Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Expanding Flexible Use of	)	GN Docket No. 18-122
the 3.7 to 4.2 GHz Band	)	
	)	

PETITION FOR PARTIAL RECONSIDERATION OF THE 3.7-4.2 GHz BAND REPORT AND ORDER

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SUMMARY

The Aviation Petitioners respectfully ask the Commission to reconsider and redress the failure of the *Report and Order* to take into account critical record evidence of harmful interference to radio altimeters certified by the FAA as safety-critical systems operating in the 4.2-4.4 GHz Band from prospective flexible use operations in the 3700-3980 MHz range. Sound spectrum management required the Commission, in light of the record evidence and its own policies and stated intentions of protecting incumbents, to conduct a complete assessment of the issue *before* setting the technical and operational parameters for flexible use operations. The *Report and Order*'s decision in favor of "no action" regarding the protection of radio altimeters and seemingly requiring the aviation community to "protect thyself" from harmful interference was not supported by the evidence and sharply contrasts with other actions taken *in this very proceeding* to protect other incumbent adjacent band operations.

The Aviation Petitioners do not seek to delay the auction of flexible use licenses or affect the migration of Fixed Satellite Service operations from the lower 300 megahertz of the 3.7-4.2 GHz Band or the reimbursement of their transition costs. Protecting radio altimeters from harmful interference caused by flexible use operations need not undermine the Commission's central objective of making available 280 megahertz of "mid-band" spectrum for flexible use applications, including 5G.

As the Commission is aware, and recounted in the Petition, radio altimeters provide critical safety-of-flight functions throughout flight, and are especially important during periods of poor weather, low visibility, and difficult maneuvers. Pilots, crews, and the flying public rely upon interference-free operation of radio altimeters throughout flight to get them safely to their destination. The Aviation Petitioners, the Aerospace Vehicle Systems Institute ("AVSI"), and other aviation and aerospace interests submitted into the record (1) data indicating the need to

address the potential for interference to radio altimeters, (2) detailed technical responses to the single critic which misunderstood the AVSI studies, and (3) a practical study of a simple and common aeronautical configuration, which showed that a single flexible use base station operating under the rules at 3840 MHz, based on the technical parameters set out in the *Draft R&O* for flexible use operations, would present a cognizable risk of harmful interference to radio altimeters. This example alone fully rebutted the erroneous statements in the *Report and Order* that aviation had not shown a risk of harmful interference in so-called likely, reasonable scenarios. Yet the *Report and Order* did not address these critical submissions in the record before deciding to take no action to protect radio altimeters; rather it seemingly disregarded them completely.

And the *Report and Order* was wrong, in any event, to assume that safety-of-life aviation systems need only be available in "likely" and "reasonable" scenarios. Testing of FAA-certified radio altimeters requires that they meet FAA standards in all foreseeable conditions. Even more surprising, the *Report and Order* requires the aviation community to bear the burden themselves of solving any interference problems caused by new entrants who are disturbing the radio frequency environment in which radio altimeters have operated and benefitted the flying public for decades.

Accordingly, the Aviation Petitioners ask the Commission, on reconsideration, to:

- Make clear that flexible use licensees, as new entrants, must resolve and correct any harmful interference caused to safety-of-life radio altimeters;
- Take into account and assess the record evidence of the potential for harmful interference in scenarios relevant to aviation safety-of-life operations;
- Actively involve itself in a process to appropriately and promptly further assess that potential – facilitating input from both aviation and commercial mobile wireless stakeholders; and
- Adopt expeditiously any necessary mitigation measures applicable to flexible use licensees to protect radio altimeters as dictated by the record evidence and further assessment, before the auction in 3700-3980 MHz begins.

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PETITION FOR PARTIAL RECONSIDERATION

The Aerospace Industries Association ("AIA"), the Aerospace Vehicle Systems Institute ("AVSI"), Air Line Pilots Association, International ("ALPA"), Airbus, Aviation Spectrum Resources, Inc. ("ASRI"), Garmin International, Inc. ("Garmin"), the General Aviation Manufacturers Association ("GAMA"), the Helicopter Association International ("HAI"), Honeywell International Inc. ("Honeywell"), the International Air Transport Association ("IATA"), and the National Air Transportation Association ("NATA") (collectively, the "Aviation Petitioners"), pursuant to Section 1.429 of the Commission's Rules, 47 C.F.R. § 1.429, hereby petition the Commission to reconsider, in part, its March 3, 2020, *Report and Order* in the above-captioned proceeding.[1] Specifically, the Aviation Petitioners respectfully ask the Commission to reconsider the failure of the *Report and Order* to take into account critical record evidence of the potential for harmful interference to Federal Aviation Administration ("FAA")-certified radio altimeters operating in the safety-of-life 4.2-4.4 GHz allocation from prospective flexible use operations in the newly created 3700-3980 MHz range – and the resulting failure to take steps to ensure their protection. As explained herein, the *Report and Order* prematurely ended agency consideration of the potential for harmful interference to radio altimeters. But, in light of the record evidence, sound spectrum management requires the Commission to conduct a complete assessment of the issue when setting the technical and operational parameters for flexible use operations, including measures to mitigate the risk of potential interference to radio altimeters.

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[1] *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, GN Docket No. 18-122, Report and Order and Order of Proposed Modification, 35 FCC Rcd 2343 (2020) ("Report and Order").

I. INTRODUCTION

The Aviation Petitioners[2] understand the requirement to make so-called "mid-band" spectrum available in the United States for flexible use operations, such as 5G. They also appreciate the myriad substantial and unprecedented issues raised in this proceeding regarding the relocation of incumbents from the lower 300 megahertz of the 3.7-4.2 GHz Band. Nevertheless, there is an equally strong public policy imperative that aviation safety not be compromised in the process. The *Report and Order* did not address a critical aspect of the band realignment. The decision in favor of no action regarding radio altimeter protection was not supported by the evidence or the Commission's spectrum management policies, as manifested by other actions taken *in this very proceeding* to protect other adjacent band operations.

Fortunately, there is still time, if the Commission acts quickly, to set this matter aright and ensure that a threat to the safety of the flying public, pilots, aircrews, and persons is not unknowingly created as an unintended byproduct of the introduction of flexible use operations in the 3700-3980 MHz range. The Aviation Petitioners have no doubt that this is a result that no one wants to occur.

At the outset, the Aviation Petitioners wish to underscore what they are not seeking. They are *not* seeking to delay the auction of flexible use licenses in the 3700-3980 MHz range. They are *not* seeking to delay, condition, or otherwise affect the migration of Fixed Satellite Service ("FSS") space or earth station operations from the 3700-4000 MHz range, or the contemplated increased use by the FSS of the 4000-4200 MHz range. They are *not* seeking actions that would impact the reimbursement of costs called for in the *Report and Order* for the migration of incumbent space stations, earth stations, or Fixed Service stations. Protecting radio

[2] Descriptions of the Aviation Petitioners may be found in Exhibit 1.

altimeters from harmful interference caused by flexible use operations need not undermine the Commission's central objective in this proceeding, namely making available 280 megahertz of "mid-band" spectrum for flexible use applications, including 5G. This Petition does not propose an "either/or" solution, but rather seeks a both/and outcome: the Commission can *both* make spectrum available at 3700-3980 MHz for flexible use *and* ensure continued protected use of the safety-of-life radio altimeter function in the band at 4.2-4.4 GHz, where radio altimeters have uniquely operated for over fifty years.

