation System, or MCAS, flaw that overrode pilot auctions in the flight deck of 737 MAXes was an implausible scenario, and yet it did happen. We are in the implausible, implausible scenario business, and so, that is why there is such a thin safety margin in aviation.

That is why, frankly, we take personally because we take responsibility for aviation safety on this subcommittee. We talk about implausible scenarios because there really aren't implausible scenarios when it comes to aviation safety.

So, I just want to underscore that point about that, using that term, because it really sort of tells me that you all don't really get what we are trying to do. I think that has changed. Granted, I think that has changed, but also it seems to underscores a fundamental foundational problem that got us here in the first place.

I mentioned in the beginning about just very different cultures, different cultures between the industries, different cultures between the agencies involved. So, I hope we have made that point strongly.

Mr. Viola, on helicopters, given the fact that there are currently no AMOCs for helicopters, just how are—I presume helicopters are flying, but what does your future look like right now?

Mr. VIOLA. Well, thank you very much for the question, Chairman Larsen. Well, that is kind of the problem we have. We have got some regulatory compliance issues, and because of the ADs and the NOTAMs, there are a lot of aircraft that aren't flying right now. And so, we are really working for clarification as to what are the requirements.

If the aircraft is required or if it was a newer aircraft that has a radio altimeter on it, well, then that is when the AD kicks in on certain types of—you actually need to rewrite what the procedures are that describe when the radar requirement was needed. And then if the aircraft didn't have a radar altimeter and didn't need it, then those aircraft can still fly.

So, we are still, last night and even this morning before our testimony here, working to see what exactly—if everybody in the FAA can agree to what the AD means for helicopters and what the NOTAM actually means for helicopters. Does it mean a possible interference or does it mean that you can't fly in that area at all?

Mr. LARSEN. Your testimony said there are 55 public use heliports in the country—is that right—on page 6 of your testimony?

Mr. VIOLA. Yes.

Mr. LARSEN. Fifty-five heliports. But that number is dwarfed by anywhere from 6,533 to 8,533 helicopter or ambulance landing sites in the United States. Is that right?

Mr. VIOLA. Yes, sir. That is correct.

Mr. LARSEN. You have any indication that any of these numbers were taken into any consideration by the NTIA or the FCC as they looked at these issues?

Mr. VIOLA. No. We have——

Mr. LARSEN. None at all?

Mr. VIOLA. We have no indication that they tried to avoid any of our known heliports. And I think it is kind of the same thing as it is for the airports, where normally, when a risk is introduced to aviation or there are methods or systems that prevent that risk from being introduced, I think in this case here, the risk is introduced and now we are dealing with it.

Mr. LARSEN. It is backwards.

Mr. Fanning, if you talk to your members, is there one single radio altimeter fix or is it multiple fixes for altimeters based on the altimeter?

Mr. FANNING. We don't know yet. The real testing only started once we got the data, the information from the telecoms, and the FAA is in daily conversation with the manufacturers about what they are learning, which also feeds into the AMOCs. It has been stated, but it is worth repeating, that an AMOC is not a permanent thing, and it doesn't give blanket coverage. Each AMOC is different, and they are adjusted or reviewed every 30 days.

So, there is no one fix yet because we still don't have a full definition of the problem, but there is some optimism that the more modern altimeters are going to test well. But we just don't know what falls into those three buckets of an existing altimeter that is going to be fine with 5G, those that have to be retrofitted with a filter, and those that just won't work in the environment.

But we are gathering the data in real time and, again, daily conversations with the FAA and also with the telecoms to get that data so we can test against it.

Mr. LARSEN. All right. All right.

I want to thank the panelists, the second panel, for your testimony and your informative answers to help us understand these issues a lot better than we did even for us 3 years ago, 2 years ago, 1 year ago, 6 months ago, 2 months ago, and even last week. But we have been, as a committee, subcommittee, trying to get up to speed on these issues as well. But having said that, I see that there is a lot more work to do, so we are going to stay very engaged on this as well.

With that, that concludes our hearing.

I want to thank the witnesses again. I 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 be submitted to them in writing, and I would expect you all to get a few questions.

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

Without objection, so ordered.

With that, this subcommittee stands adjourned.

[Whereupon, at 3:37 p.m., the subcommittee was adjourned.]

SUBMISSIONS FOR THE RECORD

Letter of February 7, 2022, and 5G Timeline from Captain Joseph G. DePete, President, Air Line Pilots Association, International, Submitted for the Record by Hon. Peter A. DeFazio

FEBRUARY 7, 2022.

The Honorable RICK LARSEN,
Chair,
Subcommittee on Aviation, House Committee on Transportation and Infrastructure, 2163 Rayburn House Office Building, Washington, DC 20515.

The Honorable GARRET GRAVES,
Ranking Member,
Subcommittee on Aviation, House Committee on Transportation and Infrastructure, 2402 Rayburn House Office Building, Washington, DC 20515.

DEAR CHAIR LARSEN AND RANKING MEMBER GRAVES:

Thank you for holding the very productive and informative hearing on Thursday, February 3, 2022, on "Finding the Right Frequency: 5G Deployment and Aviation Safety". We have created the safest aviation system in the world thanks to your leadership, commitment to safety, and steadfast support for a collaborative safety risk-management environment between frontline employees, the regulator and airline operators. ALPA stands ready to build on that record of safety and support you as we ensure that no third party will ever again be able to introduce risk into the national airspace system without labor, airlines and the regulator having a full say in the matter.

As I mentioned during the hearing, enclosed is a timeline of aviation's interactions with the Federal Communications Commission (FCC), highlighting where the Air Line Pilots Association, International (ALPA) joined our fellow industry organizations in advocating for a collaborative approach for safe 5G deployment in the C-Band. Unfortunately, the FCC not only failed to heed our concerns, but they willfully neglected to carry out their regulatory responsibilities and ask licensees for critical data needed to plan for launching 5G while maintaining aviation safety. This failure on the part of the FCC has resulted in uncertainty, complexity, and increased workload for every flight. For airline pilots, safety is nonnegotiable. It's not about politics or profit. For this reason, it was an affront to us when the FCC licensed part of the C-Band spectrum to the telecom sector without acknowledging our concerns about aviation safety.

Below is additional information for the record regarding the validity of the RTCA report, the cost to retrofit radar altimeters, concerns about telecommunications providers refusal to share necessary information, and the need to evaluate 5G risks to all aviation operations.

There has been significant criticism of "the RTCA report." RTCA, Inc. (formerly known as the Radio Technical Commission for Aeronautics), is a 500-member not-for-profit standards development organization that serves as the primary forum in the United States for the development of avionics standards. The members of RTCA include unions, all airline aircraft manufacturers, avionics providers, airlines, airports, companies that serve as the air traffic control infrastructure industrial base, and more. The engineers and experts who attend RTCA represent the best technical minds of industry and U.S. and foreign governments. By working in a consensus-based environment, RTCA and its member participants have a long history of developing standards for aviation equipment that provide the necessary performance to ensure safety in operations.

In conjunction with its European-based, sister organization, EUROCAE, the standards they have developed have been adopted by safety regulators; including the Federal Aviation Administration (FAA), the European Aviation Safety Agency (EASA), Transport Canada, and the Agência Nacional de Aviação Civil of Brazil; for most of the electronic navigation equipment on board commercial airplanes. The

International Civil Aviation Organization (ICAO) has also recognized and adopted RTCA standards as a method of compliance as well.

To be absolutely clear, the staff of RTCA do not write the standards, their members do. The members of RTCA develop consensus-based standards and all participant concerns are reconciled before a document is published. In cases where they cannot be reconciled, the dissenting opinions, known as "non-concur comments" are included in the document. This process was followed by RTCA during its review of radar altimeters and the C-Band 5G environment.

After the FCC Report and Order for Flexible Use of C-Band was issued, the RTCA President made several efforts to reach out to the wireless industry, including CTIA, to invite them be part of the process in developing the report which was eventually filed to the FCC docket in October 2020. While CTIA members attended, and provided an inadequate level of meaningful data, the information was used nonetheless to evaluate the 5G signal impact on radar altimeters. The intent was to work collaboratively with the wireless industry to ensure safe deployment of 5G C-Band with minimum disruption to aviation at least 18 months prior to the activation of C-Band service. Unfortunately, RTCA's data-driven report was rebuffed by the same CTIA members who were unwilling to provide data to support their dissenting views; their non-concur and rationale are fully documented in the RTCA report.

The hearing provided damning insight into how broken the federal radio spectrum and licensing process is in relation to aviation safety and the need for immediate reform. Notably, I am troubled by the FAA Administrator's disclosure that productive conversations between the agency and the telecommunications providers did not begin until early January. It was further noted that the FCC had never asked the wireless industry for the data needed to conduct the safety risk mitigation assessment. Given that the agency legally tasked with oversight of the telecommunications industry completely failed to provide critical information relevant to the safety of the U.S. airspace system and *voluntary* dialogue by private sector companies did not begin until the precise time their actions posed catastrophic harm to public safety, it is clear there is a systemic failure of governance over the wireless industry's use of spectrum, disclosure of information, and licensing. This necessitates a redesign of the government's authority over these providers, including granting affected agencies, like the FAA, authority to reject or modify new or expanded spectrum applications as well as the ability to directly interact with the FCC.

The hearing also raised questions regarding the importance of modifying and developing radar altimeter equipment and standards to potentially solve spectrum problems. To that end, it is important to make note of the costs involved. While it is difficult to provide specific information, we are generally aware that avionics upgrades can be more expensive than many would ever imagine. Because multiple radar altimeters are installed aboard large air transport aircraft, the cost of the modified or new equipment, including the cost of labor to install the equipment, and the cost of aircraft time out of service, the overall cost could easily be $100,000–$150,000 per aircraft, depending on the aircraft type. Of course, there are still a lot of hurdles to jump through before we know for sure, just exactly how difficult and involved that this equipment upgrade will be, so the estimated costs are also subject to change.

