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

In the Matter of	)	
	)	
Use of Spectrum Bands Above 24 GHz For Mobile Radio Services	)	GN Docket No. 14-177
	)	
Establishing a More Flexible Framework to Facilitate Satellite Operations in the 27.5-28.35 GHz and 37.5-40 GHz Bands	)	IB Docket No. 15-256
	)	
Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42-43.5 GHz Band	)	RM-11664
	)	
Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95 and 101 To Establish Uniform License Renewal, Discontinuance of Operation, and Geographic Partitioning and Spectrum Disaggregation Rules and Policies for Certain Wireless Radio Services	)	WT Docket No. 10-112
	)	
Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations	)	IB Docket No. 97-95

COMMENTS OF VIASAT, INC.

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SUMMARY

As a leading provider of both satellite and terrestrial broadband communications solutions, and as the operator of a large fleet of Ka-band spacecraft, ViaSat welcomes the opportunity to comment on the Commission's *Notice of Proposed Rulemaking* ("*NPRM*") in this proceeding. ViaSat's comments focus on the 27.5-28.35 GHz band ("28 GHz Band"), the 37.5-40 GHz band, and the 64-71 GHz band.

The 28 GHz Band has been available for use by satellite networks since the Commission first opened the Ka band for commercial licensing, and has remained available for satellite use under the Ka-band band plan that the Commission adopted twenty years ago. Access to the 28 GHz Band has been an essential part of the design of ViaSat's ground-breaking, high-throughput broadband satellite network, which has revolutionized the industry, enabled the delivery of high-quality broadband service to end users across the country, and afforded millions of Americans with an effective competitive alternative to both wired and wireless terrestrial broadband providers. The 28 GHz Band is essential to the ViaSat spacecraft currently in operation, as well as to the even more advanced ViaSat spacecraft under development that will serve the United States in the next few years.

ViaSat uses, and has continued plans to use, the 28 GHz Band for a number of purposes, most critically for its earth station facilities that aggregate traffic and provide interconnection to the Internet and other critical terrestrial networks. Those facilities are located throughout the United States, and are close to where most of ViaSat's customer base is located—in and around the *populated* parts of the nation. Those facilities have coexisted successfully for years with the terrestrial LMDS service that is part of the Commission's existing Ka-band band plan.

With the proper planning and a suitable regulatory framework, ViaSat also believes that its 28 GHz Band earth station facilities can continue to coexist with the new mobile wireless services that the Commission proposes to introduce into the 28 GHz Band. ViaSat commends the Commission for recognizing the need to ensure that certain essential satellite earth stations will be able to continue to operate even if the Commission dramatically changes the operating environment in the 28 GHz Band by allowing new terrestrial mobile services. However, ViaSat does not believe that the Commission's proposal goes far enough, as it does not ensure the continued operation of the earth stations that are essential to the next-generation ViaSat spacecraft currently under development.

In adopting the current band plan for the Ka band, and in authorizing spacecraft, the Commission made clear that while 28 GHz Band earth stations would be secondary to fixed LMDS operations, they would have licensing priority over any other terrestrial operations, such as the mobile service proposed in the *NPRM*. Based on this existing legal framework, the satellite industry has invested billions of dollars that must be protected going forward.

Fortunately, and as demonstrated by ViaSat's enclosed preliminary analysis, coexistence between terrestrial mobile operations and ViaSat's critical 28 GHz Band earth stations is feasible as long as terrestrial mobile operators design their networks to accept a reasonable amount of unwanted energy from satellite earth stations. ViaSat's analysis shows that any areas of incompatibility are likely to occur in an area that is no more than about 160 meters from the earth

station. And that area could be reduced in size even further through shielding of the earth station, where feasible. Under these circumstances, ViaSat does not believe it is either efficient or necessary to require 28 GHz Band earth station operators to acquire terrestrial spectrum rights through geographic licenses to protect their facilities from the impact of new terrestrial mobile services.

ViaSat also supports the Commission's proposal to allow the licensing of a broad range of earth stations, including blanket-licensed user terminals, under the existing secondary designation in the 28 GHz Band for satellite earth stations. Sharing technologies, such as database solutions, can enable broad sharing between satellite and terrestrial networks in ways that were not feasible at the time the current Ka-band band plan was adopted twenty years ago.

The 37.5-40 GHz band also is important for the continued support and growth of the satellite broadband industry, particularly as the Ka band becomes increasingly congested. ViaSat and other satellite operators have begun laying the groundwork to use this spectrum in future generation satellite networks based on the existing co-primary designation for the band. Given that the Commission proposes to fundamentally change the nature of the terrestrial uses for this band (*i.e.*, by allowing mobile services), it is appropriate also to reconsider the existing limitations on satellite operations in this band. In particular, increasing the power limits for space-to-earth transmissions could allow satellite operators to use this spectrum more effectively without impacting terrestrial users. Moreover, the operating environment in this band is conducive to flexible use by any type of satellite earth station (even user terminals on a secondary basis), because the earth stations operate in receive-mode in this band.

ViaSat supports the Commission's proposal to authorize unlicensed wireless operations under Part 15 of the Commission's rules in the 64-71 GHz band to complement similar operations in the adjacent 57-64 GHz band.

Finally, ViaSat is pleased that representatives of the satellite and terrestrial wireless industries have commenced discussions to understand the parameters of their respective networks in an effort to explore the means by which the 28 GHz Band and the 37.5-40 GHz band could be shared. ViaSat is encouraged by these ongoing discussions, which seek to find a path forward that allows all interested parties to maximize the use of those bands. That said, at this juncture, it is clear that in order for sharing to work in the 28 GHz Band or the 37.5-40 GHz band, all parties need to invest in new technology and contribute to creating an environment where spectrum can be used intensively and efficiently. One type of user should not have to bear the entire burden of sharing where other types of users in a greenfield deployment can implement reasonable measures to accommodate shared uses, including populating databases that alert other spectrum users of their operations, or employing modern antenna technology that helps eliminate the effect of sources of unwanted energy.

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Exhibit 1: Compatibility Analysis

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COMMENTS OF VIASAT, INC.

