Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Expanding Flexible Use of the 3.7 to 4.2 GHz Band	)	GN Docket No. 18-122
	)	
	)	
Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz	)	GN Docket No. 17-183 (Inquiry Terminated as to 3.7-4.2 GHz)
	)	
Petition for Rulemaking to Amend and Modernize Parts 25 and 101 of the Commission's Rules to Authorize and Facilitate the Deployment of Licensed Point-to-Multipoint Fixed Wireless Broadband Service in the 3.7-4.2 GHz Band	)	RM-11791
	)	
Fixed Wireless Communications Coalition, Inc., Request for Modified Coordination Procedures in Band Shared Between the Fixed Service and the Fixed Satellite Service	)	RM-11778

COMMENTS OF
THE BOEING COMPANY

The Boeing Company ("Boeing") urges the Commission to proceed with caution in considering any additional uses for the 3.7-4.2 GHz frequency band, which is used for critically important C-band satellite communications services and is immediately adjacent to frequencies that are necessary for aeronautical safety services. In contributing to this proceeding, Boeing is reflecting in its comments several important perspectives and interests.

First, Boeing is the world's largest manufacturer of commercial and governmental aircraft, which use the immediately adjacent 4.2-4.4 GHz band for radio altimeters that monitor the altitude and aid in the safe flight and landing of aircraft. Boeing is also developing wireless avionics control systems that will use the 4.2-4.4 GHz band to provide wireless backup for operational and

monitoring systems within the aircraft mainframe that are currently controlled solely through hardwired communications links.

Second, Boeing is a major manufacturer of satellite communications systems, including C-band satellites used to support critical communications services throughout the world. The U.S. and global markets for satellites with C-band transmission capabilities remains strong because C-band satellites continue to provide by far the most effective means to transmit large amounts of video programming and other data over large geographic areas while ensuring a very high level of availability and reliability.

Boeing therefore cautions that any consideration of additional or alternative uses of any portion of the 3.7-4.2 GHz band must not impair the ability of C-band satellite users in the United States to continue to access such services. Instead, the Commission should preserve C-band spectrum for satellite use and lift the freeze on the filing of new C-band satellite and earth station applications. The Commission should also continue to provide full-band and full-arc protection for existing and future C-band earth stations. Finally, the Commission should take no action that might risk causing harmful interference to highly sensitive aeronautical safety services in the adjacent 4.2-4.4 GHz band.

I. THE COMMISSION MUST PROTECT AERONAUTICAL SAFETY SERVICES BY REFRAINING FROM INTRODUCING ANY NEW SPECTRUM USES IN THE UPPER PORTION OF THE 3.7-4.2 GHZ BAND

As Boeing emphasized in its comments and reply comments in the Commission's mid-band notice of inquiry proceeding, any consideration of additional use of the 3.7-4.2 GHz band must prioritize the continued protection of aircraft radio altimeters, which operate in the

immediately adjacent 4.2-4.4 GHz band.[1] The 4.2-4.4 GHz band is allocated globally to the aeronautical radionavigation service for the use of radio altimeters,[2] which are critical to many aircraft functions, including precision approach, landing, ground proximity, and collision avoidance. An aircraft's Automatic Flight Control System uses radio altimeters as a height-controlling sensor during automated approaches and landings. Radio altimeters are also often connected to the Traffic Collision-Avoidance System and Automatic Dependent Surveillance-Broadcast System, which are used to monitor the airspace around an aircraft and warn pilots of potential threats of mid-air collision. Altimeters are also used to support the Ground Proximity Warning System, which warns the pilot if the aircraft is flying too low or descending too quickly.[3] The precise and reliable operation of all of these aircraft systems—and thus of radio altimeters—are essential to the safety of the flying public.

Radio altimeters operate by transmitting radio signals toward the ground and then determining the aircraft's altitude based on the time it takes the signal to reflect off the ground and back to the aircraft receiver.[4] Radio altimeters are highly susceptible to interference "both within [their] operational swept bandwidth as well as from outside this bandwidth."[5] The sensitivity of radio altimeters to interference is largely due to the fact that radio altimeters operate at a relatively

---

[1] *See* Comments of the Boeing Company, GN Docket No. 17-183, at 2-4 (Oct. 2, 2017) ("*Boeing Comments*"); Reply Comments of the Boeing Company, GN Docket No. 17-183, at 6-8 (Nov. 15, 2017) ("*Boeing Reply Comments*").

