

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of)	
)	
Unlicensed Use of the 6 GHz Band)	ET Docket No. 18-295
)	
Expanding Flexible Use in Mid-Band)	GN Docket No. 17-183
Spectrum Between 3.7 and 24 GHz)	

To: The Commission

**COMMENTS OF
THE BOEING COMPANY**

The Boeing Company (“Boeing”) provides the following comments on the Commission’s proposal to identify 1,200 MHz of additional spectrum in the 6 GHz band for unlicensed devices and services while facilitating the protection of incumbent services.

I. INTRODUCTORY SUMMARY

Boeing expresses its support for the identification of additional spectrum in the 6 GHz band as available for use by unlicensed devices and services. As highlighted in the Commission’s Notice of Proposed Rulemaking (“*NPRM*”), and also in these comments, there is a substantial need for additional spectrum available for unlicensed use, particularly in frequency bands below 24 GHz where transmitting equipment may already be available with only minor modifications.

Boeing employs a wide range of unlicensed wireless systems to support its leadership in the design and manufacture of aircraft, defense, and aerospace systems. Unlicensed wireless systems contribute to research and development, worker safety and automated manufacturing, plant communications and coordination, and are incorporated within many of the aircraft, defense systems, and aerospace vehicles manufactured by Boeing. Boeing’s experimental research not

only requires the use of unlicensed spectrum resources, but also helps facilitate the development of new wireless applications and equipment that benefit industry, the government and consumers.

In expressing support for the designation of unlicensed spectrum in the 6 GHz band, Boeing recognizes that important incumbent communications services operate in the 6 GHz band and these services must continue to be protected. Although the Commission's *NPRM* discusses protection measures for most of these services, little attention is given to ensuring the continued viability of ultra-wideband ("UWB") devices operating under Part 15 of the Commission's rules. Therefore, additional investigation is needed on this issue.

In addition, Boeing recommends herein several relatively modest additions to the Commission's proposed rules for 6 GHz unlicensed services in order to make them available for additional applications, including:

- Authorizing the use of U-NII-5 and U-NII-7 devices in indoor locations without requiring the use of automated frequency coordination ("AFC");
- Treating commercial aircraft as indoor locations for all 6 GHz U-NII devices, just has been done for U-NII devices in the 5 GHz band; and
- Treating commercial aircraft parked at airport facilities as non-mobile for purposes of U-NII-5 and U-NII-7 communications between the aircraft and ground facilities.

As discussed in these comments, each of these measures would permit even greater use of 6 GHz unlicensed systems in a wide range of important operating conditions without resulting in harmful interference to incumbent spectrum uses in these frequency bands.

II. A SUBSTANTIAL NEED EXISTS FOR ADDITIONAL UNLICENSED SPECTRUM AVAILABLE FOR USE IN INDUSTRY AND AVIATION

The Commission's *NPRM* recounts with impressive detail the substantial growth and use of unlicensed frequency bands, particularly with respect to broadband Wi-Fi connectivity.¹ Most of the statistics that are highlighted in the *NPRM* appear focused on consumer use, such as the number of North American households using Wi-Fi and its use in consumer gathering places, such as restaurants and bars, hotels and shopping centers, and parks and stadiums.²

What is also impressive, but potentially less well documented, is the substantial use of unlicensed frequencies and Wi-Fi connectivity in industrial settings for such purposes as automation, worker safety, operational coordination, shipping and receiving, and security, in addition to the more typical usage by laptops and tablets. The increases in efficiency made possible through these improvements in communications and control has dramatically increased the productivity of American factories and is driving still greater adoption of networked manufacturing using unlicensed frequencies.

At Boeing, for example, aerospace manufacturing facilities employ modern tooling and fabrication machines that rely on wireless data links to receive instructions, report status, and communicate among themselves. In some Boeing locations, current operations effectively utilize the entirety of all available unlicensed spectrum. For instance, Boeing's Everett, Washington site is the largest manufacturing building in the world, enclosing 472 million cubic feet of space across 98.3 acres. In and around this facility, more than 30,000 Boeing employees support aircraft

¹ See Unlicensed Use of the 6 GHz Band, Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz, *Notice of Proposed Rulemaking*, FCC 18-147, ¶¶ 3-6 (Oct. 24, 2018) ("*NPRM*").