In developing the new radar altimeter standards, a key piece of information needed before standards can be written is the external interference environment that radar altimeters must be able to tolerate globally, for the next several decades. To meet this demand, the aviation industry needs the active cooperation and input of the wireless industry to define the environment. We are pleased to hear that the FAA intends to share their flight test data with RTCA, for the development of future radar altimeter standards.

Once new altimeter standards are available, the timeline for design, testing, certification, manufacturing, and installation is likely to take four or more years, even with priority placed on these upgrades. There may also be additional unforeseen costs to accelerate the process and upgrade all airliners, including those operated by international airlines operating in U.S. airspace. This truly is a global problem.

During the hearing, I noted my concern with CTIA's continued sensitivity toward protecting proprietary information between competitors AT&T and Verizon. I wish to emphasize that *in aviation, we do not compete on matters of safety*. "One Level of Safety" has been the foundational principle for ALPA. The aviation industry, which features intense competition between carriers, manufactures and other parties, is nonetheless able to share information necessary for addressing matters of safety. The wireless industry can and must be held to the same standard. It appears that Verizon and AT&T are beginning to understand the need to share data for the advancement of safety, even if their trade association, CTIA, does not.

Finally, as we look forward to new entrants to the aviation system—Remotely Piloted Aircraft Systems and drones, Advanced Air Mobility, Hypersonic aircraft, and Commercial Space operations—we need to make sure that these entities are also not impacted by 5G interference. A thorough review and risk mitigation of the systems used by these stakeholders is also needed before allowing 5G in the C-Band to continue expansion.

The U.S. air transportation system is the world's safest. As I said during the hearing, I feel very strongly that if or when another industry seeks to introduce risk into the system, the burden should be on that industry to prove its actions won't degrade aviation safety. The launch of the new 5G service caused an avoidable crisis. The process must be reformed so that the United States can continue to be a world-stage competitor in 5G and set the global standard in aviation safety.

In closing, we again thank you for holding such a productive hearing. Speaking for the 62,000 pilots flying for 38 airlines that ALPA represents, we strongly encourage the committee's continued attention on the C-Band matter, and also in taking steps to ensure that this unnecessary breakdown in intragovernmental processes never happens again.

Sincerely,

CAPTAIN JOE DEPETE,
President, Air Line Pilots Association.

Attachment: "5G Timeline Doc 02072022"

cc: The Honorable Peter A. DeFazio, Chair
House Committee on Transportation and Infrastructure

The Honorable Sam Graves, Ranking Member
House Committee on Transportation and Infrastructure

ATTACHMENT: "5G TIMELINE DOC 02072022"

Below is a list of activities surrounding the issue of 5G and Radar Altimeters (radalts). ALPA actions and participation is noted where appropriate.

Docket 17–340 opened on 12/1/2017—Spectrum Policy Recommendations

2018

- 1/31/18—Aviation Spectrum Resources, Inc. (ASRI)—comments on need to protect aviation spectrum:
  https://ecfsapi.fcc.gov/file/1013180946363/ASRI%20Comments%20TAC%20Spectrum%20Policy-FINAL.pdf
- 2/15/18—Boeing comments on need to protect aviation spectrum:
  https://ecfsapi.fcc.gov/file/10216647614758/Boeing%20TAC%20Recommendations%20Reply%20Comments%202%2015%202018%20final.pdf
- FCC Docket 18–122 opened on 4/18/2018—Flexible Use of 3.7–4.2 GHz
- 5/29/18—ALPA Initial Comments:
  https://ecfsapi.fcc.gov/file/10531182083849/ALPA%20Comments%2017-183%2018-122.pdf
- 5/31/18—ASRI initial filing:
  https://ecfsapi.fcc.gov/file/10531846006939/ASRI%20ex%20parte%20Gen%20Dkt%20No%2018-122.pdf
- 6/19/18—Aviation Industry (ALPA, AOPA, A4A, AFC, AIA, GAMA, HAI, IATA, NATA, NBAA)—summary of discussions with Commission on need to protect radalts:
  https://ecfsapi.fcc.gov/file/10620182163379/19062019%20Aviation%20Associations%20Joint%20Ex%20Parte%20Filing%20Dkt%20No%2018-122.pdf
- 10/29/18—ASRI again comments on need to protect radar altimeters, recommending FCC work with FAA.
  https://ecfsapi.fcc.gov/file/1030875426359/ASRI%20-%2020181029-__C-Band__NPRM__Filing-FINAL__Rev1a.pdf
- 12/17/18—Aviation Industry (including ALPA) met with FCC technical staff on need to protect radalts
  https://ecfsapi.fcc.gov/file/12172825300371/12.17.18%20Aviation%20Industry%20Ex-Parte%20FINAL.pdf

2019

- 10/25/19—Aviation Industry (including ALPA) met with FCC technical staff again on need to protect radalts
  https://ecfsapi.fcc.gov/file/1025793221250/Aviation%20and%20Aerospace%20FCC%20Engineering%20Meeting%20Ex%20Parte%20Notice%20(FINAL%2010-25-19).pdf
- 11/12/19–2/19/20—aviation met 6 additional times with FCC staff on protecting radalts

2020

- 2/21/20—Aviation Industry (including ALPA)—warning of interference on RadAlts if Draft Report and Order goes forward:
  https://ecfsapi.fcc.gov/file/10222078579238/202002121-3.7-4.2%20GHz%20Aerospace%20Aviation%20Associations%20Letter%20to%20FCC%20GN%2018-122-FINAL.pdf
- Industry (including ALPA) meetings with Commissioners' Staffs 2/21/20
- 3/3/2020—FCC Report and Order—https://www.fcc.gov/ecfs/filing/0303046335999

Additional FCC Docket 18–122 Items:

- 5/26/20—Aviation Industry (including ALPA) Petition for Reconsideration—asking for FCC to convene aviation/telcom industry work group:
  https://ecfsapi.fcc.gov/file/10527379225572/C-BAND%20Petition%20for%20Recon.pdf

  § Note that this Petition did NOT oppose the Order, but asked for FCC leadership in identifying mitigations

- 7/9/20—Aviation Industry Reply Comments to Petition:
  https://ecfsapi.fcc.gov/file/10710274414682/Aviation%20Petitioners%20Reply%20to%20Oppositions.pdf
- 12/7/20—Aviation Industry files proposals for mitigations to protect radalts:
  https://ecfsapi.fcc.gov/file/12072836329004/20201207-Aviation%20and%20Aerospace%20Suggested%20C-Band%205G%20Mitigations%20GN%2018-122-Filed%20Version.pdf
- 12/7/20—Aviation Industry (including ALPA) filed letters asks FCC to delay spectrum auction:
  https://www.fcc.gov/ecfs/filing/1207131706609

2021

- 5/12/21—Aviation Industry (including ALPA) describes how CTIA analysis of aviation concerns is incorrect
  https://ecfsapi.fcc.gov/file/105130442707885/Organizations%20Supporting%20Aviation%20Safety%20Ex%20Parte%2012%20May%202021.pdf
- 8/10/21—Aviation Industry (including ALPA) describes technical details of radalt and need to protect
  https://ecfsapi.fcc.gov/file/1081157361951/Aviation%20and%20Aerospace%20Ex%20parte%20Notice%20Aug%206%202021%20w%20OET%20WTB%20IB.pdf
- 8/27/21—Meetings including ALPA, with FCC commissioner Carr's staff:
  https://ecfsapi.fcc.gov/file/10827030728422/Rad%20Alt%20Aug%2026%20Watson%20Meeting%20Ex%20Parte%20Letter%20FILED.pdf
- October 2021—ALPA begins to lead industry coalition coms efforts including common talking points used by all coalition members
- 11/2/21—Aviation Industry including ALPA filing asking for details of 5G deployment in order to develop aviation-side mitigations
  https://ecfsapi.fcc.gov/file/1103321105177/Aviation%20Community%20FCC%20Filing%20for%20Needed%205G%20Parameters.pdf
- 11/4/21—Verizon and AT&T voluntarily agree to delay their turn on from 12/5/21 to 1/5/21.
- 11/4/21—Aviation industry including ALPA began a series of meetings with the White House National Economic Council (NEC). The NEC begins leading interagency meetings between the FCC and FAA.
- 11/19/21—Aviation Industry including ALPA reply to CTIA, describing how international deployments differ from US
  https://ecfsapi.fcc.gov/file/1119034580247/Aviation%20Industry%20Reply%20to%20CTIA%2011-19-2021.pdf

- 11/24/21—AT&T and Verizon offer a six month reduction in power around airports. The aviation coalition determines that this action is insufficient to protect even one model of transponder as compared to the RTCA report.
https://ecfsapi.fcc.gov/file/11241848723664/2021-11-24%20ATT%20Verizon%20Letter%20FINAL.pdf
- 12/06/21—Aviation files a counter-proposal to the Verizon/AT&T letter, which provides protection to aviation radar altimeters:
https://ecfsapi.fcc.gov/file/1206159800868/Aviation's%20Safety%20Proposal%2012.6.pdf
- 12/07/21—FAA issues the Airworthiness Directives which prohibit certain operations in TBD areas where 5G interference is expected. The FAA will issue NOTAMs to activate the ADs.
- 12/07/21—ALPA issues safety alert to all members about FAA AD on all transport and commuter category aircraft with radar altimeters
- 12/09/21—Boeing holds multi-model operator telcons with customers worldwide, with ALPA also included, to describe that Boeing aircraft will be subject to the ADs, and that in their opinion further restrictions may be necessary.
- 12/10/21—ALPA joins in a meeting with airline tech pilots on the impact of the 5G restrictions.
- 12/14/21—ALPA coordinates with coalition members on background materials for reporters and transmits on behalf of industry
- 12/14/21—ALPA has a telcon with NATCA to discuss ATC side of handling radar altimeter AD/NOTAMs. ATC does not know what to expect. We supported any action by NATCA to slow traffic as needed to manage the unknown impacts starting on 1/5/22.
- 12/16/21–12/17/21—Aviation including ALPA visit with staff for each of the 4 FCC Commissioners. Aviation made the case that there will be severe economic impacts to airline passenger and cargo operations, with significant schedule impacts and passenger disruptions. Helicopter safety operations will be grounded. The FAA restrictions will not be easy or fast to overcome with Alternate Methods of Compliance (AMOCs), and that FCC needs to act to prevent and industry economic disaster on 1/5/22.
- 12/20/21—ALPA letter to Senator Cantwell and Senator Wicker debunking myth that 5G is being deployed successfully in other countries without mitigation.
- 12/23/21—FAA issues an updated SAIB:
https://rgl.faa.gov/Regulatory__and__Guidance__Library/rgSAIB.nsf/dc7bd4f27e5f1074
86257221005f069d/379cfb187d16db10862587b4005b26fc/$FILE/AIR-21-18R1.pdf
- 12/23/21—FAA issues SAFO 21007 with example NOTAMs:
https://www.faa.gov/other__visit/aviation__industry/airline__operators/airline__safety/safo/all__safos/media/2021/SAFO21007.pdf
- 12/31/21—DOT asked Verizon and AT&T to delay their roll out 5G in order to work on mitigations that will protect more of aviation around several major airports. Verizon and AT&T rejected any further delay on 1/2/22, with an offer to implement limitations as in France. Aviation tech team has determined that the offer is only partial limitations that France has imposed, and does not protect aviation sufficiently.