As explained herein, radio altimeters provide critical safety-of-flight functions in the 4200-4400 MHz Band under a primary allocation to the Aeronautical Radionavigation Service ("ARNS"). The outputs of radio altimeters and the several certified aviation systems that rely upon radio altimeter input (*i.e.*, height above terrain) are critical for safe and efficient flight, especially during periods of poor weather or low visibility and during difficult maneuvers, as well as for proximity warnings to the ground and other obstacles. Pilots, crews, and the flying public rely upon interference-free operation of radio altimeters throughout flight to get them safely to their destination or aid them in their intended mission.

The Chairman and the *Report and Order* both expressly recognize that radio altimeters must operate without harmful interference. Yet, while acknowledging that radio altimeters may suffer harmful interference from the new, flexible use operators in 3700-3980 MHz, the *Report and Order* seeks to relegate that possibility to an "unlikely" realm or simply assure "significant" protection. In the realm of aviation, ensuring safety in reasonably likely scenarios to a significant degree is not sufficient: the reality is that FAA-certified avionics tasked with keeping lives safe, such as radio altimeters, are held to standards as stringent as one chance for error in

one billion flight hours.[3] In this proceeding, there was existing evidence in the public record of the potential for interference from flexible use operations that endangers the functioning of the radio altimeter[4] in common single base station situations, which demonstrated the need for further study before appropriate action, if any, could be formulated (as explicitly recognized in the draft *Report and Order*). Unfortunately, the Commission did not commit to take action as necessary to ensure that the deployment of ground-based flexible use systems protect the functioning of radio altimeters. Instead, in stark contrast with the draft *Report and Order* made available to the public by the Commission just three weeks earlier – under which the Commission would have welcomed further studies and promised to take action as appropriate to protect safety-of-life radio altimeters – the Commission placed the burden solely on the aviation industry to "take account of the RF environment that is evolving below the 3980 MHz band edge and take appropriate action, if necessary, to ensure protection of such devices."[5]

Accordingly, the Aviation Petitioners request that the Commission, as the nation's spectrum manager, reconsider its hands-off approach to this problem. The Aviation Petitioners ask the Commission on reconsideration to direct its engineers to work with the aviation industry and the commercial wireless industry members, and other relevant stakeholders interested in the 3700-3980 MHz sub-band to expeditiously conduct any further analysis to ascertain what

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[3] 14 C.F.R. § 25.1309(b)(1) reflects the extremely high system assurance rate that certified aviation systems, of which radio altimeters form a part, during a Category III approach must satisfy: "The occurrence of any failure condition which would prevent the continued safe flight and landing of the airplane is extremely improbable." Additional FAA installation guidance further defines "extremely improbable" as failure conditions that have "a probability on the order of 1 x 10-9 or less." FAA, AC 25.1309-1A, *System Design and Analysis,* at 15 (June 21, 1988).

[4] The Commission's rules employ a stricter standard for harmful interference to a safety-of-life system, such as radio altimeters operating in the ARNS, namely "[i]nterference which endangers the functioning of a radionavigation service or of other safety services." 47 C.F.R. § 2.1(c).

[5] *Report and Order* ¶ 395.

mitigation measures are appropriate and how long they should remain in place.

II. BACKGROUND: RADIO ALTIMETERS AND SAFETY OF FLIGHT

The 4.2-4.4 GHz Band is allocated to both the ARNS and Aeronautical Mobile (en route) Service ("AM(R)S") on a primary basis.[6] Radio altimeters operating in the ARNS are "an essential component of aeronautical safety-of-life systems, including precision approach, landing, ground proximity and collision avoidance systems."[7] The radio altimeter is the only sensor on the aircraft that provides a direct and independent measurement of the clearance height between the aircraft and the terrain, and is a uniquely vital system for Cat. II/III landings and other critical operational scenarios (*e.g.*, low-altitude helicopter operations, common in medical evacuation, firefighting, utility infrastructure maintenance, search-and-rescue, and other applications). The ARNS has been used by the airborne radio altimeter for over five decades, until the *Report and Order*, within a mostly unchanged spectrum neighborhood. Radio altimeters were introduced to improve safety after a number of studies looked at the occurrence of Controlled Flight Into Terrain ("CFIT") accidents.[8] As a result of recommendations from the U.S. National Transportation Safety Board ("NTSB"), radio altimeters are now required equipment on commercial airplanes as part of the Ground Proximity Warning System ("GPWS") and the Terrain Awareness and Warning System ("TAWS")[9] for operation during all phases of

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[6] "Use of the band 4200–4400 MHz by the aeronautical radionavigation service is reserved exclusively for radio altimeters installed on board aircraft and for the associated transponders on the ground." 47 C.F.R. § 2.106, note 5.438. *Accord id.* note US261.

[7] Operational and technical characteristics and protection criteria of radio altimeters utilizing the band 4 200-4 400 MHz, ITU-R Recommendation M.2059-0, at 1.

[8] *See* FAA, AC 23-18, *Installation of Terrain Awareness and Warning System (TAWS) Approved for Part 23 Airplanes*, at 9 (June 14, 2000).

[9] In 2000, the FAA mandated installation of TAWS to further reduce CFIT accidents. AC 23-18, at 10. TAWS requiring a radio altimeter input was mandated for installation in turbine-powered airplanes capable of carrying ten or more passengers by 14 C.F.R. § 121.135, 14 C.F.R. § 135.154, and 14 C.F.R. § 91.1045. Many operators not covered by the mandate have also voluntarily equipped their airplanes with TAWS due to its safety benefit.

flight.[10] Radio altimeters provide critical height above-terrain information to the pilot and to several automated on-board systems essential for safe flight. Aircraft, including all commercial passenger aircraft, often have multiple radio altimeters to ensure all of the systems operate reliably to give information to pilots on a timely and continuous basis. The international adoption of this system has significantly improved aviation safety in the United States and worldwide.[11]

Radio altimeters are required to provide very high levels of accuracy, particularly at lower altitudes, which necessitates a fine range resolution. Range resolution, and thus altitude accuracy, as a matter of physics, is inversely proportional to transmitted signal bandwidth, and therefore a large bandwidth is required to achieve high levels of altitude accuracy.[12] The two main types of radio altimeter systems used commercially are Frequency Modulated Constant Wave ("FMCW") and pulsed radar systems. For an FMCW altimeter, this wide bandwidth requirement manifests as a large sweep bandwidth, while for a pulsed altimeter it manifests as a very narrow pulse width (and thus a wide pulse bandwidth). Whereas most commercial radio

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[10] This includes all commercial passenger airplanes, a significant percentage of business and general aviation airplanes, and a significant percentage of helicopters.

[11] The experience with GPWS and CFIT is more dramatic: "Between 1946 and 1955, large passenger aircraft averaged 3.5 fatal CFIT accidents a year. Think of it: a fatal CFIT accident about every 15 weeks. Through the mid-70s, we were still averaging two fatal passenger airline accidents per year due to CFIT. In contrast, no jet operator has suffered such an event in U.S. airspace since 1974." Excerpt from speech by Nicholas A. Sabatini, FAA Associate Administrator for Aviation Safety (May 12, 2006), available at http://www.chinaaviationdaily.com/news/0/456.html. Since the Associate Administrator gave this speech fourteen years ago there has not been a single passenger fatality due to CFIT in a U.S. airliner with TAWS installed.