² See *id.*, ¶ 5.

fabrication and production, product development, aviation safety and security and airplane certifications for the 747, 767, 777, and the 787 airplanes. Each of these tasks employs machines and data systems, many of which require reliable access to unlicensed spectrum for wireless communications and control. The use of wireless systems to improve operational efficiency is also being implemented across other industries, including automobile manufacturing, transportation and shipping, water supply, oil and gas prospecting and refining, and electrical generation and distribution.

The growing need for access to additional unlicensed spectrum is also placing strain on the capabilities of wireless communications systems to support passengers on commercial airplanes. The passenger cabin of a large commercial aircraft is quickly becoming the single most congested wireless operational environment in the world, with hundreds of seated passengers using personal wireless devices to simultaneously access video and internet content over the same inflight wireless network. Passengers on commercial aircraft are continually demanding more services from their favored air carriers requiring access to greater amounts of unlicensed frequencies. To assist its airline customers in meeting this consumer demand, Boeing is increasing the capacity and capabilities of unlicensed systems on each new model of commercial aircraft.

Boeing's ability to keep pace with these requirements, however, will be compromised if newly available unlicensed frequency bands are unnecessarily restricted with prohibitions on their use inside manufacturing facilities or aircraft. The need for access to additional unlicensed bands is particularly important around 6 GHz because unlicensed radio systems are already manufactured for the adjacent 5 GHz band and this equipment can easily be modified to operate at 6 GHz. In contrast, additional research and development may be needed to commercialize unlicensed wireless equipment for use in the millimeter wave frequencies that the Commission recently made

available³ (or has proposed to make available)⁴ for use by unlicensed systems. Given the importance of providing near-term additional access for industry and aviation, the Commission should avoid where ever possible imposing prohibitions on the use of unlicensed frequencies in locations when such restrictions may not be necessary to prevent harmful interference to incumbent spectrum uses.

III. THE COMMISSION SHOULD INVESTIGATE MEASURES THAT CAN BE EMPLOYED TO MAINTAIN THE VIABILITY OF UWB SYSTEMS

Although a substantial need exists for additional unlicensed spectrum, the Commission must concurrently recognize the growing importance of Part 15 UWB systems that are employed in a wide range of industrial and consumer applications. Boeing, for example, uses a UWB-based inventory control system for the thousands of tools, carts, and other large devices that are employed in the aircraft manufacturing process. UWB technology is also used in systems to conduct aircraft inspections and ensure that various aircraft components adhere appropriately.

The maximum power levels of UWB devices were set very low by the Commission in order to ensure that such devices would not result in harmful interference to primary licensed services in the 6 GHz band, including satellite earth stations and point-to-point microwave systems. These same very low power levels, however, would make UWB devices highly susceptible to

³ See Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, *et al.*, *Report and Order and Further Notice of Proposed Rulemaking*, 31 FCC Rcd 8014, ¶ 130 (2016) (making the 57-71 GHz band available for unlicensed use); Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, *et al.*, *Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order*, FCC 17-152, ¶ 80 (Nov. 22, 2017) (“*Spectrum Frontiers Second Order*”) (making the 57-71 GHz band available for unlicensed use aboard aircraft).

⁴ In the Matter of Spectrum Horizons, *et al.*, ET Docket No. 18-21, *Notice of Proposed Rulemaking*, FCC 18-17, ¶¶ -54-55 (Feb. 28, 2018) (seeking comment on permitting unlicensed use of the 122-123 GHz, 174.8-182 GHz, 185-190 GHz, and the 244-246 GHz bands).

interference from Wi-Fi systems or other high power Part 15 devices. Thus, although Boeing acknowledges that UWB systems have secondary status in the 6 GHz band, the Commission should undertake efforts to ensure that the substantial investments that businesses and individuals have made in UWB systems are not forfeit by the wide scale introduction of Wi-Fi type devices in this spectrum.