2022

- 1/2/2022—ALPA filed a comment in support of the A4A Petition for Emergency Stay on the FCC Docket:
https://ecfsapi.fcc.gov/file/10102521821451/ALPA%20Comments%20In%20Support%20of%20A4A%20Petition%2001.02.2022%20Final2.pdf
- 1/2/2022—ALPA sent a letter to FCC Chair Rosenworcel, asking for FCC to work collaboratively with aviation, to share data that shows that aviation's safety case is met.
https://www.alpa.org/-/media/ALPA/Files/pdfs/news-events/letters/2022/0103-5g-fcc-rosenworcel.pdf?la=en
- 1/4/2022—Additional voluntary action by Verizon and AT&T; delay until 1/19/2022 for start of 5G service.
- 1/18/2022—ALPA issues safety alert to pilots prior to 5G signal broadcasts beginning.

- 2/3/2022—ALPA testifies before the Aviation Subcommittee of the U.S. House Transportation and Infrastructure Committee reinforcing how the recent deployment of AT&T and Verizon's 5G services to impact aviation safety.

Letter of February 2, 2022, from Present and Former Members of the Federal Aviation Management Advisory Council, Submitted for the Record by Hon. Peter A. DeFazio

FEBRUARY 2, 2022.

The Honorable PETER DEFAZIO,
Chairman,
Committee on Transportation and Infrastructure, U.S. House of Representatives, Washington, DC 20515.

The Honorable RICK LARSEN,
Chairman,
Subcommittee on Aviation, U.S. House of Representatives, Washington, DC 20515.

The Honorable SAM GRAVES,
Ranking Member,
Committee on Transportation and Infrastructure, U.S. House of Representatives, Washington, DC 20515.

The Honorable GARRET GRAVES,
Ranking Member,
Subcommittee on Aviation, U.S. House of Representatives, Washington, DC 20515.

DEAR CHAIRMEN AND RANKING MEMBERS:

The undersigned are present and former members of the Federal Aviation Management Advisory Council (MAC). This letter represents our personal viewpoints alone, however, and is not sent in any official capacity on behalf of the Management Advisory Council or any other organization. We are writing to express our personal views on recent developments involving the FCC and the FAA's concern about possible harmful interference from 5G towers using C-band spectrum in the vicinity of airports. We would ask that this letter be included in the record of the February 3 hearing before the Subcommittee on Aviation.

Like everyone, we were dismayed that the much-anticipated rollout of new 5G networks by AT&T and Verizon had to be postponed and modified as the result of aviation concerns that had not been addressed beforehand to the FAA's satisfaction. Like all Americans, we look forward to benefiting from the promise of 5G technology. We also believe, however, that the root cause of the disruption has not been sufficiently understood in the commentary we have seen to date. That root cause is a system for spectrum regulation that is no longer wholly fit for purpose—not, at least, where FCC decisions potentially compromise the statutory responsibilities of other federal agencies like the FAA.

It is not our purpose to opine on whether the FCC's analysis of the potential for interference is better than that of the FAA or vice versa. First, that question is complicated by recent reports of the FAA's inability to obtain timely data it needed to assess accurately whether such interference would reduce the reliability of critical aircraft safety equipment—notably radar altimeters. (Earlier research filed with the FCC clearly said it would.) Second, it is essentially beside the point. What is not in dispute is that the FAA, responsible for an aviation system whose safety record is second to none, remained uncertain about the validity of the FCC's analysis and thus was required to take the actions that it did.

More importantly, once the FCC was made aware of the FAA's concerns—concerns expressed over a period of years by both the FAA and the aviation industry—it should have affirmatively undertaken to resolve those concerns to the mutual satisfaction of everyone concerned. Rather than seek that mutually satisfactory solution, however, the FCC reverted to the familiar confines of the formal administrative process. It reviewed submissions to the record, formed its conclusions, and based its decision on those conclusions. That process—while wholly in keeping with the conventional regulatory jurisprudence—simply does not appropriately acknowledge that Congress vested final responsibility for aviation safety decisions in the FAA alone.

The confusion, delay, and frustration that followed the decision were wholly foreseeable and could have been avoided entirely had the FCC adopted a more collaborative approach early in the process—ideally, before launching a formal proceeding. The FAA cannot be treated as just another "interested party" that can be expected to accept quietly an outcome it deems insufficiently tested in the real world. Indeed,

walking away from the issue despite its continuing uncertainty would represent a clear violation of the FAA's statutory obligation to ensure the safety of flight.

Simply put, the FAA should not be required to bear the burden of proof before the FCC on a matter of aviation safety; if anything, it should be just the reverse. The bottom line is clear: the FCC should never be permitted to make a decision on the use of spectrum that the FAA believes might compromise aviation safety; it must ensure that the FAA's concerns are resolved to its satisfaction *before* making any decision, and certainly *before* auctioning spectrum, lest bidders be inadequately informed of possible limits on the use of the spectrum they are bidding on.

A legislative amendment might easily be crafted to establish a more appropriately balanced process—one that recognizes that Executive Branch agencies like the FAA are not mere "interested parties" but rather instruments of government policy in their own right. They have a legal obligation to take whatever action they deem required by the public interest and, as we have seen, will do so.

We believe, however, that a more readily available solution should be encouraged. The problem might be resolved easily by a memorandum of understanding between the FCC and the Executive Branch in which the FCC commits that it will make no decision that another agency believes will adversely affect critical systems for which that other agency is responsible before achieving a mutually acceptable agreement with that agency regarding the mitigations to be undertaken. The FCC would formally adopt that commitment as a standing policy; it would be within the scope of its statutory discretion to do so.

If such an understanding cannot be achieved quickly among the affected agencies, we would advocate seeking a legislative solution. Without one or the other, we can look forward to many more conflicts of this kind as the electromagnetic spectrum becomes increasingly crowded, injecting an unacceptable level of uncertainty and instability into FCC decisions that are essential to America's future growth and prosperity.

Respectfully,

STEPHEN A. ALTERMAN,
President, Cargo Airline Association.
LINDA HALL DASCHLE,
former FAA Deputy Administrator.
DEREK KAN,
former OMB Deputy Director, and former DOT Under Secretary of Transportation for Policy.
WILL RIS,
former SVP, Government Affairs, American Airlines.
BRIAN WYNNE,
CEO, Association for Unmanned Vehicle Systems International.
PETER J. BUNCE,
President and CEO, General Aviation Manufacturers Association.
CHRISTOPHER A. HART,
former Chairman, National Transportation Safety Board.
DONNA MCLEAN,
former DOT Assistant Secretary for Budget and Programs, and Chief Financial Officer.
JEFFREY N. SHANE,
former DOT Under Secretary of Transportation for Policy.

Statement of Ed Bolen, President and Chief Executive Officer, National Business Aviation Association, Submitted for the Record by Hon. Peter A. DeFazio

On behalf of the National Business Aviation Association (NBAA), thank you for holding this hearing to discuss critical aviation safety concerns related to 5G telecommunications networks operating from 3.7–3.98 gigahertz (GHz), a commonly referred to as the C-band. NBAA represents more than 11,000 member companies and professionals that rely on general aviation aircraft for business purposes. Like commercial airlines, general aviation operators also rely on radio altimeters for various safety-critical functions, including low-visibility operations and other onboard safety systems. Beginning in 2015, NBAA and a broad coalition of aviation stakeholders raised detailed safety concerns about the potential for 5G interference with radio altimeters. We appreciate the Subcommittee's continued attention to this important matter.

NBAA members operate at thousands of airports across the nation, many of which are not served by commercial airlines. For example, general aviation aircraft deliver organs for transplant, perform air medical flights, assist in the aftermath of natural disasters and deliver critical supplies related to the COVID–19 pandemic. The United States general aviation industry, including business aviation, supports 1.2 million jobs and $247 billion in economic output.

Radio altimeters are crucial for many general aviation missions, especially for low-visibility landings and helicopter operations. Also, radio altimeter data on the precise distance of the aircraft from the ground is integrated into other safety-critical flight control and warning systems needed for all phases of flight. This integrated nature of aircraft avionics systems means that simply replacing the radio altimeter is not an option or is prohibitively expensive. Potential radio altimeter replacement costs are of specific concern to general aviation aircraft operators since 85% are small and mid-sized businesses.