ViaSat, Inc. ("ViaSat") submits these comments in response to the Commission's Notice of Proposed Rulemaking in the above-captioned proceeding, in which it is considering rules

regarding the use of frequency bands above 24 GHz ("millimeter wave bands") for 5G terrestrial mobile radio services, and a revision to its 28 GHz Band Plan.[1]

I. BACKGROUND

ViaSat is a leading provider of communications solutions across a wide variety of technologies (both terrestrial and satellite), and it uses a fleet of spacecraft to provide its Exede broadband service in the Ka band to fixed and mobile terminals. ViaSat's advanced satellite broadband network technology has revolutionized the satellite industry by reducing the "cost per bit" of delivering broadband service, providing a high-quality service to end users, and affording millions of Americans an effective competitive alternative to wired and wireless terrestrial services.

ViaSat's satellite broadband customers include individual consumers, small and large businesses, government and military users, and major airlines such as United, JetBlue and Virgin America. ViaSat serves nearly 700,000 customers using its Ka-band broadband network at fixed locations, and provides in-flight broadband on approximately 419 commercial, 300 business and 400 government aircraft.[2] In fact, nearly one million personal electronic devices connect each month to the W-Fi service provided though these broadband connections to aircraft. ViaSat also is a provider of satellite broadband service to government and military users for their essential missions and communications needs. Notably, these customers are distributed across the United States in a manner that roughly follows the U.S. population distribution, as depicted in the figure

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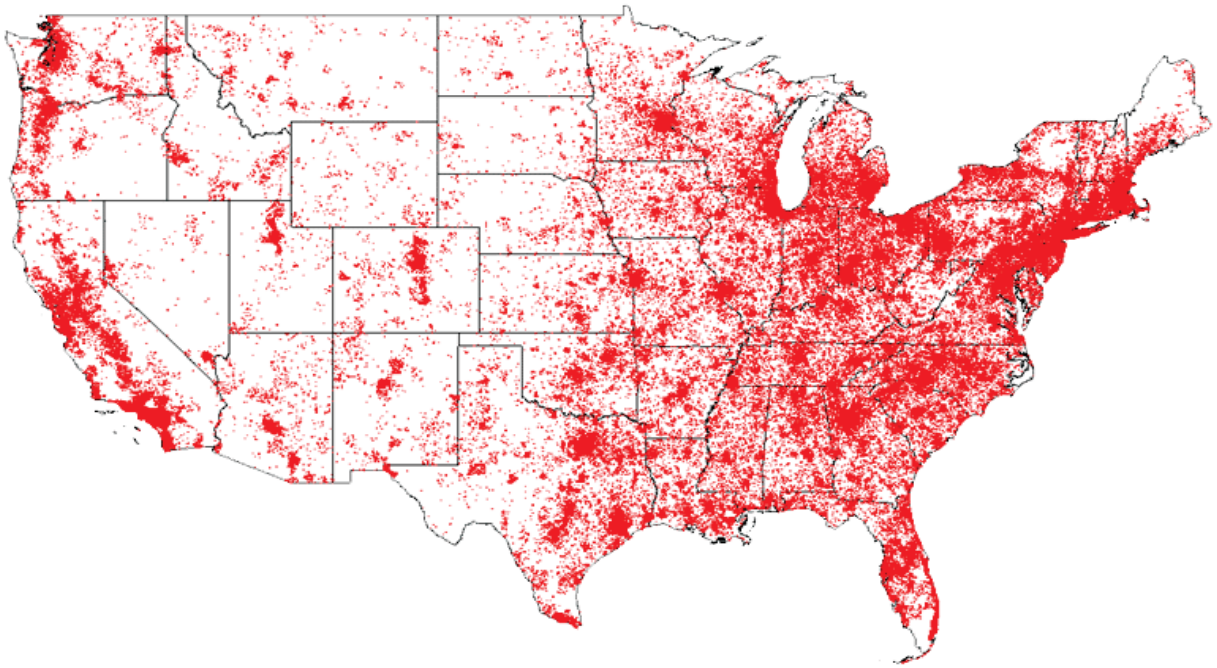
1 *Use of Spectrum Radio Bands Above 24 GHz for Mobile Radio Services*, GN Docket No. 14-177, et al., Notice of Proposed Rulemaking, FCC 15-138 (rel. Oct 23, 2015) ("*NPRM*").

2 *See Press Release: ViaSat Announces Second Quarter Fiscal Year 2016 Results* (Nov. 9, 2015), *available at* http://investors.viasat.com/releasedetail.cfm?ReleaseID=941679.

below. The aircraft that utilize ViaSat's broadband service traverse the United States, as well as international routes.

Figure 1. ViaSat Broadband Subscriber Density



ViaSat's satellite broadband service relies upon a fleet of four spacecraft: (i) ViaSat-1, its first-generation, high-capacity satellite; (ii) WildBlue-1; (iii) the Ka-band payload on Anik F2; and (iv) the Ka-band payload on AMC-15.[3] In addition, ViaSat owns the Ka-band payload on Galaxy 28, and is authorized by the Commission to operate two next-generation Ka-band

[3] *See* ViaSat, Inc., IBFS File No. SAT-LOI-20080107-00006, as amended and modified, Call Sign S2747 (granted Aug. 18, 2009) (authorizing ViaSat-1 at the nominal 115º W.L. orbital location) ("*ViaSat-1 Authorization*"); IBFS File No. SES-MOD-20121107-00993, Call Sign E050033 (authorizing earth station facility using WildBlue-1, Anik F2 and AMC-15 as points of communication).

spacecraft to serve the United States—one of which has a launch milestone in December 2018, and the other of which has a launch milestone in June 2019.[4]

ViaSat's satellite broadband service also relies upon a network of earth stations deployed throughout the United States that communicates with ViaSat's spacecraft, and which also operates in the Ka band. This ground network consists of user terminals located at customer premises; earth stations that aggregate traffic and interconnect with the Internet backbone and other critical terrestrial networks; telemetry, tracking and command facilities to control the spacecraft; earth stations mounted on aircraft; and transportable temporary-fixed earth stations. All of these earth stations are distributed across the United States—they are not primarily located in remote or rural areas. To the contrary, they are located close to the customers and connections to the Internet backbone, which are often in more populated areas.