IV. U-NII-5 AND U-NII-7 DEVICES SHOULD BE PERMITTED IN INDOOR LOCATIONS WITHOUT AUTOMATED FREQUENCY COORDINATION

As long as it would not interfere excessively with UWB equipment, Boeing would support the Commission's proposal to authorize the use of U-NII-5 and U-NII-7 devices in indoor locations without requiring the use of automated frequency coordination ("AFC").⁵ Such action would substantially reduce the costs of U-NII-5 and U-NII-7 devices that are designed solely for indoor use. It would also complement the Commission's proposal to restrict the use of unlicensed devices in the U-NII-6 and U-NII-8 frequency bands to indoor locations.⁶ Given the fact that the vast majority of unlicensed systems operate indoors, a decision to permit all 6 GHz U-NII devices to operate indoors without AFC control is warranted and can be implemented without resulting in harmful interference to incumbent services.

The transition in the past half century toward the use of energy-efficient construction materials has significantly increased the attenuation of buildings, substantially reducing the power of any unlicensed transmissions that may leak outside of residential or commercial structures. Thus, as the *NPRM* acknowledges, average building attenuation can be expected of approximately 18 dB for traditional construction and 30 dB for thermally efficient construction, with increasing

⁵ See *NPRM*, ¶ 73.

⁶ See *id.*, ¶ 59.

building entry losses at larger elevation angles.⁷ Coupled with the Commission's proposal to limit the power levels of indoor unlicensed devices to those imposed in the U-NII-2 band, no concern should exist regarding harmful interference to incumbent users of the U-NII-5 and U-NII-7 bands, or of the U-NII-6 and U-NII-8 bands.

The *NPRM* also requests comment on methods that can be employed to ensure that U-NII devices that are restricted to indoor operations are in fact kept indoors.⁸ One obvious example identified in the *NPRM* is requiring the use of AC power cords for indoor unlicensed devices.⁹ Other design considerations are also available to compel indoor use, such as placing open air vents on the upper casing of U-NII devices and using casing materials and control panels that clearly are not resistant to rain or other outdoor conditions. In contrast, the *NPRM* proposal to require U-NII devices to cease operations if a GPS signal is detected will likely result in considerable confusion and frustration among consumers who may not realize that the intermittent operation of a U-NII device indoors is resulting from GPS signal reception and not because of a faulty device.¹⁰

V. THE COMMISSION SHOULD CONTINUE TO TREAT THE INSIDE OF AIRCRAFT AS AN INDOOR LOCATION

The *NPRM* proposes to prohibit the operation of unlicensed U-NII devices in the 6 GHz band on moving vehicles, explaining “[w]e are especially concerned about the interference

⁷ ITU Recommendation P.2109, §§ 3.2-3.3 and at Figure 1.

⁸ *See NPRM*, ¶ 71.

⁹ *See id.*

¹⁰ *See id.*

consequences of allowing operation onboard aircraft because the longer line-of-sight distances from devices at typical aircraft altitude could result in interference over a wide area.”¹¹

These same concerns were originally expressed with respect to the operation of U-NII devices onboard aircraft in the 5 GHz band and, as a result of extensive work in the international study process, the Commission and other jurisdictions appropriately concluded that 5 GHz U-NII devices could operate safely inside aircraft using the same operating restrictions that exist for U-NII devices designed for indoor locations. For example, based on a contribution by the United States, the Inter-American Telecommunication Commission (“CITEL”) adopted a draft new recommendation that “CITEL countries consider the operation of RLANs in the frequency band 5 150 – 5 250 MHz inside aircraft having a metal fuselage to be an indoor use.”¹² CITEL reached this conclusion because of tests showing that an aircraft fuselage “provides significant attenuation” of more than 20 dB for most aircraft, coupled with the anticipated operation of wireless systems at relatively low power levels onboard aircraft due to the small size of the cabin area.¹³

The European Commission also adopted a decision on the use of license-exempt wireless access systems in the 5 GHz band that specifically defines “indoor locations” as including the inside of an aircraft.¹⁴ This decision was adopted because of “the strong attenuation offered by

¹¹ See *id.*, ¶¶ 84-85.

¹² Inter-American Telecommunication Commission, *Draft New Recommendation, Classification of 5 GHz RLANs on Board Aircraft as Indoor Systems*, PCC.II/REC. 22 (IX-07), Annex B, Recommends 1 (Jan. 27, 2005).