[12] *See* Comments of ASRI, ET Docket No. 10-123 (Apr. 22, 2011). Radio altimeter performance has been generically defined at the ITU-R. *See* Operational and technical characteristics and protection criteria of radio altimeters utilizing the band 4 200-4 400 MHz, ITU-R Recommendation M.2059-0.

altimeters do not use the entirety of the 200 megahertz allocation individually,[13] many types of aircraft utilize two or three co-located radio altimeters to provide the necessary integrity and availability requirements, which typically involve offsetting the center frequency, leading to virtually all of the 200 megahertz of the 4.2-4.4 GHz being utilized by a single aircraft.

Information yielded by radio altimeters is a key input to a pilot's decision-making as the aircraft descends to the approach's designated decision height, at which point the pilot must determine whether to land or to abort an approach.[14] Indeed, radio altimeters are an integral part of the systems used for approaches to land in all weather conditions. Interference-free operation of radio altimeters is especially crucial in low-/zero-visibility weather and night flying, and any interference that compromises reported information can immediately and adversely affect aircraft safety systems such as the autopilot function or the GPWS, and also pilot decision-making. Any and all interference to the radio altimeter, no matter how brief, should be considered a safety-of-flight issue.[15]

The FAA also requires radio altimeters to be deployed on any helicopter operated under a

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[13] For commercial FMCW altimeters, for example, anywhere from 100 MHz to 170 MHz is common. *See* ITU-R Recommendation M.2059-0, at 12, Tables 1, and 15, Table 2 (chirp bandwidth excluding temperature drift reported between 104 and 176.8 MHz for representative analog and digital radio altimeters).

[14] A radio altimeter display capability is recommended to be available for Category I approaches. FAA, AC 120-29A, *Criteria for Approval of Category I and Category II Weather Minima for Approach*, at 58 (Aug. 12, 2002). A radio altimeter display is required for each pilot for Category II approaches. *Id*. at 60.

[15] Radio altimeters also provide essential inputs to the correct operation of the traffic collision avoidance system ("TCAS II"), a safety-of-life system that "provide[s] collision avoidance protection for a broad spectrum of aircraft types." FAA, Introduction to TCAS II Version 7.1, at 5 (Feb. 28, 2011), available at https://www.faa.gov/documentLibrary/media/Advisory_Circular/TCAS%20II%20V7.1%20Intro%20booklet.pdf. Interference with the radio altimeter input could prevent TCAS II from inhibiting a traffic avoidance resolution advisory that could increase the possibility of a collision avoidance maneuver by the crew that could result in an aircraft's crashing into the ground.

Part 135 certificate.[16] Displayed radio altimeter height above ground improves situational awareness during helicopter hover and landing, and a TAWS system which uses a radio altimeter when available is now required on helicopter ambulance operations[17] and deployed on many other types of commercially-operated helicopters. The FAA explains that:

> [r]adio altimeters can greatly improve a pilot's awareness of height above the ground during hover, landing in unimproved landing zones, and landings in confined areas where a more vertical approach may be required. Additionally, radio altimeters help increase situational awareness during inadvertent flight into instrument meteorological conditions (IMC), night operations, and flat-light, whiteout, and brownout conditions.[18]

Finally, radio altimeters provide a display of the actual height above ground to the pilot and are often used as an input to automatic flight control system ("AFCS") computers during automated airplane and helicopter approach and landing operations.[19] The radio altimeter input helps ensure the AFCS operates the aircraft in a stabilized manner at a controlled descent rate and speed.[20] AFCS requires at least two radio altimeter inputs[21] for automated flare and touchdown maneuvers, the purpose of which are to avoid hard landings or worse, situations where the most stringent FAA safety-of-flight requirements apply.[22] Harmful interference to the radio altimeter during final approach and landing resulting in lost or misleading altitude

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16 14 C.F.R. § 135.160.

17 *See* 14 C.F.R. § 135.605. After April 24, 2017, no person may operate a helicopter in helicopter air ambulance operations unless that helicopter is equipped with an HTAWS that meets the requirements in TSO-C194 and Section 2 of RTCA DO-309.

18 *See* FAA, *Helicopter Air Ambulance, Commercial Helicopter, and Part 91 Helicopter Operations*, 79 Fed. Reg. 35, at 9933, table 1 (Feb. 21, 2014).

19 *See* ITU-R M.2059-0, *supra*, at 5-7.

20 *Id*. at 6. *See id*. at 3 (noting "[r]adio altimeters are essential for landing on autopilot and in low-visibility conditions. Additionally, radio altimeters are employed when landing manually to help alert a pilot when to or automatically engage in a maneuver known as a 'flare' which is performed just before touchdown to lessen the force upon landing with the ground").

21 FAA, AC 120-28D, *Criteria for Approval of Category III Weather Minima for Takeoff, Landing, and Rollout*, at 25, 27 (July 13, 1999).

22 *See* note 3, *supra*.

information significantly increases flight crew workload and places the aircraft, crew, and passengers at catastrophic risk.[23]

III. THE REPORT AND ORDER ARBITRARILY AND CAPRICIOUSLY DISREGARDED SOUND SPECTRUM MANAGEMENT AND DECLINED TO PROTECT RADIO ALTIMETERS FROM NEW ENTRANTS

A. The Record Substantiated a Concern for the Protection of Radio Altimeters

Throughout this proceeding, participants such as the Aviation Petitioners, AVSI, and Collins Aerospace (f/k/a Rockwell Collins, Inc.) have advised the Commission that radio altimeters might be adversely affected by the deployment of flexible use operations in the 3.7-4.2 GHz Band depending upon the band alignment and the technical operational parameters that would govern flexible use deployment.[24] T-Mobile called early for cooperative study of commercial mobile wireless service compatibility with radio altimeters,[25] noting the Commission may need "to continue to study whether terrestrial wireless services would interfere with Wireless Avionics Intra-Communications ('WAIC') and radio altimeter operations in the 4.2-4.4 GHz band."[26]

ASRI, Garmin, Collins Aerospace, and others explained that testing of coexistence was ongoing, but would require information from the Commission or input from the mobile community to allow the testing to consider representative flexible use operations that were

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[23] ITU-R M.2059-0, at 6-7.

[24] *See, e.g.*, Comments of ASRI, IB Docket No. 18-122 (Oct. 29, 2018); Reply Comments of ASRI, IB Docket No. 18-122 (Dec. 11, 2018); Comments of Rockwell Collins, Inc., IB Docket No. 18-122 (Mar. 31, 2018); Comments of Garmin International, IB Docket No. 18-122 (Oct. 29, 2018) ("Garmin Comments"), and other filings of Aviation Petitioners cited in Exhibit 2 hereto; *see also* discussions of the AVSI Preliminary and Supplemental Reports, *infra*.

[25] *See* Comments of T-Mobile USA, Inc., GN Docket No. 18-122, *et al.*, at 33 (Oct. 29, 2018).

