Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Petition of The Boeing Company for	)	RM-11773
Allocation and Authorization of Additional	)	
Spectrum for the Fixed-Satellite Service in the	)	
50.4-51.4 GHz and 51.4-52.4 GHz Bands	)	

COMMENTS OF
THE BOEING COMPANY

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October 17, 2016

SUMMARY

Broadband satellite systems are a critical means to extend high data rate broadband services to rural and remote communities that are currently unserved or underserved by terrestrial broadband infrastructure. As the Commission has repeatedly acknowledged, there exists a persistent digital divide in broadband access, with consumers in urban and suburban areas benefiting from much better service than consumers outside those areas. The Commission has recognized that high-speed broadband access is critical to economic development, education, and social integration. Therefore, the Commission should take steps to ensure that broadband satellite systems will be able to meet the anticipated capacity and throughput requirements of consumers in the decades ahead.

As Boeing has documented in the Commission's Spectrum Frontiers proceeding, broadband satellite systems will require access to a full 5 GHz of paired spectrum in the V-band to serve the growing needs of consumers. The end user downlink spectrum requirements for broadband satellite systems include full access to the 40.0-42.0 GHz band and opportunistic access to the 37.5-40.0 GHz and the 42.0-42.5 GHz bands. Broadband satellite systems will also require access to a matching 5 GHz of spectrum for gateway uplink transmissions to service the downlinks to end users, including access to the 47.2-50.2 GHz and the 50.4-52.4 GHz bands. To fulfill these requirements, Boeing filed its Petition for Rulemaking seeking an Earth-to-space allocation for the fixed-satellite service ("FSS") in the 51.4-52.4 GHz band and inclusion of the 50.4-51.4 GHz band in the Section 25.202 list of bands available for FSS operations.

In seeking access for broadband satellite services at 50.4-52.4 GHz, Boeing acknowledges that the Commission is currently considering making this spectrum available for its newly created Upper Microwave Flexible Use Service ("UMFUS"). Given the critical

importance of the V-band to the future of broadband satellite systems – and also considering the substantial amount of spectrum that has already been identified, or is currently being considered, for UMFUS in other spectrum bands – the Commission should consider whether the public interest would be best served by making the 50.4-52.4 GHz band exclusively available to FSS Earth-to-space communications. If the Commission does find it necessary to identify the 50.4-52.4 GHz band for UMFUS, non-burdensome measures can be used to enable spectrum sharing between UMFUS and individually licensed satellite earth stations in this spectrum. For example, individually licensed satellite earth stations could be excluded from core urban areas where UMFUS systems are most likely to operate in these higher millimeter wave frequencies. Outside core urban areas, first-in-time coordination and transparent operational measures can be used to ensure that UMFUS and individually licensed satellite earth stations do not cause harmful interference to each other.

Through the use of these basic spectrum sharing techniques, the 50.4-52.4 GHz band can be used in a highly efficient manner to ensure that "5G" broadband services – whether delivered terrestrially or by satellite – are made equally and robustly available to all Americans regardless of where they work and live.

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To: The Commission

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The Boeing Company ("Boeing") provides these comments in support of its petition for rulemaking ("Petition") to allocate and authorize additional spectrum for the fixed-satellite service ("FSS") in the 50.4-51.4 GHz and 51.4-52.4 GHz ("50 GHz") bands.[1] As Boeing explained in its Petition, additional spectrum is needed for FSS to enable the next generation of broadband satellite systems to use the V-band to provide very high data rate "5G" services to consumers that can fully bridge the broadband digital divide.[2] Boeing urges the Commission to incorporate Boeing's petition in its Spectrum Frontiers proceeding and adopt the requested FSS allocation in the context of a Second Report and Order in that proceeding.

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[1] *See* Public Notice, *Consumer & Governmental Affairs Bureau, Reference Information Center, Petition For Rulemaking Filed*, Report No. 3051 (Sept. 16, 2016) (providing public notice of Boeing's Petition for Rulemaking).

[2] *See* Petition of The Boeing Company for Allocation and Authorization of Additional Spectrum for the Fixed-Satellite Service in the 50.4-51.4 GHz and 51.4-52.4 GHz Bands, RM-11773, at 5-9 (June 22, 2016) ("*Petition*").

