

Before the  
**FEDERAL COMMUNICATIONS COMMISSION**  
Washington, DC 20554

In the Matter of	)	
	)	
Notice and Opportunity for Public	)	
Comment under Section 605(b) of	)	GN Docket No. 18-122
the MOBILE NOW Act	)	

**COMMENTS OF  
THE BOEING COMPANY**

The Boeing Company (“Boeing”) provides these comments to support the Commission’s report to Congress addressing the feasibility of allowing commercial wireless systems to use or share use of the 3.7-4.2 GHz spectrum band.<sup>1</sup> Boeing is among the world’s largest manufacturers of aircraft, which use of the 4.2-4.4 GHz band—the band immediately adjacent to the 3.7-4.2 GHz band—for the operation of radio altimeters and wireless avionics intra-communications (“WAIC”) systems. Both of these services either are now, or will become, essential to the safe and effective operation of aircraft and the flying public must be permitted to depends on them for their safety. The Commission should accordingly advise Congress of the need to proceed with the utmost caution before making available a portion of the 3.7-4.2 GHz band to mobile wireless services. As instructed in the Public Notice,<sup>2</sup> Boeing summarizes and incorporates by reference herein its

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<sup>1</sup> See Public Notice, *Office of Engineering and Technology, International, and Wireless Telecommunications Bureaus Seek Comment for Report on the Feasibility of Allowing Commercial Wireless Services, Licensed or Unlicensed, to Use or Share Use of the Frequencies Between 3.7-4.2 GHz, Notice and Opportunity for Public Comment under Section 605(b) of the MOBILE NOW Act*, GN Docket No. 18-122, DA-18-446 at 2 (May 1, 2018) (“Public Notice”).

<sup>2</sup> See Public Notice at 1 n.2 (“To the extent commenters wish to submit materials in the current docket . . . that are substantially similar to materials filed in other potentially related Commission proceedings . . . , we ask commenters to submit an abbreviated filing that incorporates by reference the relevant arguments from any previously filed material . . .”).

comments<sup>3</sup> and its reply comments<sup>4</sup> submitted in response to the Commission’s Notice of Inquiry (“NOI”) on expanding flexibility for wireless systems in frequencies between 3.7 and 4.2 GHz.

**I. THE COMMISSION SHOULD ADVISE CONGRESS THAT ANY ADDITIONAL USE OF THE 3.7-4.2 GHZ BAND MUST PROTECT RADIO ALTIMETERS FROM HARMFUL INTERFERENCE**

As Boeing emphasized in its comments and reply comments in the Commission’s mid-band NOI 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.<sup>5</sup> The 4.2-4.4 GHz band is allocated globally to the aeronautical radionavigation service for the use of radio altimeters.<sup>6</sup> These radio altimeters support several essential aircraft functions, including precision approach, landing, ground proximity, and collision avoidance. Specifically, 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. And altimeters are used to support the Ground Proximity Warning System, which warns the pilot if the aircraft is flying too low or descending too quickly.<sup>7</sup>

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<sup>3</sup> See Comments of the Boeing Company, GN Docket No. 17-183 (Oct. 2, 2017) (“*Boeing Comments*”).

<sup>4</sup> See Reply Comments of the Boeing Company, GN Docket No. 17-183 (Nov. 15, 2017) (“*Boeing Reply Comments*”).

<sup>5</sup> See *Boeing Comments* at 2–4; *Boeing Reply Comments* at 6–8.

<sup>6</sup> See 47 C.F.R. § 2.106, notes 5.438 and US261.

<sup>7</sup> See *Boeing Comments* at 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.<sup>8</sup> As a result, radio altimeter operations are highly sensitive to interference, and they may be adversely affected by signals transmitted near the edge of the 4.2-4.4 GHz band. In fact, the ITU-R concluded that radio altimeters are highly susceptible to interference from “both within [their] operational swept bandwidth as well as from outside this bandwidth.”<sup>9</sup>

The sensitivity of radio altimeters to interference is largely due to the fact that radio altimeters operate at a relatively low power level, and thus there is a risk that ground-based radio transmitters operating near the 4.2-4.4 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.<sup>10</sup> This interference could potentially distort the signal received back by the radio altimeter receivers on the aircraft. For example, if mobile broadband services are conducted in 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 back to the pilot.<sup>11</sup> Although radio

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<sup>8</sup> *See id.* at 1, 3 & 5.

<sup>9</sup> *Id.* at 18.

<sup>10</sup> *See id.* at 12–17 (setting forth the transmit power levels of different kinds of analog and digital radio altimeters); *Boeing Comments* at 3.

<sup>11</sup> *See Recommendation M.2059-0* at 9.

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 4.2-4.4 GHz band.<sup>12</sup> The ITU-R accordingly concluded that altimeter performance could be affected by signals at the edge of the band.<sup>13</sup>

The International Telecommunication Union's Radiocommunication Sector ("ITU-R") has concluded that 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.<sup>14</sup> Consistent with this, most radio altimeters on large aircraft today use Frequency Modulated Carrier Wave ("FMCW") digital technology,<sup>15</sup> which transmits a very wide bandwidth signal, sometimes as large as 196 MHz.<sup>16</sup> Boeing and other aircraft manufacturers install three radio altimeters on most large commercial aircraft for redundancy and backup, with the center frequencies spaced at 5 MHz intervals part at 4.295, 4.300 and 4.305 GHz.<sup>17</sup> Thus, the bandwidth of the lowest signal extends to the lower edge of the band at 4.2 GHz.

Other parties have expressed these same concerns to the Commission about the need to protect critical safety-of-life communications—including radio altimeter operations—from interference caused by mobile wireless devices. In its comments in the Commission's mid-band

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<sup>12</sup> *See id.* at 11.