ViaSat's network of earth stations will continue to expand as ViaSat launches its next-generation spacecraft authorized by the Commission, acquires more customers, and continues to expand its infrastructure to maintain its ability to deliver broadband service at levels that are competitive with terrestrial alternatives. To illustrate, ViaSat-1, which was brought into operation in 2011, supports a throughput of approximately 150 Gbit/s and relies on a network of 17 earth stations that aggregate traffic and interconnect to the Internet backbone. When it was launched, ViaSat-1 had more than 10 times the throughput of the other Ka-band satellites in orbit

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[4] *See* ViaSat, Inc., IBFS File No. SAT-LOI-20140204-00013, as amended and modified, Call Sign S2917, Attachment ¶ 12 (granted June 18, 2014) (authorizing market access for a Ka-band satellite at the nominal 89º W.L. orbital location) ("*89º W.L. Authorization*"); IBFS File No. SAT-LOI-20130319-00040, as modified, Call Sign S2902, Attachment ¶ 13 (granted Dec. 12, 2013) (authorizing market access for a Ka-band satellite at the nominal 70º W.L. orbital location) ("*70º W.L. Authorization*"); IBFS File No. SAT-ASG-20130515-00070, Call Sign S2160 (assigning Ka-band payload on Galaxy-28 from Intelsat to ViaSat).

at that time.[5] ViaSat's second-generation high-capacity satellite will double this capability, will have the capability to support speeds well over 100 Mbit/s,[6] and will require more than 40 such earth stations to aggregate and interconnect traffic. With the planned deployment of multiple third-generation ViaSat high-capacity satellites, each of which will provide over 1 Terabyte per second (1,000 Gbit/s) of throughput and will support even higher speeds,[7] ViaSat will require a total of hundreds of such earth stations to aggregate and interconnect traffic.

These revolutionary advances in throughput have been made possible by incorporating greater bandwidth into satellites, facilitated by the Commission's Ka-Band Band Plan, which was adopted in 1996. Specifically, ViaSat's newest spacecraft are designed to operate across a wide range of the Ka band—including the 27.5-28.35 GHz band segment under consideration in this proceeding (the "28 GHz Band"). ViaSat-1 was the first commercial spacecraft to operate in this band, and ViaSat's two newest spacecraft under construction employ this band as well.[8] This band segment currently is used by the earth stations that aggregate and interconnect to the Internet backbone, in a manner that is compatible with existing LMDS uses of this band segment. In fact, these types of earth stations have successfully shared the 28 GHz Band with authorized LMDS users without any reported cases of interference. ViaSat also has sought

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5 *See ViaSat-1 FAQ*, *available at* https://www.viasat.com/sites/default/files/legacy/web/ViaSat-1_FAQ_3_09_V3.pdf (last visited Jan. 27, 2016).

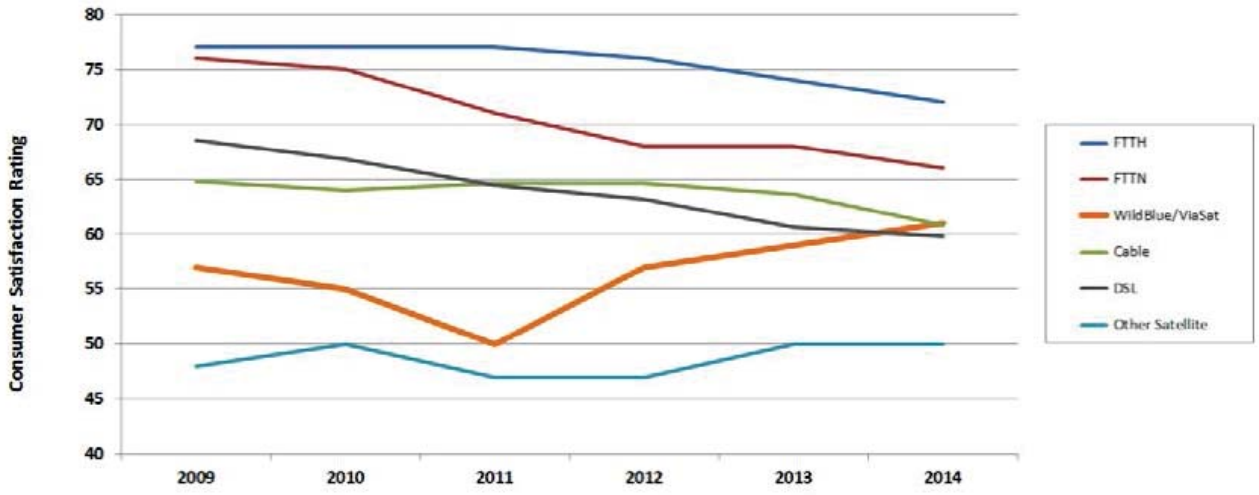
6 *See ViaSat Q2 2016 ViaSat Earnings Conference Call* (Nov. 9, 2015), *available at* http://investors.viasat.com/events.cfm.

7 *Id.*

8 *See 70º W.L. Authorization*, Attachment ¶ 12; *89º W.L. Authorization*, Attachment ¶ 11.

authority to use this band segment to serve aircraft above 10,000 feet, likewise in a manner that is compatible with existing LMDS uses.[9]

These advances in satellite broadband technology have attracted customers who have switched to satellite broadband from terrestrial alternatives, such as 3G and 4G wireless, cable, and DSL. In fact, ViaSat's satellite broadband service now has an overall user satisfaction rating that is on par with that of many broadband service providers. The chart below depicts reported customer satisfaction levels with different broadband technologies available in the marketplace. Notably, the level of satisfaction of ViaSat customers has been rising, and is considerably higher since it launched ViaSat-1 in 2011. To emphasize, the satellite broadband capabilities that have made this level of service possible require the spectrum inputs that the Commission has authorized for the ViaSat network, including the 27.5-28.35 GHz band.



FTTH: FiOS; FTTN: U-Verse; Cable: average score of CableOne, Charter, Comcast, Cox, MediaCom, Time Warner; DSL: average score of AT&T, Century Link, FairPoint, Frontier, Verizon, Windstream ViaSat not ranked in 2013, data point is interpolated.

Source: *Consumer Reports* issues published February 2010, May 2011, June 2012, May 2013, May 2014, and May 2015, *available at* www.consumerreports.org.

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9 *See* ViaSat, Inc., IBFS File No., SES-MOD-20160108-00029, Call Sign E120075 (filed Jan. 8, 2016).