[2] *See* 47 C.F.R. § 2.106, notes 5.438 and US261.

[3] *See Boeing Comments* at 3.

[4] *See* Operational and Technical Characteristics and Protection Criteria of Radio Altimeters Utilizing the Band 4 200-4 400, ITU-R Recommendation M.2059-0 at 1, 3 and 5 (Feb. 2014) ("*Recommendation M.2059-0*").

[5] *Id.* at 18.

low power level, and thus there is a risk that ground-based radio transmitters operating near the upper edge of the 3.7-4.2 GHz band could direct sufficient power in an upwards direction to overpower the relatively weak radio altimeter signals that have been reflected off the ground.[6] For example, if mobile wireless or point-to-multipoint fixed services are introduced near the upper edge of the adjacent 3.7-4.2 GHz band, out-of-band emissions from those services could mix with the radio altimeter signal and cause an aircraft's radio altimeter to mistake the mixed signal as terrain, potentially resulting in the radio altimeter reporting a false altitude to the pilot.[7]

Radio altimeters require access to the entire 4.2-4.4 GHz band for their operations because the accuracy of the altitude data they produce is directly related to the total bandwidth of the radio altimeter signal.[8] Consistent with this, most radio altimeters on large aircraft today use Frequency Modulated Carrier Wave ("FMCW") digital technology,[9] which transmits a very wide bandwidth signal, sometimes as large as 196 MHz.[10] Boeing and other aircraft manufacturers install three radio altimeters on most large commercial aircraft for redundancy and backup, with the center

[6] *See id.* at 12–17 (setting forth the transmit power levels of different kinds of analog and digital radio altimeters).

[7] *See id.* at 9. Although radio altimeters do use band pass filters designed to reject transmissions outside the operating band from degrading the altimeter's performance, these filters have limited ability to reject transmissions close to the edges of the 4.2-4.4 GHz band. The ITU-R accordingly concluded that altimeter performance could be affected by signals near the edge of the band. *See id.* at 11.

[8] *See id.*

[9] *See id.* at 2-3.

[10] *See id.* at 16, table 2.

frequencies spaced at 5 MHz intervals part at 4.295, 4.300 and 4.305 GHz.[11] Thus, the bandwidth of the lowest signal extends to the lower edge of the band at 4.2 GHz.

A second reason why the Commission must refrain from authorizing wireless mobile or fixed point-to-multipoint services in the upper portion of the 3.7-4.2 GHz band is because of the harmful effects that could result to Wireless Avionics Intra-Communication ("WAIC") systems that are being developed for use on aircraft in the 4.2-4.4 GHz band.[12] WAIC systems involve the use of wireless communications systems within an aircraft to replace a potentially substantial portion of aircraft wiring. Because the safe and effective operation and monitoring of aircraft systems entails a significant amount of communications, WAIC systems require access to the entire 4.2-4.4 GHz band to accommodate the monitoring and data transfer requirements of modern aircraft.

WAIC systems and radio altimeters are capable of sharing the 4.2-4.4 GHz band with each other because WAIC systems send and receive transmissions exclusively inside an aircraft, and thus they receive the benefit of fuselage attenuation, which protects radio altimeters from the relatively low-power WAIC transmissions inside the aircraft.[13] Mobile wireless and fixed point-to-multipoint systems, however, transmit relatively powerful signals that could cause substantial interference to WAIC and radio altimeter systems if they bleed into the 4.2-4.4 GHz band. To

[11] *See id.* at 10 (describing the use of three altimeters with center frequency separations of 5 MHz).

[12] *See Boeing Reply Comments* at 6–7; *Boeing Comments* at 4; Presentation of the Aerospace Vehicle Systems Institute for Working Parties 5A, 5B, 5C, "Agenda Item 1.17 Wireless Avionics Intra-Communication" (May 23, 2012), *available at* https://www.itu.int/ITU-R/study-groups/docs/workshop-wp5abc-wrc15/WP5ABC-WRC15-P2-5.pdf.