[26] *Id.* T-Mobile also urged the Commission "to work with other federal agencies, such as the National Telecommunications and Information Administration and the [FAA], to determine an appropriate technical framework to allow mobile use at 3.7-4.2 GHz without causing harmful interference to properly engineered adjacent aviation operations." *Id.*

contemplated in the 3.7-4.2 GHz Band. As Garmin explained, the Notice of Proposed Rulemaking "lack[ed] important details about potential deployment scenarios, such as the permitted spacing of ground-based transmitters, as well as specifications for certain antenna parameters – such as height, gain/radiation pattern, downtilt, and polarization," details "necessary to ensure that the AVSI testing can adequately characterize the potentially interfering signals from ground-based transmitters operating in the 3.7-4.2 GHz band . . . ."[27] This information was never forthcoming, and so a number of aviation stakeholders forged ahead with testing conducted by AVSI and presented the results to the Commission's Office of Engineering and Technology ("OET") in preliminary form on October 22, 2019.[28] That study, which was supplemented in February 2020 to reflect updated results benefitting from OET input,[29] indicated that coexistence issues existed meriting further study and that the flexible use station power limits and band alignment ultimately adopted would not offer appropriate protection of the embedded base of radio altimeters.

Representatives of the aviation industry also provided OET with a practical example of potential harmful interference to nearby radio altimeters from a *single* flexible use base station operating at 3840 MHz based on the technical parameters in the *Draft R&O* (which were adopted

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[27] Garmin Comments at 9.

[28] *See* "Behavior of Radio Altimeters Subject to Out-Of-Band Interference," attachment to Letter of Dr. David Redman, AVSI, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 18-122 (Oct 22, 2019) ("AVSI Preliminary Report"); *see also* Letter of Edward A. Yorkgitis, Jr., Kelley Drye & Warren LLP, Counsel to ASRI, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 18-122 (Oct. 25, 2019) (*ex parte* notice regarding the aviation industry's October 23, 2019 meeting with OET).

[29] *See* "Effect of Out-of-Band Interference Signals on Radio Altimeters," attachment to Letter of Dr. David Redman, AVSI, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 18-122 (Feb. 4, 2020) ("AVSI Supplemental Report").

in the *Report and Order*).[30] This harmful interference scenario was not dependent on any particularly unusual set of operating conditions for aircraft but on a rather common situation, particularly for helicopters.[31]

Only one party, T-Mobile, addressed the matter of coexistence in response to the AVSI Preliminary Report.[32] No party responded to the *AVSI Supplemental Report* or the subsequent submission of a practical case scenario showing harmful interference to radio altimeters put into the record by AVSI and others. In its meeting with OET on February 14, 2020, and the subsequent *Aviation/Aerospace Letter*, representatives of aviation and aerospace, including several of the Aviation Petitioners, replied point by point to the *T-Mobile Response* and *Alion Study*.[33] A detailed written critique was placed into the record to explain why the T-

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[30] *See* Letter of Edward A. Yorkgitis, Jr., Kelley Drye & Warren LLP, Counsel to ASRI, to Marlene H. Dortch, Secretary, Federal Communications Commission, Notice of Ex parte Meeting, GN Docket No. 18-122, at 12-13 (Feb. 19, 2020; Corrected Copy filed Feb. 20, 2020); *see also id.*, Attachment A, at 9-12 & Attachment B, at 1-4 ("Aviation/Aerospace Letter"). Since the *Draft R&O* was limited in technical detail, additional reasonable assumptions were made regarding the base station characteristics based upon available ITU documentation, as explained in the *Aviation/Aerospace Letter.*

[31] A helicopter performing medical evacuation or utility infrastructure maintenance, for example, could easily be forced to operate within a few hundred feet of a flexible use base station, which was the scenario described.

[32] *See* Letter from Steve B. Sharkey, Vice President, Government Affairs, Technology and Engineering Policy, T-Mobile USA, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 18-122 (Jan. 22, 2020) ("T-Mobile Response"); *id.* at Attachment, "Alion Review of AVSI Report, 'Preliminary Report: Behavior of Radio Altimeters Subject to Out-Of-Band Interference,'" Alion Science and Technology Corporation ("Alion Study").

[33] *See Aviation/Aerospace Letter*, at 5-11; *id.* at Att. A, 3-8. The *Aviation/Aerospace Letter* addressed in detail the T-Mobile/Alion criticisms of the interference margin assumptions and the waveform used. *Id.* at 6-9, 9-10. In addition, the *Aviation/Aerospace Letter* responded to T-Mobile/Alion and explained (1) why the operational assumptions in the *AVSI Preliminary Report* (and the *AVSI Supplemental Report*) properly reflected those typical of testing for aeronautical systems and (2) how the AVSI studies established the need for further exploration of potential interference before flexible use operations under the parameters suggested by the *Draft R&O* – and ultimately adopted by the *Report and Order* – could be given a clean bill of health in terms of not posing a potential interference threat to radio altimeters. *See id.* at 10-11.

Mobile/Alion criticisms of the AVSI Preliminary Report reflected a misunderstanding of AVSI's methods and justification of its study choices, and that T-Mobile/Alion failed to appreciate that the testing of aviation safety devices, like radio altimeters, must not only examine "likely reasonable scenarios," but must consider *all* foreseeable aviation conditions given the exacting purposes of the equipment – to keep lives safe, and often multiple if not hundreds of lives safe at a time under all conditions. Aviation system safety requirements specify acceptable rates of erroneous operation of anywhere from $1x10^{-5}$ per flight hour to $1x10^{-9}$ per flight hour, depending on the type of aircraft and how it is being operated, a standard the Aviation Petitioners submits is far more rigorous than that which might apply to non-safety terrestrial radio systems where error is unlikely to lead to a potentially fatal accident. Despite the suggestions of T-Mobile and Alion, assurances of aviation safety simply cannot be demonstrably met without considering a far wider range of scenarios than what might otherwise be considered "reasonable."

B. The Commission Recognized That Radio Altimeters Must Be Protected

The Chairman of the Commission, on the eve of announcing that the *Report and Order* would be considered at the February 28, 2020 Open Meeting, recognized the utmost importance of protecting radio altimeters. In a January 24, 2020 letter to the Honorable Peter A. DeFazio, Chair of the House Committee on Transportation and Infrastructure, the Chairman stated plainly:

> I share your view that any actions the Commission takes to repurpose the C-band should not interrupt existing services, including the use of altimeters by helicopters and airplanes in the 4.2-4.4 GHz band. One of my four guiding principles in this proceeding is to ensure that incumbent services are protected. Any actions the Commission takes regarding this band will be carefully designed so that aircraft are able to use altimeters in a continuous and uninterrupted manner.
>
> Because protecting incumbents is one of my top priorities in this proceeding, I have tasked the Commission's outstanding engineers with studying the effect that future terrestrial operations in C-band would have on aeronautical equipment in the 4.2-

4.4 GHz band.[34]

The Chairman added that "[b]ased on the review and analysis of the record by these engineers," there was "a path forward . . . without having a negative impact on radio altimeters . . . [and] while ensuring that existing users are held harmless."[35]

Two weeks after the Chairman's letter to Rep. DeFazio, the Commission released its *Draft R&O*,[36] addressing not only the Chairman's plan to relocate incumbents from and make the lower 280 megahertz of the band available for flexible use licensees, but also the "path forward" that the Chairman believed would "ensur[e] that existing users are held harmless," including "radio altimeters." The *Draft R&O* recognized that "[r]adio altimeters are critical aeronautical safety-of-life systems . . . and must operate without harmful interference."[37] Although the *Draft R&O* considered the evidence that the aviation industry had submitted with the *AVSI Preliminary Report*, the draft suggested that the Commission was poised to "agree with T-Mobile and Alion that the AVSI study does not demonstrate that harmful interference would likely result under reasonable scenarios."[38] The *Draft R&O* did not offer any analysis of the Commission's own or express what it meant by "likely" or "reasonable scenarios."[39] While the *Draft R&O* did not envision particular measures to mitigate potential interference from flexible use operations below 3980 MHz, it noted, consistent with the Commission's role as spectrum manager, that the

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[34] Letter of Ajit Pai, Chairman, Federal Communications Commission, to Rep. Peter A. DeFazio, U.S. House of Representatives, at 1 (Jan. 24, 2020).