ViaSat's focus is on providing efficient and cost-effective broadband solutions, regardless of technology, and it works with and employs terrestrial-based communications to meet the communications needs of its customers. By way of example, ViaSat recently acquired NetNearU Corp., a wireless network systems provider that delivers managed Wi-Fi Internet access services on unlicensed frequencies to over 10 million Wi-Fi access points worldwide. Leveraging the management platform acquired in that transaction, ViaSat now provides wireless network systems that deliver broadband service to consumers, businesses, and government customers, in buildings and through outdoor hotspots.

As a leading innovator of communications technologies, including those that rely on shared spectrum, and as a provider of both satellite and terrestrial wireless services, ViaSat is uniquely positioned to offer insights in this proceeding that support solutions for making the most efficient use of spectrum while enabling flexibility for the development and operation of a wide range of technologies and services.

II. THE CONTEMPLATED 5G OPERATIONS ARE CONDUCIVE TO SHARING

As the Commission develops a framework in this proceeding to promote deployment of 5G mobile technologies in the millimeter wave bands, ViaSat encourages the Commission to use this opportunity also to structure the regulatory framework in the 28 GHz Band and 37.5-40 GHz band to accommodate existing and future satellite operations. Doing so would maximize the efficient use of scarce spectrum resources by a variety of technologies, and would be consistent with the Commission's endorsement of the need to reexamine "outdated paradigms" and to explore ways to facilitate the development of new services while protecting investments made in

reliance on the current operating environment.[10] Indeed, given the feasibility of sharing and opportunities for making more intensive and efficient use of the 28 GHz Band and the 37.5-40 GHz band, there is no good reason to retain strict and exclusive designations for a single use, to maintain rules based on legacy sharing paradigms that are now obsolete, or to change the current licensing priority that satellite services have over terrestrial mobile services in the 28 GHz Band (as discussed below).

Sharing in the 28 GHz Band and the 37.5-40 GHz band is feasible, in part, due to the nature of the characteristics of the contemplated 5G services on one hand, and the existing and planned satellite operations on the other. As an initial matter, the propagation characteristics of millimeter-wave frequencies make terrestrial use of these bands suitable for short transmission distances to provide coverage of smaller areas, primarily in densely populated urban areas.[11] Based on the record in the *Notice of Inquiry* for this proceeding, 5G technology will employ highly directional antennas that will be tilted downward and either will be steerable or will employ beam forming.[12] Significantly, mobile uses of the 28 GHz Band and the 37.5-40 GHz band are being contemplated not for stand-alone services but rather as supplementary channels to deliver additional terrestrial mobile wireless capacity in areas where it is needed; 5G networks will necessarily include the continued use of "core" spectrum in lower bands (*e.g.*, PCS, AWS) to ensure ubiquitous and continuous network coverage.[13] In less densely-populated areas,

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10 *NPRM* ¶ 33; *see also id.* ¶ 24 (seeking to adopt a "regulatory framework that maximizes flexibility and enables the widest possible variety of services").

11 *See, e.g., id.* ¶ 111 (proposing smaller geographic licensing areas for 28 GHz and 39 GHz).

12 *Id.* ¶ 7 n.5.

13 *Id.* ¶ 8.

spectrum in the 28 GHz Band and the 37.5-40 GHz band could be used for highly concentrated signals in focused beams to provide point-to-point connectivity suitable for backhaul.[14]

Satellite services readily could coexist with 5G networks based on these operating scenarios. Representatives of the satellite and terrestrial wireless industries have commenced discussions to understand the parameters of their respective networks in an effort to explore the means by which spectrum could be shared. ViaSat is encouraged by the ongoing discussions that seek to find a path forward that allows all interested parties to maximize the use of the spectrum under consideration in this proceeding. One thing is clear at this juncture: for sharing to work, all parties need to invest in new technology and contribute to creating an environment where spectrum can be used intensively and efficiently. One type of user should not have to bear the entire burden of sharing where other types of users in a greenfield deployment can implement reasonable measures to accommodate shared uses, including populating databases that alert other spectrum users of their operations, or employing antenna technology that creates "nulls" in the direction of interference sources.[15]

As a threshold matter, considerations for evaluating sharing proposals will differ at 28 GHz and 37.5-40 GHz due to the nature of the existing and proposed satellite and terrestrial operations in each band. In the 28 GHz Band, satellite operations are in the earth-to-space direction and thus have the potential to generate unwanted energy into terrestrial receivers. If the level and location of that unwanted energy does not unreasonably impede terrestrial operations, or if that unwanted energy ceases when the terrestrial receiver is operating, coexistence between the earth stations and the terrestrial receivers can be ensured.

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14 *Id.* ¶ 22.

15 *See id.* ¶ 147 (proposing that terrestrial licensees be required to provide information on fixed and mobile deployments in order to facilitate sharing); *see also id.* ¶ 157 (exploring the feasibility of the use of active signal cancelling by terrestrial wireless operators).

In contrast, in the 37.5-40 GHz band, satellite operations are in the space-to-earth direction. Compatibility between satellite and terrestrial operations in this scenario can be managed by ensuring that terrestrial receivers are designed to operate in the presence of specified satellite downlink power flux density ("pfd") limits at the earth's surface.[16] Satellite gateway earth stations currently are designated as co-primary with terrestrial operations in this frequency band. However, widely-deployed secondary earth stations used to serve customers also could operate without impacting terrestrial operations by requiring that such secondary earth stations accept unwanted energy from any nearby terrestrial transmitters. Accordingly, these comments present the issues and sharing potential separately for each of these bands.

III. ANY REVISED FRAMEWORK FOR THE 28 GHZ BAND SHOULD PROTECT ESSENTIAL EARTH STATION FACILITIES

Satellite operators are investing billions of dollars to develop and deploy satellite broadband networks and services that are based on the current regulatory framework in the 28 GHz Band, in which satellite uplinks have express licensing priority over any terrestrial mobile service.[17] Therefore, the new framework adopted in this proceeding should afford protection to the essential facilities for these networks that use the 28 GHz Band. Doing so would not inhibit 5G deployment. However, establishing sharing criteria will require defining the level of unwanted energy that terrestrial wireless systems in the 28 GHz Band should tolerate.