With the significant benefits that 5G technology will provide for connectivity across the nation, NBAA believes these networks must safely co-exist with aviation. Achieving these benefits and preserving aviation safety requires enhanced interagency collaboration between the Federal Aviation Administration (FAA), the Federal Communications Commission (FCC), and other government stakeholders. In 2019, the aviation industry formally expressed concerns to the FCC about the implementation of 5G networks and conducted a study using the best available information at that time, which identified issues with radio altimeter interference. During this time, the aviation industry has been open to working with the FCC, FAA, and other agencies to advance the discussion on these issues.

Unfortunately, since the December 2020 auction of the 5G-C spectrum, the required levels of coordination did not occur. This lack of coordination meant that as the rollout of 5G networks approached this year, we were in a reactive position because the necessary proactive coordination had not occurred. We applaud the FAA's dedicated work to quickly issue Airworthiness Directives, Notices to Air Missions (NOTAMs), and other guidance on the impact of 5G networks. Still, the reactive nature of these efforts created significant challenges and uncertainty for general aviation operators.

Following the activation of 5G networks, the FAA is to be commended for its work to approve Alternative Methods of Compliance (AMOCs) that allow most commercial air carrier aircraft to operate safely at airports where there is potential for 5G interference. However, the FAA has only issued limited mitigations for business aircraft and helicopters to date. Without approved AMOCs or other relief, these aircraft continue to be prohibited from conducting low-visibility approaches and are subject to other flight restrictions in all 5G deployment areas, which will expand across the country. We respectfully request that the FAA dedicate the necessary resources to approve Letters of Acceptance for data submittals by altimeter manufacturers and supporting AMOCs, where appropriate, for general aviation aircraft and helicopters.

With the current AMOC process, the FAA must re-issue each approval every 30 days, which requires significant agency resources. As new 5G towers come online, the FAA must review the data to determine if existing AMOCs still maintain an adequate level of safety or if modifications are necessary. This process of reviewing data and analyzing AMOCs for the commercial air carrier fleet means that FAA resources are often not available for general aviation aircraft operators and manufacturers. If the telecom providers could share data on tower locations and deployment plans with the FAA as soon as it becomes available, the agency could manage the AMOC process more proactively and dedicate additional resources to general aviation operators.

As the 5G rollout continues across the country, the FAA will face a growing workload to review and re-issue AMOCs each month. By working collaboratively with the FCC, telecom providers, and other stakeholders, the FAA could have better visibility into future 5G impacts. For example, data sharing between the FAA and telecom providers in as close to real-time as possible would allow the FAA to perform a more forward-looking analysis and could mitigate the need to re-issue AMOCs every 30 days. The general aviation community looks forward to working with the FAA on an improved process so we can continue accessing airports across the nation and performing our critical missions.

The dynamic and on-demand nature of business aviation operations also means that receiving NOTAMs on 5G restrictions with relatively little notice presents significant challenges. Unlike commercial airlines, most business aviation flights do not operate on a fixed route between the same airports. NBAA members can access more than 5,000 public-use airports in the U.S., requiring additional detailed flight planning before each trip. The requirement to operate to such a diverse group of airports is another reason that enhanced data sharing and more lead time on subsequent phases of the 5G rollout will be essential to the general aviation community.

Finally, we will continue to see rapid advancements in aviation and telecommunications technology that will present additional wireless spectrum challenges in the coming years. For example, advanced air mobility (AAM) aircraft are currently undergoing FAA certification review and will have unique spectrum requirements for safe operation. Long-term plans from AAM operators include autonomous vehicle op-

eration, which will have different spectrum needs and safety considerations from piloted aircraft. Groups including RTCA, Inc. are already reviewing these complex issues, which will require more of our focus in the coming years. We encourage robust interagency coordination on future spectrum use and potential challenges involving all relevant government agencies, including the FCC and industry stakeholders.

This hearing is an important opportunity to review the next steps on the 5G rollout and identify key lessons learned. We applaud the commitment of this Subcommittee and the FAA for their continued efforts to ensure the highest level of aviation safety. NBAA looks forward to working with the Aviation Subcommittee, FAA, and other agencies as we continue developing strategies to co-exist safely with next-generation wireless networks.

"Analysis of 5G Deployment: Executive Summary," by Professional Aviation Safety Specialists, AFL–CIO, Submitted for the Record by Hon. Peter A. DeFazio

ANALYSIS OF 5G DEPLOYMENT: EXECUTIVE SUMMARY

The Professional Aviation Safety Specialists, AFL–CIO (PASS), the union representing more than 11,000 Federal Aviation Administration (FAA) and Department of Defense (DoD) employees, is providing an analysis of the deployment of 5G and the potential for radio frequency interference with National Airspace System (NAS) systems and equipment. PASS utilized extensive review of various aviation and telecommunication industry white papers as well as conducting a literary review of research papers within the Institute of Electrical and Electronics Engineers (IEEE) library.

Radio frequency interference (RFI) is a well-known phenomenon in the electromagnetic spectrum.[1] It is, as defined by the FAA Spectrum Engineering & Policy department, any emission, radiation, or induction that obstructs, or repeatedly interrupts, a radio communications service operating in accordance with established regulations.

The introduction of 5G radios into the aviation band of frequencies adds to an already complex environment of the electromagnetic spectrum. Many of the traditional unintentional RFI scenarios become an area of concern due to the proximity of frequency allocation as well as the physical location of the 5G radio emitters near aviation facilities. Over the years, as more users have been introduced into a spectrum allocation block, the users—especially in non-safety of life applications—have interfered with one another and the spectrum has become very noisy and degraded due to the amount of emissions in close frequency to one another.

The 5G emissions are known to interfere with RADAR altimeters.[2] These altimeters are used by many systems on the aircraft and any interference creates significant safety risk in low visibility landing situations. RADAR altimeter is integrated into the avionics suite of many aircraft, adding necessary sensor information and data points to complete a logic sequence in the autopilot and other integrated systems computing performance calculations. Any level of interference results in a layer of safety being compromised.

The process for RFI resolution and mitigation can be a collaborative effort and should include all stakeholders to reach the best solutions. It is paramount that all aspects are considered to keep the aviation industry safe. PASS suggests the following additional solutions to safe progress:

- All manufacturers of 5G radios should send their radio to the FAA Technical Center for evaluation by the Spectrum Engineering division for testing for possible RFI scenarios.
- Different placement of antennas relative to airfields, including beam management.

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[1] NASA. "The Electromagnetic Spectrum," modified March 2013. https://imagine.gsfc.nasa.gov/science/toolbox/emspectrum1.html.

U.S. Department of Homeland Security, *Radio Frequency Interference Best Practices Guidebook*, February 2020.

Arecibo Observatory. "Sources of Radio Frequency Interference." https://www.naic.edu/~sondy/rfi.html.

[2] Federal Aviation Administration, "Safety Alert for Operators: Risk of Potential Adverse Effects on Radio Altimeters when Operating in the Presences of 5G C-Band Interference," December 23, 2021.

Federal Aviation Administration, AD 2021–23–12 and AD 2021–23–13.

- No radiation zones in the direction of airports and facilities that support aviation safety.
- Radiate the 5G radios at lower output power levels.
- Install antennas tilted downward to reduce potential interference to flights.
- Height restrictions on 5G radio towers to reduce line of site to aviation equipment.
- Fault detection and reporting on 5G radios to assist in faster RFI resolution.
- Apply spurious emission standards utilized in Europe to 5G radios in the United States.

PASS represents specialists at the FAA who are on the front lines when it comes to locating and documenting interference issues as well as inspectors who are responsible for investigating reports of aviation incidents. The crucial work these employees perform has the potential to be impacted by the deployment of 5G and PASS appreciates the opportunity to allow our concerns to be presented. The union strongly believes that addition of 5G without carefully mitigating risk to aviation will complicate the RFI resolution process by adding new interference potentials. It is crucial that both the Federal Communications Communication (FCC) and FAA dedicate resources specializing in 5G interference as future 5G rollouts are planned.

"Analysis of 5G Deployment: White Paper," February 2022, by Professional Aviation Safety Specialists, AFL–CIO, Submitted for the Record by Hon. Peter A. DeFazio

ANALYSIS OF 5G DEPLOYMENT: WHITE PAPER

The following is an analysis conducted by the Professional Aviation Safety Specialists on 5G deployment and the potential for radio frequency interference with National Airspace System equipment.

INTRODUCTION

There is the potential for newly deployed 5G radio access technology to cause radio frequency interference (RFI) in the nation's air traffic control system. This paper looks at the known interference potential with the RADAR/Radio altimeter in aircraft, as well as other potential interference issues that may arise with various ground- and space-based navigation systems within the National Airspace System (NAS).

Since 1977, the Professional Aviation Safety Specialists, AFL–CIO (PASS), has represented more than 11,000 employees of the Federal Aviation Administration (FAA) and Department of Defense (DoD) who install, maintain, support and certify air traffic control and national defense equipment, inspect and oversee the commercial and general aviation industries, develop flight procedures, and perform quality analyses of complex aviation systems used in air traffic control and national defense in the United States and abroad.

Nearly 700 million air travelers fly throughout the U.S. each year and PASS-represented employees are there to ensure the safety of the aviation system. Any mistakes or missteps could be catastrophic for the American flying public. As the demand for air travel continues to increase, so does the need to maintain the highest level of safety, integrity and reliability of the NAS. From inspectors who ensure industry compliance with FAA safety standards to systems specialists who protect the safety and efficiency of critical aviation systems, PASS-represented employees are focused on safety, every step of the way.[1]

METHODOLOGY

Utilizing extensive review of various aviation and telecommunication industry white papers as well as conducting a literary review of research papers within the Institute of Electrical and Electronics Engineers (IEEE) library, PASS has reviewed and developed the following analysis of the 5G radio, focusing on 5G and its potential to cause harmful interference with both NAS and user equipment. Spectrum analysis techniques as defined in the FAA's radio frequency interference course developed and taught at the William J. Hughes Technical Center in Atlantic City,

[1] Professional Aviation Safety Specialists. "About PASS." https://passnational.org/index.php/about-pass/about-pass

N.J., were utilized in analysis of all potential interference hazards identified in this paper.[2]

For the purposes of this research, the union analyzed the potential for harmful interference caused by frequency allocation, power radiation levels, spurious and erratic transmissions, as well as other unintentional harmful interference caused by the improper operation or failure of the 5G radio. The goal and the methods used were to take a safety perspective viewpoint in order to analyze all potential hazards, along with how to identify them, while simultaneously developing a means to mitigate the hazards for all stakeholders involved.