[35] *Id.*

[36] *See Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, GN Docket No. 18-122, Draft Report and Order and Order of Proposed Modification, FCC-CIRC2002-01 (Feb. 7, 2020) ("*Draft R&O*")

[37] *Id.* at ¶ 12.

[38] *Id.* at ¶ 351.

[39] Furthermore, the T-Mobile/Alion submission itself did not provide any analysis that showed how exactly it came to its own conclusion that the radio altimeter would not experience interference from new 5G services in the 3700-3980 MHz band.

Commission would "of course continue to monitor the results of [the AVSI] and other studies as they are provided and take appropriate action, if necessary, to protect [radio altimeters]."[40]

C. The *Report and Order* Disregarded the Commission's Role of Protecting Radio Altimeters

Although the Chairman recognized the need to protect incumbents including radio altimeters, the *Draft R&O* acknowledged that primary radio altimeters must operate without interference, and the *Draft R&O* signaled an intention to "continue to monitor" further studies of potential for interference to radio altimeters from flexible use operations, the *Report and Order* apparently shuts the door on any agency responsibility for interference that radio altimeters may suffer as a result of the Commission's decisions in this docket. The *Report and Order* reflects virtually no change in the Commission's discussion of the *AVSI Preliminary Report* and the *T-Mobile/Alion Report*. There is only a single, passing reference to the *AVSI Supplemental Report* and the *Aviation/Aerospace Letter*, but no response to the point-by-point rebuttal of the *Alion Study* in the *Aviation/Aerospace Letter* or the practical case scenario of harmful interference in a basic configuration from a single flexible use base station operating at 3840 MHz that the aviation industry had provided. As noted above, the case study reflected a rather common base station-aircraft configuration scenario, a low-altitude operating aircraft such as a medical response helicopter within several hundred feet of a base station. Both the response to T-Mobile/Alion and the case study constituted material record evidence on the issue of potential interference to radio altimeters. Yet, the Commission, without considering this information, concluded that no mitigations were needed, or even needed to be considered, to protect radio altimeters, maintaining, as did the *Draft R&O*, that "the AVSI study does not demonstrate that harmful interference would likely result under reasonable scenarios (or even reasonably

[40] *Draft R&O*, at ¶ 351.

'foreseeable' scenarios to use the parlance of AVSI)" and that "the limits we set for the 3.7 GHz Service are sufficient to protect aeronautical services in the 4.2-4.4 GHz band."[41]

The only reference to the *AVSI Supplemental Report* was to quote the *Aviation/Aerospace Letter*'s statement that "further analysis" would be required to "characterize statistical likelihood of interference levels."[42] The *Report and Order* treats this as an admission, when it was simply a statement of next possible steps in the analysis required to protect radio altimeters, not a concession that interference would not occur in relevant scenarios. As the *Aviation/Aerospace Letter* underscored, the AVSI studies made no assumptions as to likelihood of specific occurrences because "radio altimeters must meet MOPS requirements under all foreseeable conditions," as required by the FAA.[43]

The *Report and Order* abandons the notion that the Commission would monitor the situation and take appropriate action, if needed. Without any additional analysis by the Commission in response to the substantial evidence that AVSI and the aviation/aerospace industries provided in response to T-Mobile/Alion and the *Draft R&O*, the *Report and Order* not

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[41] *Report and Order*, at ¶395. Any suggestion in the *Report and Order* that the power levels and spectral separation between the flexible use operations and radio altimeter bands were adopted to protect radio altimeters would be unfounded. The power levels established by the *Report and Order* for flexible use licensees and the 220 megahertz separation between flexible use licensees and the 4.2-4.4 GHz band were part and parcel of the Commission's plans to relocate satellite services from the 3700-3980 MHz band and totally unrelated to protecting radio altimeter operation.

[42] *Id.* (quoting *Aviation/Aerospace Letter*, at 12).

[43] *Aviation/Aerospace Letter*, at 8 ("[T]he AVSI analysis used allowable conditions for minimum separation distances, maximum radiated powers, and maximum radio altimeter-to-radio altimeter interference coupling via a ground-bounce (rather than direct line-of-sight) path to determine the worst-case experimental settings for simulated in-band interference signal powers [and] does not consider the likelihood that these conditions exist, because radio altimeters must meet MOPS requirements under all foreseeable conditions."). MOPS are Minimum Operational Performance Standards as dictated by the applicable FAA Technical Standard Order ("TSO").

only fails to accommodate further assessment before adopting final technical rules, but also shifts the burden and responsibility to radio altimeter manufacturers and users to protect themselves. In particular, the *Report and Order* states that the Commission "expect[s] the aviation industry to take account of the RF environment that is evolving below the 3980 MHz band edge and take appropriate action, if necessary, to ensure protection of such devices."[44] In other words, the Commission seemingly found that it is aviation's burden, in operating a safety-of-life service, to protect itself against a fundamental change conceived just over two years ago in the otherwise-stable RF spectrum environment in which radio altimeters have operated for over five decades.

IV. THE COMMISSION IN THE *REPORT AND ORDER* AND ELSEWHERE HAS RECOGNIZED THE NEED FOR NEW ENTRANTS TO PROTECT INCUMBENT SERVICES IN ADJACENT BANDS

The *Report and Order* created a new mobile (except aeronautical mobile) allocation band in the 3700-4000 MHz range.[45] The *Report and Order* also provided for the relocation of incumbent FSS out of that range into the 4000-4200 MHz range. Not only does the *Report and Order* allow for reimbursement of the actual, reasonable, and necessary costs to move incumbents' space and earth stations, but they are also entitled to protection after they move. In particular, the Commission recognized that the now-adjacent band incumbent earth stations relocated to 4000-4200 MHz are entitled to passband filters at the flexible use licensees' expense to protect the earth stations against out-of-band interference from the flexible use operations.[46]

The *Report and Order* inconsistently treats adjacent band radio altimeter incumbents, despite Chairman Pai's promise that they would be protected. The Aviation Petitioners are not suggesting that radio altimeters should be equipped with passband filters at the flexible use

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44 *Report and Order*, at ¶ 395.
45 *Id.* at ¶ 58.
46 *Id.* at ¶ 171.

licensees' expense,[47] but it is suggesting that reasonable and consistent treatment of radio altimeters requires that the flexible use licensees be responsible for protecting them with reasonable mitigation measures. Given the substantial evidence of potential harmful interference presented by AVSI and the aviation industry in the record, the Commission should reconsider the *Report and Order* in part and proceed to work with industry stakeholders to identify and address the potential for interference, adopting reasonable mitigation measures as needed for deployments in the 3700-3980 MHz band, or that portion of it where mitigation is required, to protect radio altimeters and the flying public.