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16 *See, e.g., Establishment of Policies and Service Rules for the Broadcasting-Satellite Service at the 17.3-17.7 GHz Frequency Band and at the 17.7-17.8 GHz Frequency Band Internationally, and at the 24.75-25.25 GHz Frequency Band for Fixed Satellite Services Providing Feeder Links for the Broadcasting-Satellite Service and for the Satellite Services Operating Bi-directionally in the 17.3-17.8 GHz Frequency Band*, Report and Order and Further Notice of Proposed Rulemaking, 22 FCC Rcd 8842, 8864-5 ¶ 55 (2007) (adopting pfd limits in the 17.7-17.8 GHz band to facilitate co-frequency satellite downlinks and terrestrial operations).

17 *See infra* Section III.A.

A. Earth Stations Currently Have Priority over Terrestrial Mobile Services in the 28 GHz Band

As an initial matter, ViaSat respectfully disagrees with the *NPRM*'s premise that Fixed Satellite Service ("FSS") network operators should have understood that their earth stations would be subordinate to terrestrial mobile services in the 28 GHz Band.[18] In fact, the Commission made clear that the opposite is true: terrestrial mobile services are subordinate to the FSS in the 28 GHz Band. This is apparent from a plain reading of the Commission decisions twenty years ago adopting the 28 GHz Band Plan.

When the Commission adopted the 28 GHz Band Plan, it expressly articulated the rights of various users of that band segment vis-à-vis one another, and it set up a three-tier priority system. The Commission designated LMDS, defined as a fixed point-to-multipoint or fixed point-to-point service, and as having top "licensing priority."[19] The Commission designated the FSS (and its associated earth stations) as having licensing status below LMDS. Most significantly, the Commission also designated the FSS as having "licensing priority vis-à-vis *any third service allocated domestically or internationally in the band*."[20] As reflected in the U.S. Table of Frequency Allocations in effect at that time, that included the terrestrial mobile service.[21] In other words, the FSS has licensing priority over terrestrial mobile service today,

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18 *See NPRM* ¶ 26.

19 *Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services*, First Report and Order, 11 FCC Rcd 19005, 19024 ¶ 44 (1996) ("*28 GHz First Report and Order*").

20 *Id.* (emphasis supplied).

21 *See* 47 C.F.R. § 2.106 (1996).

and it has had that priority since 1996.[22] Significantly, ViaSat's satellite authorizations that use 28 GHz Band frequencies make clear that ViaSat's FSS operations in that portion of the Ka band are secondary with respect to LMDS, and not terrestrial services more generally.[23]

Stated another way, satellite operators, like ViaSat, who have invested hundreds of millions dollars, and have plans to invest billions more, in reliance on the 28 GHz Band Plan, have settled expectations that (i) the stable operating environment that has been in place for over two decades will not be disturbed, (ii) the many individually-licensed earth stations that are vital to the operation of satellite broadband networks can continue to operate in accordance with the 28 GHz Band Plan, and unimpeded by the introduction of terrestrial mobile services, and (iii) the additional earth stations that they need to deploy to complete their satellite networks that have been authorized by the Commission will be licensed and allowed to operate in accordance with the 28 GHz Band Plan, and unimpeded by the introduction of new terrestrial mobile services.[24] This is true even in areas in which there is an actively-licensed LMDS operator.

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22 While the Commission acknowledged the possibility of expanding LMDS to include a mobile component, the Commission also recognized that doing so would require a change in the existing *allocation* for the band based on a fully developed record in support of such change. *Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services,* Second Report and Order, 12 FCC Rcd 12545, 12555 ¶ 10, 12634 ¶ 200, 12637-8 ¶ 207 (1997) ("*LMDS Second Report and Order*").

23 *See ViaSat-1 Authorization,* Attachment – Conditions for Letter of Intent ¶ 2; *70º W.L. Authorization,* Attachment ¶ 12; *89º W.L. Authorization,* Attachment ¶ 11.

24 *See, e.g., Landgraf v. Usi Film Prods.*, 511 U.S. 244, 265 (1994) ("Elementary considerations of fairness dictate that individuals should have an opportunity to know what the law is and to conform their conduct accordingly; settled expectations should not be lightly disrupted."); *Epilepsy Found. Of Ne. Ohio v. NLRB*, 268 F.3d 1095, 1102 (D.C. Cir. 2001) (declining to grant retroactive application to NLRB's changed interpretation of § 7 of the National Labor Relations Act because "the governing principle is that when there is a substitution of new law for old law that was reasonably clear, the new rule may

As detailed below, however, as long as terrestrial mobile operators design their networks to accept a reasonable amount of unwanted energy from FSS earth stations, coexistence in the band appears feasible.

B. Protection Zones Around ViaSat's Essential Facilities Should Be Extremely Small and Should Not Impede 5G Deployment

In order to assess the likely compatibility of its current and planned earth station deployment and 5G operations, ViaSat performed a preliminary, illustrative analysis of the level of unwanted energy its earth stations would generate in the direction of possible 5G receivers. That analysis, attached as Exhibit 1, reveals that the impact of those earth stations is *de minimis*. In the absence of a defined 5G interference threshold, ViaSat used the 47 dBuV/m specified in Part 27 of the Commission's rules, which the *NPRM* proposes as a suitable level for coordination between 5G licensees in adjacent areas.[25] For simplicity, this illustration assumes free-space propagation and 10 to 20 dB of attenuation to account for shielding from neighboring terrain, foliage or nearby buildings, which reasonably can be assumed for real-world operation conditions. The analysis does not consider the impact of employing RF screening at the earth station or any down-tilt or beam null-forming of 5G base station installations, which would provide additional attenuation, further reducing the size of the compatibility zone. Under these conditions, the operation of the earth station would not adversely affect any 5G receiver located

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justifiably be given prospectively-only effect in order to protect the settled expectations of those who had relied on the preexisting rule" while "retroactive effect is appropriate for new applications of existing law, clarifications, and additions") (citations, internal quotation marks, and modifications omitted); *see also AEP Tex. N. Co. v. Surface Transp. Bd.*, 609 F.3d 432, 440 (D.C. Cir. 2010) (approving of agency's reasoning in not modifying its existing rate-setting rule, as such a modification would "'not only undermine settled expectations but [] erode investor confidence'" and further noting that "investors might not invest sufficiently in railroads if they have no confidence in the stability of the Board's" rate-setting rules) (citation omitted).