Careful consideration and time were dedicated to reviewing the design and use of the technology being deployed by the telecommunications industry for use in the 5G radio. PASS ensured that all aspects of beam management, radio location, frequency allocation, tower heights and power levels were considered in the analysis of 5G in regard to aviation equipment and potential interference, utilizing similar criteria as seen in the South Korean research on 5G conducted by the Electronics and Telecommunications Research Institute.[3] Any mathematical formulas, equations or techniques are from referenced material and online resources.

LITERARY REVIEW

Radio Frequency Interference: An Overview

Radio frequency interference (RFI) is a well-known phenomenon in the electromagnetic spectrum.[4] Research into what types of RFI exist, such as intermodulation and how to mitigate the effects on communication equipment, date back 100 years or more and is well documented research.[5] Modern day RFI is still an issue that many manufacturers try to address during the engineering and design phase of any electronic device. Even with multiple aspects of RFI taken into consideration during design, unforeseen issues often arise or there are issues that simply cannot be avoided. Regarding the aviation industry, there are multiple types of interference reported each day within the NAS which affect the operation of NAS components. As more users enter or become adjacent to the frequencies that are utilized for safety of life applications, it is extremely important that all aspects of RFI be considered and mitigated before they are introduced into the NAS and become unknown risks.

Harmful interference as defined by the FAA Spectrum Engineering & Policy department is any emission, radiation, or induction that obstructs, or repeatedly interrupts, a radio communications service operating in accordance with established regulations. Some types of intentional interference are: Phantom controller, electronic attack (military), GPS jammers and any illegal operation by an unauthorized user. Some types of unintentional interference are brute force, spurs, intermodulation, as well as faulty, degraded and/or aging electronic equipment (see "Interference Concerns" below). Most RFI experienced by the FAA is unintentional in nature and takes cooperation between multiple stakeholders to resolve.[6]

Aviation Band of Frequencies

The introduction of 5G radios adjacent to. Many of the traditional unintentional RFI scenarios become an area of concern due to the proximity of frequency allocation, as well as the physical location or proximity of the 5G radio emitters. By design, 5G is intended to operate within the frequency range and power thresholds set forth by the Federal Communications Commission (FCC) and should not infringe on the use of any other adjacent frequencies.[7] It is important to note that the telecommunications industry's 5G radios encompass a large variety of equipment and manufactures. These multiple types of 5G radios fall under 3rd Generation Partner-

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[2] Federal Aviation Administration, William J. Hughes Technical Center, "RFI Resolution Course."

[3] Ho-kyung Son and Young-jun Chong, *Interference Analysis for Compatibility Between 5G System and Aeronautical Radio Altimeter*, published as part of 2020 International Conference on Information and Communication Technology Convergence (ICTC), October 21–23, 2020.

[4] NASA. "The Electromagnetic Spectrum," modified March 2013. https://imagine.gsfc.nasa.gov/science/toolbox/emspectrum1.html.

U.S. Department of Homeland Security, *Radio Frequency Interference Best Practices Guidebook*, February 2020.

Arecibo Observatory. "Sources of Radio Frequency Interference." https://www.naic.edu/~sondy/rfi.html.

[5] K. Chang, *Intermodulation Noise and Products Due to Frequency-Dependent Nonlinearities in CATV Systems*, published as part of IEEE Transactions on Communications (Volume 23, Issue 1), January 1975.

[6] Federal Aviation Administration, William J. Hughes Technical Center, "RFI Resolution Course."

[7] CFR Title 47.

ship Project's (3GPP)[8] n77 technical standards, which cover spectrum allocation from 3.3GHz to 4.2GHz. The aviation band has utilized the spectrum from 4.2GHz to 4.4GHz for RADAR altimeters for over 40 years. The introduction of the 5G radios places a non-safety of life user near a frequency band which is utilized in safety of life applications.[9]

The reason for concern regarding this added allocation is warranted. Over the years, as more users are introduced into a spectrum allocation block, the users—especially in non-safety of life applications—begin to interfere with one another and the spectrum becomes noisy and degraded due to the number of emissions in close frequency to one another. Radio frequency interference has been increasingly observed in data recorded by several airborne and spaceborne radar sensing systems.[10] It is important that before new users enter the spectrum, an assessment of the risks to aviation are performed to assure that safety of life applications can be maintained. Listed below in the table are the authorities for documenting RFI and reporting.

Table 1. Authority Contact Information for RF Interference Reporting[11]

Authority Contact	Information
FCC 24/7 Operations Center	https://fccprod.service-now.com/psix-esix/ • Phone: (202) 418–1122 • Email: FCCOPS@fcc.gov Non-Aviation
GPS Outages: USCG	https://www.navcen.uscg.gov/?pageName=gpsUserInput
Aviation GPS Outages: FAA	https://www.faa.gov/air__traffic/nas/gps__reports/
Military GPS Outages worldwide: GPSOC	https://gps.afspc.af.mil/ (may not open for non-military users)

One major reason that PASS is concerned with RFI related to 5G radios is due to experience with new devices over the past 10 to 15 years. With the introduction of 4G LTE and WiFi devices, there was an increase of RFI with systems such as the Terminal doppler weather RADAR and other NAS equipment. Radio frequency interference issues with broadband transmission media have been an important capacity and coverage issue for 4G, LTE, WiFi and other deployments. Interference modes unrecognized previously have risen to importance in the new wireless environment. Some of the issues encountered with 4G (e.g., from FM to LTE, CATV to LTE, and LTE to CATV) raise valid concern with 5G deployment.[12]

RADAR Altimeters

PASS represents bargaining unit employees at the FAA who are on the front lines when it comes to documenting and finding interference issues. Other unions in the aviation industry have spoken loudly about their concern of interference issues on 5G deployment, and PASS would like to echo those concerns, as well as describe some of the added complexity around the issue.

PASS-represented airways transportation systems specialists (ATSS), FAA job series 2101 employees, are located at airports across the nation and have a very complex job. An ATSS is often asked to document any complaints of interference and track and locate the source. This task is not an easy one as the source of interference is often not known and can be very difficult to find if it is not a continuous interference. When a pilot or controller reports RFI, the ATSS is notified to investigate what may be the cause. Often this may include interfacing with multiple entities and agencies to identify the source, creating a long process that takes a great amount of time.

The first step is information gathering, trying to find out how often the interference happens and if it was reported by multiple users. In the case of 5G, the issue becomes a safety concern because of several factors: including but not nec-

[8] 3GPP. https://www.3gpp.org/.

[9] Federal Aviation Administration, "Safety Alert for Operators: Risk of Potential Adverse Effects on Radio Altimeters when Operating in the Presences of 5G C-Band Interference," December 23, 2021.

[10] The National Academies Press, "Summary of the Radio-Frequency Interference Workshop," November 8, 2013.

[11] U.S. Department of Homeland Security, *Radio Frequency Interference Best Practices Guidebook*, February 2020.

[12] Chris Horne, LBA Blog, "4G LTE Radio Interference Forum Debuts," November 11, 2013. https://www.lbagroup.com/blog/4g-lte-radio-interference/

essarily limited to the location of the emitters, the power of the emitters, the frequency allocation of the emitters, and degraded or broken emitters and their interference potential (known and unknown). According to the FAA, the current known interference caused by the 5G emitters is with RADAR altimeters.[13] These altimeters are used by many systems on the aircraft and any interference creates a significant safety risk in low visibility landing situations and various other situations.

Because of its long history of integrity and accuracy the RADAR altimeter is integrated as a core sensor feed into the avionics suite of many aircraft, adding necessary information and data points to complete a logic sequence in many modern and automated aircraft systems. For instance, upon landing, the RADAR altimeter is used to assist in verifying that an aircraft has reached the ground and to initiate a sequence involving other systems (ground spoilers, thrust reversers, autobraking systems, etc.) that slow the aircraft in a timely and predictable manner. Airlines calculate performance data based on the full functionality of these systems and the FAA authorizes flight crews to plan for and utilize certain runway lengths based on the availability of those systems. If the weather is a concern and the aircraft or its crew is not able to utilize the full complement of systems, the required length of runway increases greatly. In December 2021, the FAA issued two Airworthiness Directives (ADs) that were prompted by a determination that radio altimeters cannot be relied upon to perform their intended function if they experience interference from wireless broadband operations in certain frequencies. During takeoffs and landings, as a result of this interference, certain airplane systems may not properly function. With the current 5G deployment, as with all ADs issued, PASS-represented employees in Aviation Safety are tasked with ensuring the ADs are complied with by the aviation community.

Of specific concern is that the RADAR altimeter is used by airlines and by many smaller operators such as Helicopter Air Ambulance (HAA) operators performing emergency medical transportation. When conducting HAA operations, many takeoffs and landings are off airport. HAA flight crews are picking up trauma patients by the side of the road on improvised landing sites that have not had a full analysis of the possible 5G interference afforded to similar operations at airports and heliports. Some of these landing sites can be in very close proximity to cellular towers. It is in the best interest of all stakeholders that a failure situation is considered and planned for properly. At a minimum, the capability to alert the telecommunications service provider of an out of tolerance frequency, or power output, should be considered on all deployed devices.

Interference Concerns

The introduction of the 5G radios (NR) emitter towers in proximity of landing environments or communication and navigational equipment means that there is a new source of potential RFI that did not previously exist.