Not only has the Commission recognized the need to protect adjacent band incumbents in the *Report and Order*, it has done so in other cases as well, repeatedly recognizing the need to protect incumbents and legacy equipment in adjacent bands when authorizing new services. This has included other cases in which the Commission has authorized terrestrial mobile services, including ancillary terrestrial component operations,[48] as well as cellular services.[49] Inconsistent

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[47] Any changes made to radio altimeters hardware, such as adding filters, will require a significant amount of testing and safety analysis since they are FAA-approved systems operating aboard FAA-certified aircraft.

[48] *See, e.g., Spectrum & Serv. Rules for Ancillary Terrestrial Components in the 1.6/2.4 GHz Big Leo Bands, Globalstar Licensee LLC, Auth. to Implement an Ancillary Terrestrial Component*, 23 FCC Rcd 7210, at ¶ 32 (2008) (adopting out-of-band emissions limits and "mak[ing] clear that none of these limits will relieve ATC of its absolute obligation to eliminate any harmful interference to BRS that may nevertheless occur, including its obligation to reduce the power of operations in its upper channel or channels, or cease operations entirely in its upper channel or channels, to eliminate harmful interference to BRS Channel 1 operations"); *Flexibility for Delivery of Commc'ns by Mobile Satellite Serv. Providers*, 18 FCC Rcd 1962, at ¶ 119 (2003) (finding that out-of-band limits and a "require[ment] that the ATC operator must resolve any [harmful] interference" are needed to "adequately protect incumbent PCS operations in the 1930 to 1990 MHz band from interference from MSS ATC and still maintain the usefulness of spectrum in the 2000-2020 MHz band for ATC operations").

[49] *See, e.g., Amendment of Parts 1 & 22 of the Commission's Rules with Regard to the Cellular Serv., Including Changes in Licensing of Unserved Area*, 32 FCC Rcd 2518, at ¶¶ 38-39 (2017) ("placing strict responsibility for remedying unacceptable interference on the licensee(s) causing [unacceptable] interference to public safety communications" operating on frequencies adjacent

with past cases, and despite recognizing that radio altimeters must operate without harmful interference, the Commission failed to do so in the *Report and Order*. The Aviation Petitioners are *not* suggesting that the Commission require flexible use licensees to install filters or replace radio altimeters installed on aircraft, but the Commission should, at a minimum, identify the problem and take appropriate mitigation measures, if needed, whether they be restrictions on deployments of flexible use base stations in some part of the 3700-3980 MHz band or limitations on technical parameters, such as radiated power, height, antenna gain/radiation pattern, downtilt, and/or polarization.

V. THE COMMISSION SHOULD CLARIFY, OR PROVIDE ON RECONSIDERATION, THAT FLEXIBLE USE LICENSEES, AS NEW ENTRANTS, HAVE THE RESPONSIBILITY TO RESOLVE HARMFUL INTERFERENCE TO RADIO ALTIMETERS

The *Report and Order* was issued less than two years after the Commission imposed a freeze, effective April 19, 2018, on new applications and registrations (with limited temporary exceptions) in the 3.7-4.2 GHz Band as preamble to considering whether to realign the band for flexible use operations. In light of the Commission's intent to realign the band, the aviation industry has been moving expeditiously to develop new standards for radio altimeters. Even so, there is already an installed base of tens of thousands of FAA-certified radio altimeters on existing commercial, business, and general aviation airplanes and helicopters. It takes many years to complete a new standardization process; to design, test, and receive FAA approval for conforming equipment; and to design, test, and receive FAA certification for installation of such equipment. As the Commission recognized recently, "it would be a significant matter if aircraft would need to be retrofitted in any way, as it could take at least a decade to retrofit aircraft with

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to the cellular band at 869 MHz and susceptible to cellular base station interference because "the filtering in their legacy radios does not reflect the post-rebanding channel plan").

new equipment and have them recertified by the FAA."[50]

The *Report and Order* provides for the clearing of the 3700-3820 MHz band as soon as December 5, 2021, in 46 of the top 50 Principal Economic Areas if the incumbent space station operators in the 3.7-4.2 GHz Band elect accelerated relocation, and an outside date for clearing within the contiguous U.S. of December 2025. As of this time, it is reasonable to expect that not only will the standardization process for new radio altimeters not be completed by any of these dates, but there will remain for many years to come a large base of embedded radio altimeters of the type the AVSI studies showed were most susceptible to interference from flexible use operations, especially on general aviation airplanes and helicopters. As flexible use licensees access the band, there is the potential for harmful interference to those incumbent radio altimeters with grave potential consequences in term of safety-of-flight before the aviation industry as a whole can reequip existing aircraft with newly-certified radio altimeter systems.

Consistent with other situations involving new entrants, including the framework for protecting adjacent band earth stations in the *Report and Order* itself, the Commission should reconsider the *Report and Order* and make clear that, if any interference is caused by the new flexible use entrants to radio altimeters, they must take steps to resolve such interference. The Aviation Petitioners and others in the aviation industry stand ready to work with interested stakeholders before the auction in an expedited manner, as further detailed in the next section, and with flexible use licensees after the auction to address interference concerns.

If the Commission, however, intended that the aviation industry itself is responsible to resolve all interference radio altimeters receive from flexible use operations, the Aviation

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[50] *LightSquared Tech. Working Grp. Report*, *et al.*, IB Docket No. 11-109, *et al.*, Order and Authorization, FCC 20-48, at ¶ 65 (Apr. 22, 2020) (discussing the prospect of retrofitting aircraft with GPS receivers certified under a new standard).

Petitioners ask the Commission to reconsider that solution. The accompanying suggestion in the *Report and Order* that any existing radio altimeters that may be susceptible to harmful interference from flexible use operations below 3980 MHz are not well-designed is not supported.[51] In response to the assertions appearing in the *Report and Order*, some discussion of the design and engineering realities of radio altimeters is needed. Radio engineers rightfully design for the RF environment in which their systems will be deployed. In the case of radio altimeters, engineers have taken into account the existence of a 500 megahertz-wide subjacent band used for space-to-Earth transmissions and a small number of fixed links. There was an existing MOPS for the 4.2-4.4 GHz band, and radio engineers designed radio altimeter equipment to that standard as required by the FAA.[52] Virtually all of the current radio altimeters were designed over the past several decades in the context of a very stable and compatible RF environment. The future introduction of a new terrestrial service in the subjacent band generating potentially-interfering signals many orders of magnitude greater than incumbent users – until a few years ago, only a theoretical possibility – would rightfully not have been considered. Absent significant evidence or insight that an alternate course of action is necessary, developers and manufacturers of radio equipment in aviation and other industries typically choose not to expend additional resources to generate designs that are well beyond both what is required and what has been proven to operate successfully and safely in the field for decades.