[25] *See NPRM* ¶ 290.

outside an irregularly-shaped compatibility zone that typically would be less than about 160 meters at its maximum distance. Notably, the distance behind the earth station would be smaller.

C. The Commission Has Acknowledged the Need to Protect Essential Earth Station Facilities

The Commission recognizes in the *NPRM* that certain essential satellite earth station facilities should be provided co-primary status with terrestrial services in the 28 GHz Band, but the proposal is very limited.[26] Putting aside the fact that this proposal does not reflect the priority that satellite earth stations have over all terrestrial services (other than LMDS) under the 28 GHz Band Plan, this proposal would not provide protection against mobile operations in areas in which there is an LMDS licensee. And in areas that do not have LMDS licensees, the proposal could be interpreted as not protecting earth stations against newly licensed terrestrial services unless either (i) the earth station was already licensed or applied for before the date of the *NPRM* and also is brought into operation by a date certain, or (ii) the earth station licensee seeks and obtains a waiver based on the absence of any adverse impact on future terrestrial service, such as being located in a remote area,[27] and also brings the earth station into operation by a date certain. Under these terms, ViaSat has no assurance that a large number of its aggregation and interconnection facilities would be protected with respect to new 5G services, even though (i) many of the earth stations for ViaSat-1 currently are successfully operating within LMDS license areas, (ii) it was premature to apply for earth stations for ViaSat's authorized but unlaunched spacecraft before the *NPRM* based on the expected in-service dates of

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[26] *See, e.g., id.* ¶¶ 139-145.

[27] *See id.* ¶ 145.

those spacecraft,[28] and (iii) ViaSat reasonably relied on the 28 GHz Band Plan and its satellite authorization conditions in developing its network.

ViaSat agrees that it would serve the public interest to afford co-primary protection to such essential earth station operations. To the extent that the Commission modifies the 28 GHz Band Plan to accommodate 5G, ViaSat urges the Commission to expand the essential earth station facilities that would be protected to specifically include (i) the aggregation and interconnection facilities of any spacecraft that the Commission has authorized to serve the United States in the 28 GHz Band, as well as (ii) any other individually-licensed earth station in the 28 GHz Band that would not require a compatibility zone (as discussed above) extending more than a specified distance to the earth station. Defining the level of unwanted energy that terrestrial wireless systems in the 28 GHz Band should reasonably have to accept, and thus the size of this compatibility zone, would facilitate the continued shared use of the 28 GHz Band by a wide variety of services, and across wide geographic areas.

ViaSat's proposal not only would lead to more intensive spectrum use, but also would avoid disrupting existing services and stranding significant investments made in reliance on settled expectations regarding the longstanding rules and operating environment that have governed the 28 GHz Band. In light of the small compatibility zones that would be required to separate 5G deployment from earth stations, permitting satellite operators to continue to deploy essential facilities that are compatible with terrestrial operations can feasibly be done in a manner that does not unduly restrict 5G systems and that makes efficient and intensive use of spectrum.

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[28] *See* 47 C.F.R. § 25.133(a)(1) (requiring construction of earth station facilities to be completed and brought into operation within one year of the date of the license grant). The launch milestone under the *70º W.L. Authorization* is December 2018, and the launch milestone under the *89º W.L. Authorization* is June 2019.

ViaSat opposes proposals to require satellite operators seeking protection for essential earth station facilities from new terrestrial mobile services to acquire terrestrial spectrum rights.[29] Requiring satellite operators to acquire a terrestrial license for an entire county or even a census tract unnecessarily would preclude terrestrial wireless deployment in the parts of the licensed area where an earth station would not impact terrestrial operations, given the extremely small compatibility zone. Even when assuming a compatibility zone with a circular radius of approximately 160 meters,[30] the measured area would represent only about 0.0033 percent of the area of an average U.S. county. Moreover, it would be unworkable and unnecessary to require FSS earth station licensees to seek to acquire partitioned spectrum rights from a terrestrial licensee. Such a regime would allow terrestrial licensees (and particularly the existing LMDS licensees), many of whom could be competitors of satellite broadband operators, to become gatekeepers to any satellite operations in the 28 GHz Band when such earth stations can be deployed with a negligible impact on 5G deployment.

IV. TECHNOLOGICAL ADVANCES ALLOW EVEN GREATER USE OF THE SECONDARY FSS DESIGNATION THAN BEFORE

A. The Secondary Designation Should Allow Deployment of User Terminals

In the *NPRM*, the Commission makes clear that satellite operators will continue to avail themselves of the secondary FSS designation in the 28 GHz Band during this proceeding and after 5G rules are adopted.[31] As discussed above, ensuring that capacity on satellite broadband networks can grow to meet consumer demands will depend upon the availability of additional spectrum, including in bands where satellite networks can operate on a secondary or non-

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29 *See, e.g., NPRM* ¶ 134.

30 As discussed in Section III.B above, compatibility zones will be irregularly-shaped, with shorter separation distances in areas behind the earth station antenna.

31 *NPRM* ¶ 135.

interfering basis. While ViaSat's satellite broadband services are predominantly provided to customers in ViaSat's "core" satellite spectrum that is designated for FSS on a primary basis, access to additional bandwidth on a secondary basis would significantly expand these capabilities. Just as terrestrial wireless providers view the millimeter wave bands as important supplemental capacity for mobile wireless services provided in "core" low band spectrum, allowing satellite use of the 28 GHz Band to serve end users is just as critical.

As the Commission recognizes in the *NPRM*, technological advances have made possible potential opportunities for spectrum sharing that were not feasible for wide deployment when the current regulatory framework was adopted.[32] Indeed, since the Ka-band Band Plan was adopted, satellite antenna technology has evolved significantly, and a number of spectrum sharing techniques have been proven effective in enabling more efficient use of spectrum without causing harmful interference into other users in a given band segment. Still other techniques are under investigation and at the beginning stages of deployment.