I. BROADBAND SATELLITE SYSTEMS NEED ACCESS TO THE 50 GHZ BAND TO PROVIDE VERY HIGH DATA RATE SERVICES TO ALL AMERICANS

The Commission has amply documented the persistent digital divide that exists in the United States with respect to broadband deployment.[3] Since Boeing filed its Petition, further evidence of the dearth of broadband availability in rural and remote areas has been highlighted by the Commission. For example, Commissioner Mignon Clyburn recently visited Torreon, New Mexico and the Navajo Nation where residents currently receive 2G (non-broadband) wireless services and it takes "six microwave hops from the Torreon tower (86 miles) just to reach fiber backhaul."[4] The Commissioner spoke with local officials about the high cost of deploying broadband "due in large part to being forced to navigate the patchwork of property rights and approvals that make access to rights of way slower and more expensive."[5]

In writing about the difficulties in deploying broadband in rural areas, Commissioner Clyburn emphasized that "[a]ccess to robust, affordable advanced telecommunications services, ought to be available to everyone — no matter who they are, no matter where they live."[6] In fact, "it is one of the 'prime directives' of the Telecommunications Act of 1996."[7] Nevertheless, as the Commission's 2016 Broadband Progress Report documents, "Americans in

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[3] Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, *2016 Broadband Progress Report*, 31 FCC Rcd 699 (2016) ("*2016 Broadband Progress Report*").

[4] Commissioner Mignon Clyburn, Tackling the Connectivity Challenges of Rural America: My Journey to New Mexico and Navajo Nation, FCC Blog (Aug. 15, 2016), available at https://www.fcc.gov/news-events/blog/2016/08/15/tackling-connectivity-challenges-rural-america-my-journey-new-mexico-and.

[5] *Id.*

[6] *Id.*

[7] *Id.*

rural areas and on Tribal lands [are] approximately ten times more likely than those Americans in urban areas to lack access to services able to provide advanced telecommunications capability."[8]

Certainly, the Commission should continue its efforts to remove obstacles to deployment of terrestrial broadband infrastructure. The Commission should recognize, however, that broadband satellite systems overfly such obstacles and can make very high data rate, satellite-delivered 5G services available expeditiously to *all* Americans in every location in the country, no matter how remote.

Boeing acknowledges that the Commission has previously considered the role of broadband satellites in resolving the persistent digital divide and repeatedly found satellites lacking with respect to speed,[9] latency,[10] and system capacity.[11] Notably, recent innovations in satellite technology are making satellites an increasingly attractive solution to broadband, meeting and exceeding the Commission's measures. One such innovation with great promise are non-geostationary satellite orbit ("NGSO") satellite systems operating with access to sufficient spectrum in the V-band to provide very high data rate, low latency, communications services that would be equally available to all Americans.

Boeing, for example, is developing an NGSO FSS system that would operate in the V-band to provide bi-directional broadband data rates that would significantly exceed the Commission's targets for next generation advanced telecommunications capabilities of 25 Mbps

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[8] *2016 Broadband Progress Report*, ¶ 121.

[9] *See id.*, ¶¶ 3, 48.

[10] *See id.*, ¶ 67.

[11] *See id.*, ¶ 47 n.162.

down and 3 Mbps up.[12] The aggregate capacity of Boeing's NGSO FSS system would be sufficient to serve all Americans in most areas of the country, including all rural and remote areas, while providing an attractive and competitive option for consumers in major population centers.

As Boeing explained in its recent Spectrum Frontiers Further Notice comments, in order to provide very high data rate communications on a comprehensive basis in rural and remote areas, Boeing's satellite system requires access to 5 GHz of downlink spectrum to address the very data-intensive forward link transmissions to end user terminals.[13] Boeing's downlink requirements include full primary access to the 40.0-42.0 GHz band, and shared opportunistic access to the 37.5-40.0 GHz and the 42.0-42.5 GHz bands.

Due to the "bent-pipe" nature of broadband satellite systems, Boeing will also require access to a matching 5 GHz of uplink spectrum for individually licensed gateways to support the forward-link end user transmissions. Boeing recognizes that the International Table of Frequency Allocations does include 5 GHz of FSS uplink spectrum in the V-band, consisting of the 42.5-43.5 GHz, 47.2-50.2 GHz, and the 50.4-51.4 GHz band, but the Commission's Table of Frequency Allocations does not include an FSS allocation in the 42.5-43.5 GHz portion of this spectrum in recognition that FSS operations in this band could interfere with radio astronomy. Therefore, an additional 1 GHz of FSS uplink spectrum is required, which can best be addressed

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[12] *See* The Boeing Company Application for Authority to Launch and Operate a Non-Geostationary Low Earth Orbit Satellite System in the Fixed Satellite Service (S2966), SAT-LOA-20160622-00058 (June 22, 2016).