The largest area of concern for interference with 5G radios (NR) exists with the radio altimeters located in the aircraft. The system provides data to both the pilot display and automated systems on airframes, such as ground proximity warning, terrain awareness and warning (TAWS), flight control and deployment of altitude dependent systems. The radio altimeter is a critical safety function in landing/takeoff, low level maneuvering, and avoiding changes in terrain that may not be visible at night or during bad weather. The technical requirements are that the FMWC altimeter sweeps at 200MHz, with a transmit power ranging from 0.1 to 100 watts. The protection criteria as per the International Telecommunication Union (ITU) standard is that desensitization occurs at I/N = –6dB.[14]

In a study by the Aerospace Vehicle Systems Institute ("AVSI") project team on the "Effect of Out-of-Band Interference Signals on Radio Altimeters," it was stated that while the altimeters considered in the testing are representative of the majority of systems fielded by commercial and private aviation, it is not a comprehensive set of data for all altimeters operating under all conditions.[15] The same holds true for the 5G radios. There are different service providers and carriers deploying different radios that are manufactured by multiple vendors, thus the potential for inter-

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[13] Federal Aviation Administration, "Safety Alert for Operators: Risk of Potential Adverse Effects on Radio Altimeters when Operating in the Presences of 5G C-Band Interference," December 23, 2021.

Federal Aviation Administration, AD 2021–23–12 and AD 2021–23–13.

[14] International Civil Aviation Organization (ICAO), "Radio Altimeter Spectrum," February 6, 2018. https://www.icao.int/NACC/Documents/Meetings/2018/RPG/RPGITUWRC2019-P08.pdf

[15] Notice of Ex Parte Meeting, GN Docket No. 18–122, Aerospace Vehicle Systems Institute ("AVSI"), "Effect of Out-of-Band Interference Signals on Radio Altimeters," February 2020.

ference is greatly expanded and dependent upon what type of 5G radio is interfering with what type of altimeter.

Brute Force

Excessive output power and the location of the 5G radios (NR) emitters have the potential to cause brute force. If 5G radios are near the aircraft's radio altimeter, communication or navigation receivers, there is potential for RFI. Every receiver has a point at which a signal outside its Radio Frequency band pass will break through and overload. The receiver becomes desensitized, causing the receiver to be driven into nonlinear operation.[16] The undesired signal gets detected in a highly garbled manner or the receiver becomes so desensitized that signal detection is impossible.[17]

The location and power output of the 5G emitters near airports raises concern for potential brute force scenarios with Navigational Aids (NAVAIDS) such as Instrument Landing Systems (ILS), Distance Measuring Equipment (DME) and other ground-based navigation systems. Unless the source is extremely strong, the signal may not be detectable on the ground making it necessary to get a flight inspection aircraft in the area to identify the source.

An additional aspect of concern for brute force is the beam management utilized by 5G radios (NR). The beam management technology allows the 5G radio to focus concentration on the user equipment (UE) from the base station tower (gNB) toward the users. This creates a scenario where the beam management system can aim and direct the power toward an aircraft on final approach, causing the possibility for brute force to be increased if the UE on the aircraft is not in airplane mode.[18]

Spurious Emissions

Any electronic device has the potential to generate spurious emissions. When an electronic device radiates on an unintended frequency, such as transmitting the same frequency as another device, that is a spurious emission. In many cases, radios and electronics generate spurious emission when operating normally. The 5G radios have the potential to generate spurious emissions.[19] These spurious emissions on a frequency, or frequencies, outside the assigned bandwidth are often generated from faulty transmitters or radio frequency amplifiers. Any signal above –104 dBm at a receiver's input has the potential to cause RFI.[20]

The testing and data on what types of spurious emissions a 5G radio is capable of emitting while in normal operation or failed states has not been gathered. The problem when deploying new equipment into the aviation band of the spectrum is knowing exactly how that device operates and whether or not it has sufficient filtering on the output of the transmitters amplifier section to prevent spurious emissions.

Erratic Emissions

The location of the 5G radio near airports or in close proximity to communications and navigations equipment off an airport also raises the potential for erratic emissions. Erratic emissions, which is a specific type of spurious emissions, radiate off

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[16] J. Gavan and M. B. Shulman, *Effects of Desensitization on Mobile Radio System Performance Part I: Qualitative Analysis*, published as part of IEEE Transactions on Vehicular Technology, November 1984.

Tian Tian, Hongshun Zhang and Yanzhi Hu, "Study on UWB compatibility with airborne receivers of Tactical Air Navigation System," 2008 World Automation Congress.

[17] Federal Aviation Administration, William J. Hughes Technical Center, "RFI Resolution Course."

[18] Giordani, M., M. Polese, A. Roy, D. Castor, and M. Zorzi. "A tutorial on beam management for 3GPP NR at mmWave frequencies," IEEE Comm. Surveys & Tutorials, Q1 2019.

IEEE Spectrum, Engineering Resources. https://engineeringresources.spectrum.ieee.org/?pt=dir&page=engineeringresources.

MathWorks, *Hybrid Beamforming for Massive MIMO Phased Array Systems*. https://www.mathworks.com/content/dam/mathworks/white-paper/gated/93096v00__Beamforming__Whitepaper.pdf.

MathWorks, Visual Antenna Coverage Map and Communication Links. https://www.mathworks.com/help/comm/ug/visualize-antenna-coverage-map-and-communication-links.html.

[19] Federal Aviation Administration, William J. Hughes Technical Center, "RFI Resolution Course."

IEEE Spectrum, Engineering Resources. https://engineeringresources.spectrum.ieee.org/?pt=dir&page=engineeringresources.

[20] Federal Aviation Administration, William J. Hughes Technical Center, "RFI Resolution Course."

U.S. Department of Homeland Security, *Radio Frequency Interference Best Practices Guidebook*, February 2020.

the assigned frequency to the radio and sweep across the frequency spectrum. These signals are highly dependent on several factors such as power level, temperature and humidity. Often these are very hard to source due to the intermittent nature of the RFI on specific frequencies caused by the sweeping nature, even though the source is constant.[21]

The testing and data on what types of erratic emissions a 5G radio is capable of emitting while in normal operation or failed states has not been gathered. As with spurious emissions, the aviation industry does not know if the 5G radio will generate erratic emissions. The major difference with erratic emissions compared to spurious emissions is the erratic emissions have the potential to take out or interfere with multiple types of equipment simultaneously as it sweeps across an often very broad range of spectrum.

RFI Resolution and Mitigation

The process for RFI resolution and mitigation can be a collaborative effort and should include all stakeholders to preempt any interference, and then address it if it still occurs. It is paramount that all aspects are considered to keep the aviation industry safe.

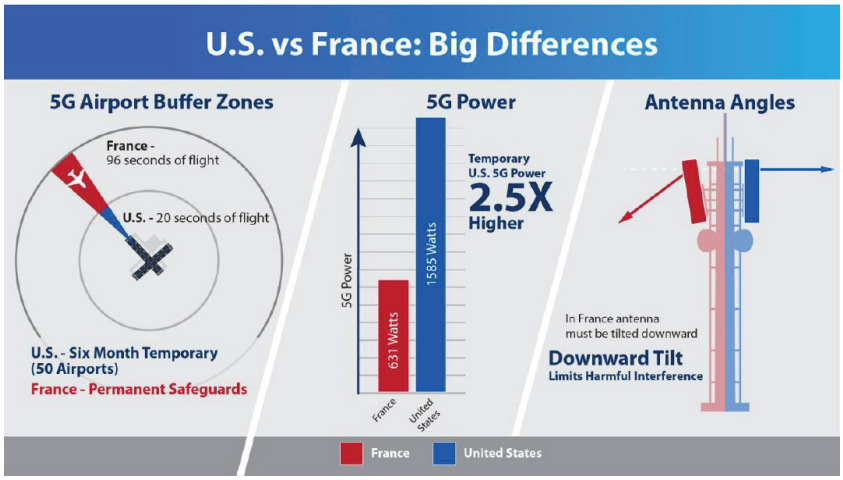
FAA, aviation industry and telecommunications communication systems and compatibility assessments with currently fielded radio altimeters are not "one size fits all," so the RTCA SC–239 Assessment[22] is a good starting place, but we must continue this work to ensure the two industries can exist in the safest way possible.

Additional solutions to safe progress may include:

- All manufacturers of 5G radios should send their radio to the FAA Technical Center for evaluation by the Spectrum Engineering division for testing for possible RFI scenarios.
- Different placement of antennas relative to airfields, including beam management.
- No radiation zones in the direction of airports and facilities that support aviation safety.
- Radiate the 5G radios at lower output power levels.
- Install antennas tilted downward to reduce potential interference with flights (see graphic below).
- Height restrictions on 5G radio towers to reduce line of site to aviation equipment.
- Fault detection and reporting on 5G radios to assist in faster RFI resolution.
- Apply stringent spurious emission standards within aviation safety bands to 5G radios in the United States.

[21] Federal Aviation Administration, William J. Hughes Technical Center, "RFI Resolution Course."

[22] Radio Technical Committee for Aeronautics, SubCommittee-239, Low Range Altimeter, "Assessment of C-Band Mobile Telecommunications Interference Impact on Low Range Radar Altimeter Operations" (RTCA Paper No. 274–20/PMC–2073) October 7, 2020. https://www.rtca.org/wp-content/uploads/2020/10/SC-239-5G-Interference-Assessment-Report__274-20-PMC-2073__accepted__changes.pdf



CONCLUSION

PASS recognizes the efforts of airline unions and other aviation organizations for raising concerns about 5G deployment and protecting the safety of the flying public. We also would like to thank the FAA and the telecommunications industry for working together to implement and deploy 5G in the safest way possible. The delay and identification of 50 airports with wireless transmitters in close proximity to runways is a good start, but we must also protect small airports, helicopters and general aviation.

The aviation safety concerns raised regarding interference to radio altimeters from wireless operations pose a hazard to the flying public. The current stop-gap solution is a preliminary response to mitigate the threat of 5G to aviation safety. However, it does not establish a sufficiently comprehensive and predictable framework for permanently addressing imminent and potential hazards to aviation caused by 5G radio interference.