¹³ See *id.* at 6.

¹⁴ European Commission Decision on the Harmonised Use of Radio Spectrum in the 5 GHz Frequency Band for the Implementation of Wireless Access Systems Including Radio Local Area Networks (WAS/RLANs), 2005/513/EC, Article 2(b) (July 19, 2005), *available at* <https://publications.europa.eu/en/publication-detail/-/publication/949d51f3-1cd9-413f-8d54-48d31d63b0c9/language-en> (*last visited* Feb. 12, 2019).

the aircraft, their operational conditions, and taking account of the fact that the installation and use of RLAN equipment inside an aircraft is regulated by administrations due to the specific certification required from the relevant aviation authorities.”¹⁵ Further, the Asia Pacific Telecommunity (“APT”) adopted a recommendation permitting the use of 5 GHz unlicensed devices onboard aircraft in recognition of the fact that “the ubiquitous use of 5 GHz wireless LAN systems on board aircraft could lead to greater efficiency and cost effectiveness for the aviation logistics and supply chain industry.”¹⁶

The Commission should reach this same conclusion with respect to unlicensed U-NII devices in the 6 GHz band. Specifically, as the Commission recently acknowledged,¹⁷ “extensive simulations and actual measurement data” confirm that typical aircraft effective fuselage attenuation is 40 dB in the 57-71 GHz frequency range,¹⁸ which is comparable to the results of international studies demonstrating up to 45 dB aircraft fuselage attenuation in much

¹⁵ European Conference of Postal and Telecommunications Administrations (“CEPT”) Electronic Communications Committee Decision of 09 July 2004 on the Harmonised Use of the 5 GHz Frequency Bands for the Implementation of Wireless Access Systems Including Radio Local Area Networks (WAS/RLANs), ECC/DEC/(04)08, at 3 n.2 (July 9, 2004) *available at* <https://www.ecodocdb.dk/download/3948246a-1552/ECCDEC0408.PDF> (last visited Feb. 12, 2019).

¹⁶ APT Recommendation on Use of 5GHz Wireless LANS on Board Aircraft, APT/AWF/REC-06 (Aug. 2007).

¹⁷ See *Spectrum Frontiers Second Order*, ¶ 82.

¹⁸ See Aerospace Vehicle Spectrum Institute AFE 85 Project Report, *Analysis of Potential Interference from WiGig Radios on Aircraft to EESS Passive Sensors*, at 79-88 (Aug. 30, 2017) *available at* <https://ecfsapi.fcc.gov/file/10831759627379/AVSI%20WiGig%20Cover%20Letter%20and%20Report%20for%20FCC%20Filing.pdf>.

lower frequency bands, including 6 GHz.¹⁹ Other studies within the International Telecommunication Union have confirmed that modern aircraft can be expected to provide 35 dB of average fuselage attenuation depending upon the elevation angle,²⁰ which includes 10 dB of attenuation of in-cabin signals above 1 GHz even under worst-case viewing angles, and up to 45 dB of attenuation for other viewing angles and non-cabin or other highly shielded areas.²¹

The attenuation that can be expected from aircraft fuselage is therefore as good or better than residential and commercial construction materials. Thus, the *NPRM* is incorrect in asserting that the signal attenuation from aircraft “is likely to be significantly less than from a building.”²² Instead, the attenuation levels are comparable, if not better with respect to aircraft. Further, all wireless systems inside aircraft will be installed by professionals (ensuring their correct installation) and will be designed to operate at relatively low power levels because of the confined space of the aircraft cabin area. Each of these measures will further ensure that unlicensed systems inside aircraft will not result in harmful interference to incumbent spectrum users. Therefore, the Commission should define the inside of an aircraft as an indoor location for purposes of its U-NII rules for the 6 GHz band. Such action would not result in interference to UWB devices in the 6 GHz band, the use of which is prohibited on aircraft. Such action would also help to fulfill the

¹⁹ See, e.g., CEPT Electronic Communications Committee, *Co-existence Study Considering UWB Applications Inside Aircraft and Existing Radio Services in the Frequency Bands from 3.1 GHz to 4.8 GHz and From 6.0 GHz to 8.5 GHz*, ECC Report 175 (March 2012).