[13] *See* Comments of the Boeing Company, GN Docket No. 14-177 *et al.*, at 7-12 (Sept. 30, 2016) ("*Boeing Further Notice Comments*").

through the identification of an FSS Earth-to-space allocation in the 51.4-52.4 GHz band, immediately adjacent to the existing FSS uplink allocation at 50.4-51.4 GHz.[14]

In seeking an FSS allocation in the 51.4-52.4 GHz band, Boeing recognizes that the Commission is currently considering an identification for its newly created Upper Microwave Flexible Use Service ("UMFUS") in the 50 GHz band, which is one of about ten candidate (and adopted) spectrum bands under consideration by the Commission for UMFUS.[15] In contrast, as Boeing explained in its Further Notice comments, the V-band is the sole remaining greenfield spectrum that is suitable for broadband satellite systems using currently feasible technology.[16] Given the critical importance of the V-band to the future of broadband satellite services, the public interest would arguably be best served by refraining from making any identification for UMFUS in the 50 GHz band and instead rely on the Commission's already identified bands, along with some of its proposed bands, as amply sufficient to serve the spectrum needs of UMFUS.

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[14] As noted in Boeing's Petition, although the Commission's Table of Frequency Allocations at Section 2.106 does include an FSS Earth-to-space allocation in the 50.4-51.4 GHz band, the Commission should amend Section 25.202 of its rules to consistently reflect this FSS allocation by including the 50.4-51.4 GHz band as available for FSS Earth-to-space transmissions.

[15] The adopted UMFUS spectrum bands include the 27.5-28.35 GHz ("28 GHz") band, the 37.5-38.6 GHz ("37 GHz") band, and the 38.6-40.0 GHz ("39 GHz") band, while the candidate UMFUS spectrum bands include the 24.25-24.45 GHz and 24.75-25.25 GHz band ("24 GHz band"), the 31.8-33.4 GHz ("31 GHz") band, the 42.0-42.5 GHz ("42 GHz") band, the 47.2-50.2 GHz ("47 GHz") band, the 50.4-52.6 GHz ("50 GHz") band, the 71-76 GHz ("70 GHz") band, and the 81-86 GHz ("80 GHz") band.

[16] *Boeing Further Notice Comments* at 4-6.

To the extent that the Commission is unwaveringly committed to authorizing UMFUS in the 50 GHz band, FSS gateways can operate on a shared basis with UMFUS in the 50 GHz band through the use of two non-burdensome spectrum sharing measures: (1) excluding FSS gateways from core urban areas and, (2) first-in-time coordination outside core urban areas.

II. EXCLUSION OF FSS GATEWAYS FROM CORE URBAN AREAS WOULD GREATLY ASSIST SPECTRUM SHARING BETWEEN FSS AND UMFUS

To maximize the spectral efficiency of broadband satellite networks, next generation systems such as Boeing's will likely operate both end user terminals and feeder link "gateways" in the same spectrum. Through this technique, all of the spectrum that is available for broadband satellite systems can be used to service end users in heavily populated areas where broadband demand requirements are most challenging. At the same time, all (or nearly all) the spectrum that is available for broadband satellite systems can be used for gateways in rural and remote locations where aggregate end user demand is more modest.[17] To implement this highly efficient spectrum management approach, satellite operators will naturally be compelled to locate their gateways along fiber backbone routes that are away from population centers.

At the same time, UMFUS licensees will be motivated in exactly the opposite direction – seeking to construct mmW systems predominantly in urban areas. Therefore, satellite gateways and UMFUS systems can be expected to construct in different areas of the country, making spectrum sharing readily achievable.

[17] In describing "aggregate" end user demand as more modest in rural areas, Boeing notes that each individual end user can be anticipated to have the same broadband speed and throughput requirements regardless of whether they live in rural or urban areas, and Boeing's NGSO system can accommodate these geographically diverse requirements. The total density of end users in rural and remote areas, however, is much lower than the end user density levels in urban areas, thus providing opportunities to locate satellite gateways in rural and remote areas.