PASS believes that there is a need to reinvest in the personnel within the FCC and FAA who are dedicated to preventing interference issues before they arise and resolving them when they occur. Over the past 10 years, the FCC has closed multiple field offices. The state of Florida has only one FCC office to investigate and deal with all reported RFI issues in the entire state. In addition, the FAA does not have adequate staffing in the job series 2101 or 0856 field for those who specialize and resolve RFI issues.

The addition of 5G will complicate the RFI resolution process by adding new interference potentials. It is crucial that federal agencies and telecommunications companies dedicate resources toward the prevention of 5G interference as future 5G rollouts are planned.

Statement of Terry L. McVenes, President and Chief Executive Officer, RTCA, Inc., Submitted for the Record by Hon. Peter A. DeFazio

Chair Larsen, Ranking Member Graves, and Members of the Subcommittee:

My name is Terry McVenes, and I am the current President and Chief Executive Officer of RTCA, Inc. RTCA was founded as the Radio Technical Committee for Aeronautics in 1935, and is a private, not-for-profit corporation that works with the Federal Aviation Administration (FAA), regulators in other countries, and industry experts to develop technical performance standards. These standards serve as a basis for government certification of equipment used by tens of thousands of aircraft flying daily throughout the world's airspace. With over five hundred members, RTCA represents organizations, entities, and governments from across the globe including aircraft and avionics manufacturers, service providers, research and development organizations, academia, and uncrewed aviation systems.

On October 8, 2020, RTCA, Inc. submitted an *ex parte* filing in the Federal Communications Commission docket to provide the Commission with the benefit of our completed report entitled "Assessment of C-Band Mobile Telecommunications Interference on Low Range Radar Altimeter Operations" ("RTCA MSG Report"). This report was the culmination of a six-month multi-stakeholder group ("MSG") effort—the 5G Task Force—that commenced in April 2020 when the RTCA Special Committee 239 ("SC–239") issued an invitation to the public to participate. The Commission had encouraged such multi-stakeholder efforts to examine spectrum coexistence issues with radar altimeters as noted in the Commission's Report and Order in the matter of *Expanding Flexible Use of the 3.7–4.2 GHz Band* ("*Order*"). The RTCA MSG Report was informed by detailed information made available by the commercial wireless and aviation industries regarding their respective systems and was therefore able to examine issues of compatibility more thoroughly between existing radar altimeters and prospective flexible use licensees than were the earlier preliminary analyses submitted to the Commission. As explained in the RTCA MSG Report, the analysis found serious threats of harmful interference to today's installed radar altimeters from anticipated flexible use licensed deployments, including from spurious emissions into the radar altimeter band.

At the time published, the RTCA MSG Report represented the most comprehensive analysis and assessment of the potential for interference to radar altimeters caused by 5G signals. It was based on the most up-to-date information exchanged between the commercial mobile industry and the aviation industry. This included experts in the design and manufacturing of radar altimeters. As stated in the Report, our analysis and its conclusions should not be considered as a definitive one-time assessment but should serve as the basis for ongoing work and analysis to continue to ensure that radar altimeters will function as intended to enable continued safe aviation operations.

Although we stand ready to continue our assessment of the relationship between 5G service and the proper functioning of radar altimeters as further information becomes available, it is important to note that the Report's findings and analysis remain uncontradicted by any authoritative response based on valid scientific and engineering methodology. Critics of the RTCA MSG Report have stated it should be dismissed because of improper assumptions and the parameters analyzed. Others have stated that the issue of potential 5G interference was looked at two years ago and no problems were uncovered. However, those calls for dismissal have never been backed up by hard science or engineering analysis. To our knowledge, no authoritative studies have been conducted that contradict the findings of the Report, and other independent testing has confirmed the RTCA findings. Furthermore, RTCA has not been approached to conduct further analysis or study based on new assumptions or parameters. Therefore, RTCA continues to stand behind the RTCA MSG Report from both a scientific and engineering perspective as well as its unbiased conclusions.

RTCA applauds the recent efforts of technical collaboration between the telecommunications industry and the FAA that has led to allowing more operations into airports while enabling the safe implementation of 5G service across the United States. Further dialogue between the aviation and mobile wireless telecommunications industries will be crucial in continuing to develop mitigations that will allow for both aviation and 5G implementation to be conducted in a safe and efficient manner. That dialogue must continue to take place with a proactive and transparent methodology, including further details of 5G implementations that may be used in deterministic analysis of the potential boundary conditions for failure or interference with low range radar altimeters.

While the current short-term collaborative mitigation activity is to be commended, RTCA is continuing our longer-term effort via SC–239. This special committee was established by RTCA in December 2019 to update the current minimum operational performance standards for radar altimeters. Our focus is protecting future radar altimeters from existing and planned in-band and out-of-band interferences.

It is important to note that future development and implementation of innovative technologies from both aviation and non-aviation interests are undoubtedly going to require new allocations of spectrum frequencies. It is also likely that those future allocations have the potential to conflict with those frequencies that have traditionally been allocated for aviation use. To address these future concerns, RTCA recently stood up a new special committee, SC–242, to take a broader look at potential frequency spectrum conflicts, analyze all of the current avionics standards in place, and then identify those areas that need to be addressed so that aviation interests can be out in front of any potential frequency conflicts early on in future technology development. We encourage Congress to support and promote appropriate govern-

ment and industry parties to proactively participate in efforts such as ours so that the challenges we have witnessed in recent months can be minimized or avoided.

The importance for the United States to maintain its international leadership in the implementation of modern technologies such as 5G cannot be overstated. Not only are billions of dollars at stake, but there are significant infrastructure and national security interests at stake as well. It is imperative that the appropriate government agencies collaborate early with each other, coupled and along with both aviation and non-aviation industries. Working together towards solutions early in the developmental process and based on an open and transparent exchange and analysis of factual engineering data by all parties will allow the United States to maintain leadership in the deployment of new technologies such as 5G as well as protecting the safety of the traveling public.

With our unprecedented history of accomplishments since 1935, RTCA stands by to serve as a facilitator for such future dialogue. By providing the necessary leadership for participatory decision-making and consensus building, we aim to serve not only the aviation industry, but also serve as a catalyst for the advancement of technology and innovation on behalf of the American people.

Thank you for the opportunity to provide this written testimony.

APPENDIX

QUESTIONS FROM HON. SAM GRAVES OF MISSOURI TO HON. STEPHEN M. DICKSON, ADMINISTRATOR, FEDERAL AVIATION ADMINISTRATION

Question 1. On January 12, 2022, the United States Environmental Protection Agency (EPA) announced that it was developing a proposal under the Clean Air Act (CAA) to issue a proposed endangerment finding for lead emissions from piston-engine aircraft. 170,000 piston aircraft in the United States typically require leaded aviation gasoline to operate. Restricting the availability or use of aviation gasoline, which may occur if the EPA issues an endangerment finding, would be devastating to general aviation and the entire aviation industry if no low-cost, widely obtainable unleaded replacement fuel is available.

The FAA's Piston Aviation Fuels Initiative (PAFI) is intended to identify unleaded aviation gasoline alternatives that can be used across the piston aircraft fleet.

ANSWER. There are approximately 190,000 piston aircraft in the United States that typically require leaded aviation gasoline (avgas) to operate. Tetra-Etyly Lead (TEL) has been added to avgas since 1921 to prevent engine damage and knocking at higher power settings. Today, avgas remains the only transportation fuel in the United States to contain lead.

Can you please provide the Committee with a detailed status update on PAFI, including:

1.a. PAFI's mission;

ANSWER. PAFI was formed to test and evaluate high-octane candidate gasolines, required by piston-engine aircraft, to replace 100 low lead (100LL) and to ultimately enable the transition of the entire U.S. aircraft fleet to unleaded gas.

1.b. a timeline of PAFI's milestones (denoting milestones accomplished and those still outstanding);

ANSWER. There are currently two candidate fuels being evaluated under PAFI as part of the initial program phase. This initial phase will determine if either or both of the candidate fuels are viable replacement fuels for 100LL.

If a fuel is successful in the initial phase, more extensive testing will be performed, including detonation testing with more engines and greater number of test conditions, longer durability test cycles, a comprehensive materials compatibility testing, and finally, flight testing using the candidate fuel on a variety of aircraft types.

The anticipated timeline for completion of the initial phase is by the end of 2022. Completion of the final testing phase is dependent on the ability of the candidate fuels to meet the testing requirements.

1.c. an estimate on when fleetwide certification or availability of an unleaded aviation gasoline is expected;

ANSWER. In parallel with the planned fuel testing, the FAA is developing a Fleet Authorization Process, as outlined under section 565 of the FAA Reauthorization Act of 2018. The Act allows the use of an unleaded aviation gasoline as a replacement for a leaded gasoline if the Administrator "adopts a process (other than the traditional means of certification) to allow eligible aircraft and engines to operate using qualified replacement unleaded gasoline in a manner that ensures safety."

The FAA will address fleet authorization of unleaded aviation fuels for different octane levels. The FAA anticipates fleet authorization for lower octane fuels will be available next year.

PAFI will continue to evaluate, test, and qualify high-octane aviation unleaded fuels with the objective to ultimately transition the fleet to unleaded aviation fuel.

1.d. action items and costs associated with ensuring the widespread availability of unleaded aviation gasoline, including the installation of new airport fueling systems;

ANSWER. The information requested will be part of the government-industry collaborative Eliminate Aviation Gasoline Lead Emissions (EAGLE) initiative, which launched earlier this month, to include efforts to determine the fuel infrastructure, airport infrastructure and associated commercial viability of unleaded aviation gasoline.