<sup>13</sup> *See id.*

<sup>14</sup> *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 11 (Feb. 2014) ("*Recommendation M.2059-0*").

<sup>15</sup> *See id.* at 2–3.

<sup>16</sup> *See id.* at 16, table 2.

<sup>17</sup> *See id.* at 10 (describing the use of three altimeters with center frequency separations of 5 MHz).

NOI proceeding, the Aerospace Vehicle Systems Institute explained that the potential of introducing mobile systems into the 3.7-4.2 GHz band was already studied in the ITU process in advance of the 2015 World Radiocommunication Conference, and it was rejected because “the interference characteristics of International Mobile Telecommunications (“IMT”) use of adjacent bands cannot be adequately predicted to ensure continued safe operation of the radio altimeters.”<sup>18</sup> It is therefore critically important that the Commission recommend to Congress that further studies be conducted to determine how much of the 3.7-4.2 GHz band should be excluded from consideration for commercial wireless services. In its report, the Commission should emphasize the need to ensure that errant signals transmitted from those wireless services—either from within the aircraft or from the ground—do not interfere with the operation of radio altimeters.

## **II. THE COMMISSION SHOULD ALSO RECOMMEND THAT CONGRESS PRIORITIZE THE PROTECTION OF WAIC SYSTEMS**

As Boeing explained in its comments and reply comments in the Commission’s mid-band NOI proceeding, any consideration of allocating a portion of the 3.7-4.2 GHz band to commercial wireless services must address the harmful effects such allocation could have on WAIC systems.<sup>19</sup> In addition to radio altimeters, WAIC are also designed to operate throughout the 4.2-4.4 GHz band.<sup>20</sup> WAIC systems involve the use of wireless communications systems within an aircraft to replace a potentially substantial portion of aircraft wiring. These systems will be increasingly

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<sup>18</sup> Comments of the Aerospace Vehicle Systems Institute, GN Docket No. 17-183, at 1 (Oct. 2, 2017); *see also Boeing Reply Comments* at 7 (providing examples of other parties who support Boeing’s position).

<sup>19</sup> *See Boeing Comments* at 6–8; *Boeing Reply* at 4–6.

<sup>20</sup> *See Boeing Comments* at 4 (explaining that the 2015 World Radiocommunication Conference allocated the 4.2-4.4 GHz band on a global co-primary basis to the AM(R)S exclusively for WAIC systems); *see also* ITU Radio Regulations No. 5.438.

deployed on new aircraft, including those manufactured by Boeing.<sup>21</sup> 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 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.<sup>22</sup> Commercial wireless operations, however, transmit a powerful signal that could cause substantial interference with WAIC systems and radio altimeter operations if they bleed into the 4.2-4.4 GHz band. Thus, if the upper portion of the 3.7-4.2 GHz band is allocated to commercial wireless services, the aviation industry would be compelled to confront the significant public safety concerns that would result from interference to radio altimeters and WAIC systems caused by wireless devices' out-of-band emissions, potentially including emissions from consumer devices onboard the aircraft.<sup>23</sup>

Two of the key considerations in the decision to allocate the 4.2-4.4 GHz band for WAIC systems were (1) the fact that this spectrum was already allocated to safety-of-life aeronautical services—specifically, radio altimeter operations—and (2) the fact that this spectrum was not adjacent or nearly adjacent to other frequency bands used for mobile consumer devices that are

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<sup>21</sup> 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>

<sup>22</sup> See *Boeing Comments* at 5 (explaining that “the significant attenuation of aircraft ‘skin’” disrupts any potential interference).

<sup>23</sup> See *id.*

routinely carried by passengers on commercial aircrafts, like smartphones, laptops, and tablets.<sup>24</sup> If mobile wireless services are able to operate in the upper portion of the band adjacent to the 4.2-4.4 GHz band, it may no longer be feasible for these safety-of-life operations to function effectively in the 4.2-4.4 GHz band, potentially compromising the safe and effective operation of the commercial aviation industry. Therefore, the Commission should recommend to Congress that, before making any portion of the 3.7-4.2 GHz band available to mobile wireless services, an adjacent-band compatibility test must be conducted. In its report, the Commission should emphasize the need for further comprehensive technical studies to determine how much of the upper portion of the 3.7-4.2 GHz band would need to be excluded from consideration for mobile wireless services to ensure that WAIC systems and radio altimeters are protected adequately from harmful interference.<sup>25</sup>

### **III. CONCLUSION**

Given the critical importance of radio altimeters, the necessity that they remain reliable and highly precise, and their significant susceptibility to interference, the Commission should advise Congress that extreme caution must be exercised to ensure that the potential use of portions of the 3.7-4.2 GHz band for commercial wireless services does not cause devastating interference to radio altimeters in the 4.2-4.4 GHz band. Similarly, WAIC systems will also be critical to the safe and efficient operation of aircrafts, and more research is needed to determine how much of the adjacent 3.7-4.2 GHz band would need to be excluded from consideration for commercial

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<sup>24</sup> *See id.*

<sup>25</sup> *See id.* at 5–6 (recommending that “any consideration of additional flexibility in the use of the 3.7-4.2 GHz band (or at least its upper portion) be regulated strictly to ensure that harmful interference does not result into WAIC receivers operating in the adjacent spectrum”).

wireless services to ensure that WAIC systems are adequately protected from out-of-band emissions. The Commission should therefore recommend to Congress that further testing be conducted to determine how much of the upper portion of the 3.7-4.2 GHz band must be excluded from use by mobile wireless services in order to avoid compromising the functionality of radio altimeters and WAIC systems.

Respectfully submitted,

**THE BOEING COMPANY**

By:

A handwritten signature in black ink, appearing to read "Bruce A. Olcott", written over a horizontal line.

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