Among other things, facilitating technical discussions between network operators and maintaining a database of terrestrial base station operations in the 28 GHz Band would allow satellite network operators to "work around" those terrestrial uses, taking into account the known compatibility zone of the blanket-licensed terminal and the nature of the neighboring terrestrial use. In other words, the types of uses that easily can be coordinated with LMDS operations is far greater than when the Commission adopted the 28 GHz Band Plan twenty years ago and indicated that it did not believe it was practical for ubiquitously-deployed earth stations to operate in the same band as LMDS at that time. Notably, the Commission left open the possibility of such earth stations sharing the band in the future if and when sharing became

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[32] *See, e.g., id.* ¶¶ 2, 23.

feasible.[33] Now is the time to take that reality into account. ViaSat thus urges the Commission to allow secondary operations of user terminals, including blanket-licensed earth stations, in the 28 GHz Band, on a secondary basis. Such secondary operations could share 5G spectrum on an "opportunistic" basis, meaning that the earth stations would use the supplemental 28 GHz spectrum only in locations and/or during times when there would not be any adverse impact on terrestrial use of the band.

B. ViaSat Supports a Database Solution as an Effective Sharing Mechanism

In order to facilitate the type of sharing discussed above, ViaSat supports the investigation of a database solution that would enable secondary FSS users to avoid impacting terrestrial operations, such as the database mechanisms that have been established for TV White Space operations or that are being developed for the tiered sharing framework in the 3.5 GHz band.[34] In each of these cases, the Commission has acknowledged that allowing multiple uses to coexist is feasible through database mechanisms and also promotes efficient spectrum usage. In this case, terrestrial licensees could be required to provide base station information necessary to facilitate coordinated operations and to maintain the accuracy of such information in the database.

ViaSat recommends that the costs of maintaining such a database not be imposed on satellite operators. As explained above, the new spectrum uses being considered for the 28 GHz Band represent a fundamental change to the Commission's longstanding band plan. In these circumstances, all parties benefitting from newly permitted uses of the spectrum resources

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33 *See 28 GHz First Report and Order* 19010 ¶ 10 n.13, 19015-6 ¶ 27, 19025 ¶ 45.

34 *See NPRM* ¶ 150; *see also Unlicensed Operation in the TV Broadcast Bands*, Second Report and Order, 23 FCC Rcd 16807 (2008); *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959 (2015).

should play a part in facilitating efficient and intensive use of spectrum. Thus, a database solution could be funded, at least in part, through the terrestrial licensing mechanism (*e.g.*, spectrum auction proceeds).

Although beacon signaling could be useful in facilitating sharing, such a solution is not as attractive as a database solution due to the additional cost and complexity of incorporating beacon transmitters into terrestrial network equipment and new receivers into satellite earth stations.

V. SHARED SATELLITE/TERRESTRIAL USE OF THE 37.5-40 GHZ BAND IS FEASIBLE

In the *NPRM*, the Commission recognizes the value of facilitating both satellite and terrestrial mobile use in the 37.5-40 GHz frequency band to enable a wide range of services.[35] In doing so, the Commission recognizes that both industries require additional spectrum resources to expand network capacity to provide broadband services that meet evolving consumer needs. As many in the satellite industry emphasized in this proceeding, the V band is an important expansion band for future broadband satellites as the Ka band becomes increasingly congested and as access is needed to meet growing demands for satellite broadband services.

ViaSat and others in the satellite industry have begun laying the groundwork to use this spectrum in future generation networks. ViaSat's filings at the ITU for future satellite networks include V-band spectrum. And technology has been developing to enable operators to tap this critical spectrum resource for commercial networks. However, the rules for satellite operations in this band need to be modified to promote further development of this service and more intensive use of spectrum in this band.

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35 *NPRM* ¶¶ 45, 52 (envisioning that mmW bands will be used for a variety of both satellite and terrestrial services).

Currently, the 37.5-40 GHz band is subject to a "soft segmentation" band plan adopted in 2003, which allows FSS operations throughout this band segment, but subject to a lower power flux density limit intended to facilitate deployment of high-density fixed terrestrial systems.[36] Satellite earth station deployment in this band segment is also restricted to gateway-type earth stations, which have co-primary status with, and thus protection from, terrestrial services. Earth station facilities that are ubiquitously deployed and those used to serve individual customers are prohibited in this band.[37] Given that the Commission in this proceeding proposes to fundamentally change the nature of the terrestrial uses for this band (*i.e.*, by allowing mobile services), it is appropriate also to reconsider these limitations on satellite operations. In particular, the pfd limits in the soft segmentation band plan should be reevaluated as the Commission is establishing parameters for a new class of terrestrial services. Increasing the pfd limits for space-to-earth transmissions could allow satellite operators to use this spectrum more effectively without impacting terrestrial users. ViaSat urges the Commission in this proceeding to determine the levels that can be tolerated by 5G terrestrial networks to enable such shared use, similar to what is being considered in the 28 GHz Band.

Once such a pfd limit is established, the band would be suitable not just for earth stations operating as aggregation and interconnection facilities for satellite networks, but also for

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36 *Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations*, Second Report and Order, 18 FCC Rcd 25428 ¶ 24 (2003) ("*V Band Second Report and Order*").

37 *See* 47 C.F.R. § 25.202(a)(1) n.15; *see also V Band Second Report and Order*, 25441-2 ¶¶ 32-33. The Commission restricted deployment in the 37.5-40 GHz band by stating that "Satellite earth station facilities in this band may not be ubiquitously deployed and may not be used to serve individual consumers." *Id.* 25442 ¶ 33 (citation omitted).

secondary uses by earth stations that serve end users. As proposed above for the 28 GHz Band, while certain essential earth station facilities should be afforded protection in the 37.5-40 GHz band, the spectrum could be used more intensively by allowing operation of a broader range of earth station facilities to operate on a secondary basis. Indeed, there would be no need to restrict deployment of user terminals on a secondary basis, because in this case, satellite earth station operators would need to avoid interference from terrestrial operations. The Commission has previously endorsed widely-deployed earth stations on a secondary, non-protected basis in this downlink direction, on the condition that the earth station operator accept the impact of any nearby terrestrial operation.[38] In other words, under this approach, there will be no impact to 5G from widely-deployed earth stations, and the earth station operator would be responsible for accepting the impact of terrestrial wireless operations.

In order to promote intensive use of the spectrum by enabling satellite earth station receive operations, ViaSat urges the establishment of parameters for 5G operations that would facilitate sharing by satellite earth stations. For instance, as discussed in the context of 28 GHz blanket licensed terminals above, maintaining a database of 5G base station locations would help earth station network operators avoid operations in the vicinity of those base stations.