²⁰ See Compatibility analysis between wireless avionic intra-communication systems and systems in the existing services in the frequency band 4 200-4 400 MHz, Report ITU-R M.2319, Annex 1, Table A-1.4 (Nov. 2014).

²¹ See Technical characteristics and spectrum requirements of Wireless Avionics Intra-Communications systems to support their safe operation, Working Party 5B, Report ITU-R M.2283-0 at 22, Table 5; see also Annex 3 (Dec. 23, 2013).

²² *NPRM*, ¶ 84.

unlicensed spectrum requirements in what has already become the single most congested spectrum environment for consumers.²³

VI. THE COMMISSION SHOULD TREAT AIRCRAFT PARKED AT AIRPORT FACILITIES AS NON-MOBILE FOR USE WITH U-NII-5 AND U-NII-7 DEVICES

The *NPRM* proposes to prohibit the operation of unlicensed U-NII devices in moving vehicles because of the apparent difficulties of managing such devices using AFC systems.²⁴ An exception to this proposed rule should be made for aircraft parked at airport facilities. Once an aircraft is parked at an airport facility, a tremendous data transfer process often begins between the aircraft, the airport operators and the air carriers. Data reports are transmitted from the aircraft to ground facilities regarding the passenger lists, aircraft diagnostics, fault reports, fuel consumption and provisioning needs. At the same time, data is transmitted to the aircraft regarding flight connections, departure schedule, the manifest for the next flight, weather and instructional data for that upcoming flight, and other relevant information supporting aircraft operations or maintenance. These wireless exchanges must begin as soon as the aircraft reaches its assigned gate or parking location and can continue until the aircraft is ready to be moved.

To help satisfy these wireless data requirements, the Commission should treat all aircraft parked at airport facilities as non-mobile for purposes of outdoor operations with U-NII-5 and U-NII-7 devices. Such treatment is appropriate because it would effectively recognize the entire

²³ Although Boeing supports the treatment of the inside of an aircraft as an indoor location, Boeing concurs with the *NPRM* with respect to the need to prohibit the use of unlicensed 6 GHz frequencies for outdoor communications to and from mobile platforms, such between cars, aircraft or drones and other mobile or stationary devices. *See NPRM*, ¶ 84.

²⁴ *See id.*

outdoor environment at an airport as an acceptable location for the operation of U-NII-5 and U-NII-7 devices outdoors.

Granted, these U-NII-5 and U-NII-7 devices would still be managed through AFC systems, thus ensuring that any incumbent spectrum uses at or near an airport are protected from harmful interference. Given the clearly defined boundaries of airports and aircraft maintenance facilities—with terminal gates and aircraft parking only in specified areas—it would not be difficult to use AFC systems to manage the spectrum sharing relationship between 6 GHz U-NII devices and nearby incumbent spectrum users. Further, some airports and aircraft maintenance facilities may be able to coordinate the relocation or shielding of nearby incumbent spectrum uses in order to allow for even greater use of U-NII systems operating in the 6 GHz band to enhance the safety and efficiency of airplane ground operations.

VII. CONCLUSION

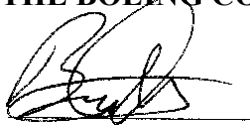
Boeing supports the identification of additional spectrum resources in the 6 GHz band for used by unlicensed systems and devices. To ensure that this unlicensed spectrum is used for the greatest benefit, the Commission should refrain from imposing operating restrictions that are unnecessary to prevent harmful interference. Specifically, the Commission should permit all 6 GHz unlicensed devices to be used indoors without AFC control. The Commission should treat the inside of aircraft as indoor spaces for purposes of these rules and the Commission should permit the use of 6 GHz unlicensed spectrum for transmissions involving aircraft parked at airport facilities. Each of these measures will expand the use of unlicensed spectrum in the 6 GHz band without resulting in harmful interference to incumbent services. At the same time, the Commission should strive to ensure that the proposed additional unlicensed uses of the 6 GHz

band do not prevent the continued operation of UWB devices that are also authorized in this spectrum.

Respectfully submitted,

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By:

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

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