In asserting that UMFUS systems will be developed primarily in urban areas, Boeing acknowledges the Commission's desire for terrestrial UMFUS to be a nationwide service that is available to all Americans. UMFUS proponents, however, continue to temper these expectations, explaining in their Further Notice comments that "[w]hile the millimeter wave bands will help strengthen 5G network *capacity*, mid- and low-band spectrum will continue to drive network *coverage*."[18] Described differently, "5G operations in spectrum bands above 24 GHz will provide ultra-high-speed service in *high-traffic* areas, supplementing 5G and 4G services that use sub-6 GHz spectrum to provide *coast-to-coast* connectivity."[19]

The Commission should therefore recognize that, while mmW spectrum may provide important opportunities for high-density broadband deployment, "[t]he high frequency spectrum contemplated in the FNPRM alone is not an all-purpose solution to the spectrum front confronting wireless providers."[20] In fact, even the most ardent 5G proponents acknowledge that wide area UMFUS coverage is far from guaranteed, explaining "[d]espite the advances in millimeter wave technology, it remains unclear how the bands will develop."[21] These recent frank assessments by 5G proponents reinforce the prior conclusions of CTIA that UMFUS is "unlikely to deliver extensive coverage in a market but instead will be best suited . . . in densely

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[18] Comments of CTIA, GN Docket No. 14-177 *et al.*, at 3 (Sept. 30, 2016) (*emphasis added*).

[19] Comments of Qualcomm Incorporated, GN Docket No. 14-177 *et al.*, at 4 (Sept. 30, 2016) (*emphasis added*). Qualcomm further explains that "base stations supporting bands above 24 GHz will likely have very small coverage areas and limited geographic coverage even in the aggregate." *Id.* at 13.

[20] Comments of AT&T, GN Docket No. 14-177 *et al.*, at 4 (Sept. 30, 2016). AT&T further explains that "5G deployments will be driven by small cell network builds, meaning that urban and rural use cases may differ significantly" and "[w]ithout additional spectrum, particularly spectrum below 6 GHz, wireless coverage and capacity may fall behind." *Id.* at 4 & 7.

[21] Comments of T-Mobile, GN Docket No. 14-177 *et al.*, at 26 (Sept. 30, 2016).

populated areas"[22] and will be used "primarily for adding capacity and high-speed data"[23] to existing networks in areas "with the greatest population density."[24]

Given these facts, it is appropriate to conclude that spectrum sharing between satellite gateways and UMFUS will be greatly facilitated simply by precluding satellite gateways from core urban areas and allowing natural market and technological incentives – along with first-in-time coordination, where necessary – to govern the co-primary use of this spectrum between FSS gateways and UMFUS.

III. NGSO FSS GATEWAYS CAN SHARE THE 50 GHZ BAND WITH UMFUS SYSTEMS USING FIRST-IN-TIME COORDINATION

As discussed above, it is highly unlikely that UMFUS systems operating in the 50 GHz band will deploy base stations for wide area coverage in the same rural geographic locations where satellite system operators are likely to deploy feeder link gateways. To the extent that overlap does exist between such deployment scenarios, however, a first-in-time coordination approach would adequately serve to facilitate spectrum sharing between UMFUS and individually licensed satellite gateways.

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[22] Letter from Scott K. Bergmann, Vice President, Regulatory Affairs, CTIA, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177 *et al.*, at 2 (May 20, 2016) ("*May 20 CTIA Letter*").

[23] Letter from Brian M. Josef, Assistant Vice President, Regulatory Affairs, CTIA, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177 *et al.*, at 2 (May 24, 2016).

[24] *May 20 CTIA Letter* at 2.

Boeing anticipates that it will need to operate a few thousand gateways in the United States, but the exclusion zones resulting from these facilities are anticipated to affect no more than about 0.1 percent of the U.S. population.[25] Boeing cannot, however, locate its gateways using restrictions that are based on quantities of gateways in Partial Economic Areas ("PEAs").[26] With only 416 PEAs in the United States – not all of them including rural areas – a restriction of one or three gateways per PEA would be vastly inadequate to accommodate the gateway requirements of Boeing and other V-band satellite system operators. Boeing also cannot locate its gateways using restrictions on the population affected in each PEA.[27] As noted above, although Boeing anticipates that its gateways will affect no more than 0.1 percent of the total U.S. population, the population affected in some very rural PEAs (where 0.1 percent of the population is not a lot of people) may significantly exceed 0.1 percent.