[13] *See Boeing Comments* at 5 (explaining that "the significant attenuation of aircraft 'skin'" disrupts any potential interference).

prevent this outcome, the Commission should refrain from making the upper portion of the 3.7-4.2 GHz band available for any additional use.

II. THE COMMISSION MUST ENSURE THAT C-BAND SATELLITE SPECTRUM REMAINS AVAILABLE IN THE UNITED STATES AND GLOBALLY FOR CRITICAL COMMUNICATIONS SERVICES THAT RELY ON THE UNIQUE CAPABILITIES OF THESE FREQUENCIES

The *NPRM* is the most recent inquiry by the Commission in a series of proceedings that have sought guidance on the importance of C-band satellite services to support critical communications services in the United States. In each of these proceedings, users of C-band satellite services have emphasized the unique characteristics of these services that make them largely irreplaceable for important communications functions. The *NPRM* acknowledges certain of these communications requirements, emphasizing that C-band satellite service "is by far the best approach for broadcast distribution"[14] and is therefore predominantly used in the United States for the "delivery of programming content to television and radio broadcasters."[15]

Although true, C-band satellite services are also used in the United States for other critical communications services that support specific industries. For example, as the Aerospace Industries Association ("AIA") explains, the 3.7-4.2 GHz band is used to support communications involving air traffic management systems between distant airports and to distribute critically-important weather data using the NOAAPort system.[16] C-band satellite networks are used for these important services in the United States because they provide very high reliability and

[14] *NPRM*, ¶ 59 (*emphasis added*).

[15] *Id.*, ¶ 10.

[16] Comments of the Aerospace Industries Association, GN Docket No. 18-122 at 2 (Oct. 29, 2018).

availability even in adverse weather conditions. Further, they provide dependable links to airports in remote locations where terrestrial fiber technologies may not be available. Given these important uses, the Commission must ensure that C-band satellite spectrum continues to remain available in the United States to support important services.

Boeing supports the comments of the Satellite Industry Association ("SIA") in detailing the important communications services that are reliant on C-band satellite services in the United States.[17] As SIA notes, given the ongoing importance of such services, the Commission should lift the freeze on licenses for new C-band satellites and earth stations, which will continue to be needed in the future to support the needs of C-band users in the United States.[18] The Commission should also preserve full-band and full-arc protection for C-band satellite earth stations in order to ensure that they can continue to make the most intensive use of the band.[19]

The Commission should also recognize that C-band satellite services remain heavily used for a wide range of communications services in other regions of the world. Although C-band satellite services are predominantly used for broadcast distribution in the United States, in less developed regions, such as Latin America, Africa and Asia, C-band satellite services continue to be a critical workhorse for highly reliable two-way voice and data communications.

C-band satellites are immune from the significant difficulties that exist in deploying terrestrial fiber networks in less developed countries. C-band satellite services also provide very high availability and reliability in less developed regions despite heavy rain conditions. Therefore,

---

[17] *See* Comments of the Satellite Industry Association, GN Docket No. 18-122 at 2-15 (Oct. 29, 2018)

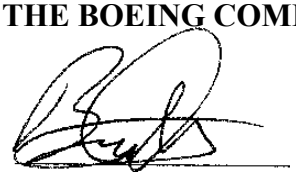
[18] *See id.* at 30-31.

[19] *See id.* at 20-29.

the Commission should continue to support U.S. satellite operators and spacecraft manufacturers in their efforts to ensure that C-band satellite services remain available both domestically and globally to fulfill these important functions including by maintaining full-band and full-arc protection and the ability to license new C-band satellites and earth stations.

Respectfully submitted,

THE BOEING COMPANY

By: 

Audrey L. Allison
Vice President, Global Spectrum Management
The Boeing Company
929 Long Bridge Drive
Arlington, VA 22202
(703) 465-3215

Bruce A. Olcott
Jones Day
51 Louisiana Ave. NW
Washington, D.C. 20001
(202) 879-3630

Its Attorneys

October 29, 2018