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[51] *See Report and Order*, at ¶ 351 ("[F]urther analysis is warranted on why there may even be a potential for some interference given that well-designed equipment should not ordinarily receive any significant interference (let alone harmful interference) given these circumstances.").

[52] *See* FAA, TSO-C87a, *Airborne Low-Range Radio Altimeter*, at ¶ 3 (last issued May 31, 2012) (referencing the applicable minimum performance standard that must be met in "EUROCAE document ED-30, *Minimum Performance Standards for Airborne Low-Range Radar Altimeter Equipment*, Edition 2, dated March 1980, as modified by Appendix 1 of this TSO").

Designing to account for unforeseen possible band realignments may drive up product costs needlessly for what may be pure speculation of the RF environment a decade or more in the future.[53]

The existing base of radio altimeters for which interference from new flexible use in the 3700-3980 MHz band would potentially present a major public safety issue are all certified by the FAA. They are radar systems designed under sound engineering principles to perform their critical radionavigation mission which, as explained in Section II above, requires a relatively wide necessary bandwidth and high sensitivity. Radio altimeters are tested to the Environmental and Electromagnetic Interference ("EMI") requirements outlined in RTCA DO-160.[54] The EMI testing includes both RF radiated susceptibility and RF conducted susceptibility, which account for the understood electromagnetic environment in which radio altimeters operate onboard aircraft, but do not and cannot account for hypothetical emissions from undefined sources outside the aircraft.[55]

Due to the inherently wideband nature of radio altimeter operations, along with the need for a very flat frequency response of the receiver hardware across the necessary bandwidth,[56] the

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53 That said, as explained *infra*, RTCA SC-239 has begun to look at future standards that should apply to radio altimeters in light of the band realignment taken by the Commission in the *Report and Order*.

54 The current revision is RTCA DO-160G, *Environmental Conditions and Test Procedures for Airborne Equipment* (Dec. 8, 2010).

55 The aviation industry explained to the OET before the *Report and Order* was issued that High-Intensity Radiated Fields ("HIRF") testing in connection with FAA-certification of radio altimeters, which is voluntary in any event, would provide no assurances of radio altimeters being able to operate in the presence of flexible-use operations at 3700-3980 MHz. *See Aviation/Aerospace February 20 Erratum*, at 15-17 ("[A] radio altimeter satisfying HIRF protection requirements would not necessarily exhibit tolerance against the types of OoBI that flexible-use deployments in the 3700-3980 MHz band are expected to present.").

56 Flat referring to both magnitude response and group delay response, both of which are also necessary factors to achieve the highest possible level of altitude accuracy.

receiver front-end filters used to provide RF selectivity and rejection of undesired out-of-band signals tend to be fairly broadband and, in many cases, will have modest to moderate roll-off characteristics. In addition, radio altimeters are compact, embedded radio devices installed onboard aircraft, and thus cannot, as a practical matter, incorporate large "brick-wall" filters to provide very high levels of out-of-band rejection. In any event, for currently deployed radio altimeter designs, such filters would not have been considered due to the lack of formal requirements from the FAA for receiver selectivity, the fact that the RF environment near 4.2-4.4 GHz had not necessitated it, and the cost-prohibitive nature of such filters based purely on a speculative RF environment that may exist sometime in the future.

VI. THE COMMISSION SHOULD, ON RECONSIDERATION, ADOPT ADDITIONAL MEASURES IN THE FLEXIBLE USE REGULATORY FRAMEWORK AS WARRANTED BASED ON THE WORK OF THE MULTI-STAKEHOLDER GROUP ADDRESSING RADIO ALTIMETERS

The *Report and Order* encouraged interested stakeholders to convene a multi-stakeholder group to consider compatibility and coexistence issues created by the relocation plan in the 3.7-4.2 GHz Band. The Commission envisioned the participation of aviation stakeholders concerned about matters of potential harmful interference to radio altimeters. Although the aviation industry was disappointed that, in contrast with the *Draft R&O* which envisioned active OET involvement in further consideration of compatibility issues raised by the realignment of the 3.7-4.2 GHz Band, the Commission, in the final *Report and Order*, assumed essentially a hands-off approach to the multi-stakeholder process, it quickly forged ahead to undertake the work and openly invite non-aviation participation. RTCA[57] had established a Special Committee, SC-239, first approved on December 19, 2019, to update the current MOPS for Low Range Radar Altimeters. This group, focused on protecting future radio altimeter designs from changes to the

[57] The Radio Technical Commission for Aeronautics, now referred to simply as "RTCA".

RF environment in and around the 4200-4400 MHz band, seemed a natural forum for the work concerning radio altimeters.[58] RTCA special committees have a long history of being used as open fora to consider compatibility between certified aviation and non-aviation systems, and in the case of SC-239, RTCA established unprecedented access for non-RTCA members to facilitate participation from stakeholders outside of aviation. RTCA SC-239 issued an open invitation to all interested parties to join the first meeting on April 22, 2020.[59] In parallel, a larger group of stakeholders, including satellite, broadcasting, cable, commercial mobile wireless, and other interests, subsequently initiated a multi-stakeholder process to consider the larger array of coexistence and transition issues raised by the *Report and Order*. The aviation industry, including representatives of several of the Aviation Petitioners and radio altimeter manufacturers, have joined that effort as well, and discussions are underway to determine the best way to proceed and take advantage of the strengths of both sets of efforts.

The aviation industry is optimistic that multi-stakeholder efforts with the good faith participation of potential flexible use licensees and related parties (*e.g.*, mobile wireless equipment manufacturers and CTIA members), can rapidly yield a more advanced assessment of the potential for harmful interference to radio altimeters from flexible use operations in the 3700-

[58] Among other things, RTCA SC-239 was established to pursue additional analysis considering other factors relevant to radio altimeters and flexible use interactions, such as multipath/ground-bounce propagation, dense network deployments, 5G user equipment on the ground within the radio altimeter antenna's main beam, and 5G user equipment operating onboard commercial aircraft. It also has the benefit of being an established forum for many aviation and RF experts that can attract smaller manufacturers that may not participate in other groups.

[59] Letter from Terry McVenes, President & CEO, RTCA, GN Docket No. 18-122 (Apr. 20, 2020). RTCA SC-239 has generated an initial list of 5G operational characteristics which are needed as inputs to further testing and analysis in order to ensure the most accurate and reliable results. Some early meetings of RTCA SC-239 included participation from telecom engineers from a few different companies, including wireless companies and related manufacturers, but they have since been absent.

3980 MHz range. The aviation industry anticipates that this work will be resolved well in advance of the target auction date of December 8, 2020, to allow the Commission to complete the work on reconsideration that it previously sought to bypass despite the evidence in the record about the potential for interference to safety-of-life radio altimeters. The Aviation Petitioners submit that this work should result in an understanding that the auction winners can take into account to minimize, if not effectively eliminate, the potential risk for interference that endangers the functioning of radio altimeters (and, therefore, account for when formulating their strategy in the competitive bidding).[60]

The aviation industry will continue to report to OET and the Commission on the progress of the multi-stakeholder group. The Aviation Petitioners urge the Commission to monitor the progress and OET to inform the process regarding the information that would be most useful to it to consider what additional mitigation measures, if any, would be appropriate to apply to flexible use operation to ensure they do not endanger the functioning of radio altimeters.