Instead, Boeing recommends that a first-in-time coordination approach be used to locate satellite gateways and UMFUS systems in the 50 GHz band. In making this recommendation, Boeing observes that satellite gateways will be very similar to UMFUS base stations in that they will transmit very narrow directed beams. Unlike UMFUS base stations, satellite gateways will always transmit upward toward satellites. For example, Boeing's satellite gateways will always transmit at an elevation angle no lower than 45 degrees. The sidelobes from the transmissions of

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[25] This count represents a minimum number of spatially separated gateway sites. Each such site already operates with multiple antennas and multiple beams to service multiple satellites in the field of view.

[26] *See* Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, GN Docket No. 14-177, *et al.*, *Report and Order and Further Notice of Proposed Rulemaking*, FCC 16-89, ¶ 412 (July 14, 2016) ("*Further Notice*") (proposing a one gateway per PEA limit for the 47 GHz band).

[27] *See id.* (proposing to employ the same gateway siting limits for the 47 GHz band that were adopted by the Commission for the 28 GHz band).

satellite gateways, however, could prevent UMFUS base stations from successfully receiving the weaker signals from its mobile user terminals. Further, satellite gateway sidelobes could also prevent UMFUS user terminals from receiving signals from UMFUS base stations if those user terminals are close to the satellite gateways.[28]

Granted, mitigation measures can be employed to minimize the sharing impact between satellite gateways and UMFUS systems. Licensees in both services can employ cooperative and selective siting methods wherein both FSS and UMFUS operators disclose their actual locations, antenna sizes, base station sector orientations, and other site specific capabilities. Further, UMFUS user devices will be able to continue to operate within close range of satellite gateways simply by switching to frequency ranges outside the 50 GHz band. All or most UMFUS end user terminals will be able to transmit on multiple bands, likely including legacy cellular bands, to address numerous situations in which UMFUS user terminals will be able to receive UMFUS signals using the 50 GHz band, but will not be able to close a return link back to the serving base station due to such factors as building attenuation, foliage, rain fade or countless other factors.

In order to employ a first-in-time coordination approach for UMFUS and satellite gateways, UMFUS licensees would identify specific locations for base stations (or links for point-to-point systems) and receive protection for those locations and their surrounding coverage areas if they construct and bring them into operation within a relatively short period, *i.e.*, one or

[28] Boeing has assessed interference between FSS gateway and UMFUS base stations in a variety of ways, using both interference to noise ratios (I/N) as well as the resulting PFD levels incident at the UMFUS base station or FSS gateway. Boeing's analyses indicate a range of potential exclusion zones (from less than 1 kilometer to 5 kilometers) based on propagation and line of sight conditions, for various I/N ratios up to 0 dB. These assessments, however, also indicate that the -77.6 dBm/m2/MHz PFD level suggested by the Commission for 28 GHz coordination may need to be adjusted to protect FSS gateways and UMFUS base stations from interference.

two years. Site licenses for satellite gateways could be issued in a similar manner. Once a proposed location for a gateway is identified in an FCC license application, the gateway licensee would receive protection for that location and could retain its coordination priority as long as the gateway is brought into operation within a relatively short period (again, one or two years) after the license is granted by the Commission. Subsequently built UMFUS systems could not claim protection from such gateway facilities.

By employing a first-in-time coordination approach – combined with a prohibition on satellite gateways in urban areas – the Commission can facilitate intensive spectrum sharing between UMFUS and satellite gateways in the 50 GHz band without appreciably burdening either type of spectrum use. Thus, if the Commission does create an UMFUS allocation in the 50 GHz band, the Commission should further its public interest mandate by concurrently adopting an FSS allocation in the 51.4-52.4 GHz band and also adopting the above-discussed co-primary spectrum sharing measures to enable intensive and highly efficient use of the 50 GHz band to provide very high data rate services to all Americans.

IV. CONCLUSION

For the reasons stated herein, the Commission should create an FSS allocation in the 51.4-52.4 GHz band and modify Section 25.202 of its rules to identify the 50.4-51.4 GHz band

as available for FSS Earth-to-space operations. The Commission should adopt these spectrally-efficient measures in the context of its concurrently pending Spectrum Frontiers proceeding.

Respectfully submitted,

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