1.e. a copy of the most recent version of the PAFI Steering Group Charter; and
ANSWER. See attached [below]:

PISTON AVIATION FUELS INITIATIVE STEERING GROUP (PSG)
MAY 29, 2013
CHARTER

In support of their ongoing commitment to facilitating the development and deployment of a high octane fuel that will have the least impact on the existing general aviation fleet and distribution system, the Aircraft Owners and Pilots Association (AOPA), American Petroleum Industry (API), Experimental Aircraft Association (EAA), General Aviation Manufacturers Association (GAMA), National Air Transportation Association (NATA), National Business Aircraft Association (NBAA) and the Federal Aviation Administration (FAA) have joined to form the Piston Aviation Fuels Initiative Steering Group.

Purpose of the Piston Aviation Fuels Initiative Steering Group (PSG): To facilitate, coordinate, expedite, promote and oversee the Piston Aviation Fuels Initiative (PAFI) based on the recommendations of the Unleaded Avgas Transition Aviation Rulemaking Committee Final Report.

The role of the PSG includes providing supporting data and coordinating the activities of member organizations in support of the PAFI program. The PSG will establish a technical advisory committee comprising representatives from key stakeholder organizations to support the development of PAFI project activities and identify and engage subject matter experts as necessary to accomplish specific tasks. The Technical Advisory committee will help identify the resources needed to support unique PAFI tasks, such as the generation of job aids, and with support of the Industry Co-Lead solicit and coordinate the in-kind support needed from industry to support the development and approval of unleaded aviation gasolines.

The PSG is organized as an industry-FAA coalition comprising industry associations and the FAA to coordinate the resources and support necessary for the program. The PSG will form working groups composed of necessary FAA and industry subject matter experts to develop procedures, plans, and other necessary information to conduct the fuel testing. The PSG will engage with industry stakeholders who allocate manpower and other resources to support these working groups and the test program.

Duration: The PSG is established with an initial five-year charter in support and recognition of the Preparatory and Project phases of the PAFI. The PSG will undergo an annual review of its charter, membership, and purpose to address the potential changing needs and tasks as the industry moves closer to the Deployment stage of new fuels.

Schedule: Members of the PSG will meet at a minimum of twice each year to receive a formal report on the status of the PAFI. The PSG will also conduct regular conference calls to support the activities of the PAFI leads and the Technical Advisory Committee.

Overview of PAFI: The FAA's Unleaded Avgas Transition Aviation Rulemaking Committee (UAT ARC) recommended the establishment of a collaborative industry-government initiative referred to as the Piston Aviation Fuels Initiative. The objectives of this initiative are to identify candidate unleaded aviation gasolines, provide for the generation of qualification and certification data on those fuels, and facilitate fleet-wide certification of the selected candidate fuel(s) with the least impact on the existing piston-engine aircraft fleet. The PAFI program is designed to support the identification of the most viable fuels consistent with the FAA 2025 Flight Plan goal of identifying a viable unleaded aviation gasoline by 2018. Additional work will be necessary to develop a transition plan that supports the production and distribution of a fuel and transition of the existing aircraft fleet, including support for the certification of any hardware modifications that might be necessitated by a new fuel. The complexity, cost and timeline for successful transition is unknown at this time and will be partially dependent on the properties and capabilities of the fuel(s) that successfully emerge from the PAFI program.

Identification of candidate unleaded aviation gasolines for the PAFI program shall be based on "Fuel Development Roadmap—AVGAS Readiness Levels" developed by the UAT ARC that identifies the key milestones in the aviation gasoline development process and the information needed to support assessment of the viability of

candidate fuels in terms of impact upon the existing fleet, production and distribution infrastructure, environment and toxicology, and economic considerations. The elements of PAFI will be a PSG, FAA Test Program, FAA review board, and a centralized FAA certification office.

PAFI includes an FAA test program which is composed of a subset of Test & Evaluation tasks from the UAT ARC final report based on the expected level of funding. The FAA test program will test candidate fuels at the FAA William J. Hughes Technical Center to generate data that can then be used by the candidate fuel developer/sponsor to support both ASTM production specification development and FAA fleet-wide certification, eliminating redundant testing activities. It includes procurement of necessary equipment and services to conduct tests in two phases: Phase 1 fuel properties testing of up to ten candidate fuels, and Phase 2 engine and aircraft testing of up to two candidate fuels.

PAFI will also include the establishment of an Industry Co-Lead and an FAA Co-Lead. The Industry Co-Lead, reporting to the PSG, will act as the industry program manager, monitoring, directing and coordinating overall industry-related PAFI activities, and interface with industry, government and candidate fuel developers. The FAA Co-Lead (manager of the Fuels Program Office, AIR–20) will act as the FAA program manager and will monitor direct and coordinate overall government-related PAFI activities.

PAFI STEERING GROUP
MEMBERS
MAY 29, 2013

Craig Fuller,
President & CEO
Aircraft Owners and Pilots Association

Bob Greco,
Group Director, Downstream and Industry Operations
American Petroleum Association

Jack Pelton,
Chairman of the Board
Experimental Aircraft Association

Peter A. White,
Fuels Program Office (AIR–20), Manager
Federal Aviation Administration

Pete Bunce,
President & CEO
General Aviation Manufacturers Association

Tom Hendricks,
President & CEO
National Air Transportation Association

Ed Bolen,
President & CEO
National Business Aviation Association

1.f. any other information relating to the certification of unleaded aviation gasoline, whether part of PAFI or not.

ANSWER. To-date, a small percentage of the piston engine fleet is permitted to operate on unleaded fuels through FAA-approved Supplemental Type Certificates (STCs).

These unleaded fuels include:
- UL 91 (91 Octane, ASTM Spec D7547);
- UL 94 (94 Octane, ASTM Spec D7547);
- Automotive gasoline (ASTM Spec D4814);
- 82 UL (ASTM Spec D6227–04);
- GAMI Gl00UL (100 Octane).

On February 23, 2022, the FAA announced a new initiative that outlines how our country can safely eliminate the use of leaded aviation fuel by the end of 2030 without adversely affecting the existing piston-engine fleet. The initiative, EAGLE, builds upon a continuing collaboration with Industry through PAFI.

The effort to remove leaded aviation fuels will be based on four pillars of action that involve the FAA, the EPA, fuel suppliers and distributors, airports, engine and aircraft manufacturers, research institutions, associations, environmental experts, communities and other key stakeholders. The four pillars are:
- Develop Unleaded Fuels Infrastructure and Assess Commercial Viability;
- Support Research & Development and Technology Innovations;
- Continue to Evaluate and Authorize Safe Unleaded Fuels; and
- Establish Necessary Policies.

QUESTIONS FROM HON. ELEANOR HOLMES NORTON TO HON. ERIC FANNING, PRESIDENT AND CHIEF EXECUTIVE OFFICER, AEROSPACE INDUSTRIES ASSOCIATION

Question 1. I would like to ask about the logistics of upgrading radio altimeters for the U.S. air fleet. What steps are involved in this process? How long would it

take to upgrade the altimeters for the entire fleet? How much would that cost and who currently bears the burden for that cost?

ANSWER. Our members are hard at work on this process. We believe there is a near term solution which includes retrofitting with a filter for those models that can accommodate them. As part of that work we are collaborating with the FAA to define how much potential interference a radio altimeter can tolerate and still be relied upon.

We do know that some radio altimeter models will not be able to be retrofitted, and those will require a new design. Over the long term we would expect that all models will need to be replaced. This requires the publication of a new standard.

The first step for a standard was taken in 2019 when RTCA formed a group to begin this process. However, a new standard will require a total re-write because the current criteria require a substantial update to enable them to work with U.S. and international operational systems.

Originally the group expected to complete the standard this year, but the current crisis has impacted this work because the same staff are now prioritizing the analysis of data and designing near-term fixes. The expectation now is that a new standard could be ready in the third or fourth quarter of 2023.

It is critical that the standard be written with the future in mind. This will require that the telecommunications industry provide data and plans for future operating environments, as well as the current ones. The development lifecycle for an altimeter can be measured in decades, so it is important for aviation to understand what 6G and 7G look like twenty years from now.

Regarding timelines, the retrofitting for aircraft where a near-term solution is possible could take up to a year. The standard development, design of new radio altimeters, certification and replacement should be measured in years. It is difficult at this juncture to ascertain the costs of such a multi-year program, until the final operational environment is defined and the standard completed.

QUESTION FROM HON. PETER A. DEFAZIO TO HON. MEREDITH ATTWELL BAKER, PRESIDENT AND CHIEF EXECUTIVE OFFICER, CTIA

Question 1. It is my understanding that many of the wireless providers will be shutting down their 3G networks in order to make room for expanding 5G networks. This will not only impact connectivity for rural users who won't have immediate access to 5G, but there are numerous impacts on home security, in-vehicle technology and transit. It is my understanding that unless there is a delay in the shuttering of 3G systems, more than 60 transit agencies will lose their real-time transit information platforms because those systems run off of a 3G network and supply chain issues have impeded their ability to upgrade. Absent real-time information about the location of trains and buses, many transit riders will consider other modes of travel, creating serious safety, congestion, and climate impacts for areas across the country.

As a matter of public safety and equity, will wireless providers be delaying their planned shut down of 3G service in order to give more time for transit agencies and others to adjust to the change?

ANSWER. Thank you for the question, Mr. Chairman. As you are aware, the national wireless carriers have each announced plans to transition the spectrum being used for 3G services to 5G services. Since those announcements, the industry has undertaken extensive efforts to educate its customers using 3G devices, including public transportation companies and transit agencies, about 3G sunset plans and how to continue service uninterrupted. Those outreach efforts included general 3G sunset notices and reminders via direct mail, email, text messages, business team engagement, industry outreach, website tools, whitepapers, articles, and webcasts, all for the purpose of minimizing customer disruption. The industry has also offered IoT customers services to obtain replacement devices and tailored solutions to streamline device procurement, activation, and configuration. In the months leading up to the 3G sunset, the industry has engaged with public transportation agencies and telematics companies to assist in device migration efforts. The wireless industry has offered assistance to migrate devices more quickly and has even offered temporary roaming solutions. As an industry, we commit to remain focused on assisting those few remaining 3G customers to work through any device migration efforts.

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