VII. CONCLUSION

For the foregoing reasons, the Commission should reconsider the *Report and Order* to make clear that flexible use licensees must resolve harmful interference they cause to radio altimeters and to take other steps described herein to ensure radio altimeters otherwise are adequately protected from such interference.

Respectfully submitted,

[60] The Joint Aviation Petitioners acknowledge that the work of the multi-stakeholder process may result in a conclusion, which all would welcome, that, despite the evidence submitted by the aviation industry into the record, flexible use operations will not present a cognizable threat to existing radio altimeters. There is no reason, at this time, to assume that outcome, and specific reason exists to be concerned that this will not be the outcome, which is why this Petition is being filed.

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Exhibit 1

Descriptions of the Petitioners

The Aerospace Industries Association ("AIA")and our over 300 members are on the cutting edge of innovation and leading the development of emerging technologies, including Unmanned Aircraft Systems and Urban Air Mobility, that will revolutionize the way in which way in which our world moves, connects, and explores. Access to interference-free spectrum, including for the radio altimeter, is critical to everything that we manufacture, operate, and develop to safely perform its intended mission.

The Aerospace Vehicle Systems Institute ("AVSI") is a cooperative research organization that facilitates research projects for its members on topics concerning aerospace vehicle systems. AVSI brings together world-class subject matter experts from the aerospace industry, governmental organizations, and academia to collaborate on pre-competitive solutions that address shared concerns. AVSI has been performing research on radio altimeter RF spectrum compatibility issues since 2005.

The Air Line Pilots Association, International ("ALPA") represents the safety interests of over 63,000 pilots flying for 34 airlines in the U.S. and Canada. ALPA members are responsible for the safe operation of airline flights, and are the end-users of the radio altimeter system.

Airbus is a global leader in aeronautics, space and related services. In 2019, it generated revenues of € 70 billion and employed a workforce of around 135,000. Airbus offers the most comprehensive range of passenger airliners. Airbus is also a European leader providing tanker, combat, transport and mission aircraft, as well as one of the world's leading space companies. In helicopters, Airbus provides the most efficient civil and military rotorcraft solutions worldwide

Aviation Spectrum Resources, Inc. ("ASRI") is the communications company of the U.S. air transport industry and is owned by U.S. airlines and other airspace users. This enables ASRI to gather expertise from across the U.S. aviation sector, promoting the safe and efficient operation aviation radio communications and navigation systems, including radio altimeters.

The General Aviation Manufacturers Association ("GAMA") is an international trade association representing over 110 of the world's leading manufacturers of general aviation airplanes and rotorcraft, engines, avionics, components, and related services. GAMA's members also operate repair stations, fixed based operations, pilot and maintenance training facilities and they manage fleets of aircraft which rely upon radio altimeter systems

Garmin International, Inc., along with its affiliates, is a worldwide provider of navigation equipment, committed to making superior products for multiple markets that are an essential part of its customers' lives. Garmin is now a leading provider of certified aviation devices, including radio altimeters and other devices which are enabled by radio altimeters.

Helicopter Association International is the professional trade association for the international rotorcraft industry; both manned and unmanned. HAI members represent more than 3,000 aviation businesses and individuals who safely operate more than 4,500 rotorcraft approximately 2.3 million hours each year in more than 73 nations. HAI is dedicated to the promotion of rotorcraft as a safe and effective method of commerce and to the advancement of the international rotorcraft community. Radio altimeters are central to safe and reliable vertical flight, including helicopters and UAS, especially in low-altitude maneuvers near structures, terrain, and other obstacles. Radio Altimeters will also be an important enabler for future UAM operations.

Honeywell International Inc., through its business unit Honeywell Aerospace is committed to safe and efficient aviation operations, offering a wide range of sensors, guidance and navigation systems, flight control systems, communications equipment, data recorders, and more. Honeywell is a leading manufacturer of radar altimeters which see widespread use in business and general aviation, helicopters, commercial air transport, and a broad range of military aircraft.

The International Air Transport Association ("IATA") is the trade association for the global airline industry, representing some 290 passenger and cargo airlines or 82 percent of total air traffic. IATA supports many areas of aviation activity and helps formulate industry policy on

critical aviation issues. The safe and efficient operations of IATA's members are dependent on a robust radio altimeter operations throughout the world.

The National Air Transportation Association ("NATA") represents airport Fixed Base Operators, Part 135 and 91K charter and fractional ownership operators, fuel suppliers, Maintenance, Repair and Overhaul stations, flight training centers, and others. Our members depend on robust navigational systems, such as the radio altimeter, to provide safe travel.

Exhibit 2

Representative Filings of Aviation Petitioners

Comments of Helicopter Association International, IB Docket No. 18-122 (May 31, 2018).

Comments of the International Air Transport Association, IB Docket No. 18-122 (May 31, 2018).

Comments of the Aerospace Industries Association and the General Aviation Manufacturers Association, GN Docket No. 18-122 (Oct. 29, 2018).

Comments of ASRI, IB Docket No. 18-122 (Oct. 29, 2018)

Comments of Garmin International, Inc. IB Docket No. 18-122, (Oct 29, 2018)

Reply Comments of the Aerospace Industries Association and the General Aviation Manufacturers Association, GN Docket No. 18-122 (Dec. 6, 2018).

Reply Comments of ASRI, IB Docket No. 18-122 (Dec. 11, 2018)

The Air Line Pilots Association, Aircraft Owners and Pilots Association, Airlines 4 America, Aeronautical Frequency Committee, Aerospace Industries Association, General Aviation Manufacturers Association, Helicopter Association International, International Air Transport Association, National Air Transport Association, and National Business Aviation Association, Written Ex Parte Presentation, IB Docket No. 18-122 (June 19, 2019).

"Behavior of Radio Altimeters Subject to Out-Of-Band Interference," attachment to Letter of Dr. David Redman, AVSI, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 18-122 (Oct. 22, 2019)

Notice of Ex Parte Meeting with the Office of Engineering and Technology and the Wireline Telecommunications Bureau, with representatives of the Aerospace Industries Association, the Aircraft Operators and Pilots Association, the Air Line Pilots Association, Airlines for America, Alaska Airlines, Aviation Spectrum Resources Inc., AVSI, Boeing, Bristow Helicopters, Collins Aerospace, Delta Airlines, Frontier Airlines, Garmin International, Inc., Helicopter Association International, Honeywell International Inc., Jet Blue, Lockheed Martin Corporation, PHI Helicopters, Southwest Airlines, Textron Aviation, United Airlines, and United Parcel Service, GN Docket No. 18-122 (Oct. 25, 2019)

"Effect of Out-of-Band Interference Signals on Radio Altimeters," attachment to Letter of Dr. David Redman, AVSI, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 18-122 (Feb. 4, 2020)

Notice of Ex Parte Meeting with the Office of Engineering and Technology and the Wireline Telecommunications Bureau, with representatives of the Aerospace Industries Association, the Air Line Pilots Association, Airbus, Airlines for America, ASRI, AVSI, Collins Aerospace, Garmin International, Inc., Honeywell International Inc., Lufthansa, and PHI Helicopters, IB Docket No. 18-122 (filed February 19, 2020, corrected version filed Feb. 20, 2020).