VI. THE 64-71 GHZ BAND SHOULD BE DESIGNATED FOR UNLICENSED OPERATIONS AS A COMPLEMENT TO 57-64 GHZ

ViaSat supports the Commission's proposal to authorize operations in the 64-71 GHz band under Part 15 on an unlicensed basis, consistent with the rules currently applicable to the

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38 *EchoStar Satellite LLC Application for Authority to Construct, Launch and Operate a Geostationary Satellite Using the Extended Ku-band Frequencies in the Fixed-Satellite Service at the 109º W.L. Orbital Location*, Order and Authorization, 20 FCC Rcd 930, 934-935 ¶ 13 (2004) (authorizing earth station receive operations in bands on a non-protected basis).

adjacent 57-64 GHz band.[39] Unlicensed wireless broadband technologies comprise an important part of the broadband ecosystem, and will grow in importance as mobile broadband networks and applications continue to proliferate. Making a significant amount of spectrum available for unlicensed use offers an important balance to the geographic area licensing schemes for terrestrial services as proposed for other bands covered by this proceeding.

Moreover, ViaSat agrees that extending the existing Part 15 rules that apply to the 57-64 GHz frequency band to enable operation over 14 GHz of contiguous spectrum would facilitate higher speeds and greater throughput for next-generation Wi-Fi and Wi-Gig networks.[40] Specifically, ViaSat supports extending to the 64-71 GHz band the current limits for emissions and conducted transmitter output power, and the requirements for frequency stability and co-location of separately authorized transmitters.[41] ViaSat also urges the Commission to remove the publicly accessible coordination channel at 57-57.05 GHz and, if it opts to extend fixed field disturbance sensor operations into the 64-71 GHz band, subject such operations to the existing limitations in Section 15.255 on such operations in the 57-64 GHz band.[42] Likewise, eliminating the prohibition on operation of equipment used on aircraft in the 57-64 GHz band would promote the development of technology needed to allow operation of consumer devices on aircraft without causing harmful interference into radio astronomy operations.[43]

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39 *NPRM* ¶ 58.

40 *See id.* ¶ 303; 47 C.F.R. § 15.255.

41 *See NPRM* ¶¶ 304, 308, 313-15.

42 *See id.* ¶¶ 307, 312.

43 *See id.* ¶ 306.

VII. CONCLUSION

ViaSat urges the Commission to recognize the important role of satellite technologies in the nation's communications infrastructure and to develop a regulatory framework in this proceeding that ensures meaningful opportunities for continued deployment and growth of satellite broadband services in particular.

Specifically, as the Commission considers revising the regulatory framework that has governed the 28 GHz Band for twenty years to allow new terrestrial mobile operations, ViaSat urges the Commission to protect the continued operation and deployment of essential satellite network operations that have been developed in reliance on the longstanding 28 GHz Band Plan. With proper planning on both sides, ViaSat's existing and future satellite networks should be able to coexist with the contemplated terrestrial mobile uses. Moreover, new sharing technologies also will allow satellite user terminals to operate in the 28 GHz Band on a secondary basis and without impeding mobile wireless deployment.

ViaSat urges the Commission to adopt a sharing framework for the 37.5-40 GHz band that allows satellite networks to make effective use of this spectrum resource for the growth and expansion of satellite broadband networks. In particular, increasing the power limits for space-to-earth transmissions could allow satellite operators to use this spectrum more effectively without impacting terrestrial users. Moreover, the operating environment in this band is conducive to flexible use by any type of satellite earth station, even user terminals, which also can operate on a secondary basis without impacting terrestrial operations.

Finally, ViaSat supports the Commission's proposal to authorize unlicensed wireless operations under Part 15 of the Commission's rules in the 64-71 GHz band to complement such operations in the adjacent 57-64 GHz band.

Respectfully submitted,

/s/

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Exhibit 1: Compatibility Analysis

This exhibit discusses the calculation of compatibility zones for ViaSat earth stations and 5G networks in the 27.5-28.35 GHz band based on the FCC's proposed boundary field strength limit of 47 dBμV/m.[44]

While a reference bandwidth was not specifically provided in the NPRM, the text does reference Part 27 rules, which references a channel bandwidth of 5.5 MHz. In this analysis the 47 dBμV/m value has been scaled accordingly to 39.6 dBμV/m to reflect the field strength in any one MHz bandwidth.

At mm wavelength frequencies, power flux density (PFD) in W/m^2 is a more common metric than field strength in V/m, so in the following tables the boundary limit has been converted to a flux density by using the formula:

$$FD = \frac{E^2}{120\pi} \quad (1)$$

where E is the field strength in V/m and FD is in W/m^2. Because the field strength is given in dBμV/m, the value is first converted from dB form to linear form while adding a correction factor of 120 to convert from μV to V.

$$\frac{V}{m} = 10^{\frac{39.6-120}{20}} = 9.5455 \times 10^{-5}\ \frac{V}{m} \quad (2)$$

The power flux density is then:

$$PFD = \frac{9.5433\times10^{-5^2}}{120\pi} = 2.4172 \times 10^{-10}\ \frac{W}{m^2} \quad (3)$$

Or in dB form:

$$10 \times \log 2.4172 \times 10^{-11} = -106.1669\ dB\left(\frac{W}{m^2}\right) \text{ per MHz} \quad (4)$$

ViaSat is currently licensed to provide service to the United States using three spacecraft that operate in a portion of the 27.5 – 28.35 GHz band. ViaSat also is licensed to operate earth stations that provide aggregation and interconnection facilities for the various spot beams of the ViaSat-1 satellite. These stations currently utilize 7.3 m class antennas. The next-generation satellite design has higher performance and is capable of operating with aggregation and interconnection facilities (AIF) that employ smaller antennas, and similarly, the recently

[44] NPRM para 289

announced third-generation high capacity satellite design will be able to operate using even smaller antennas for its AIFs.
Ultimately, the critical metric in determining the distance needed to meet a given PFD is the equivalent isotropically radiated power (e.i.r.p.) in the direction of the horizon in a given unit of bandwidth – the e.i.r.p. density. The antenna size, power output, and modulated bandwidth of the facility are all elements which may be individually adjusted to produce a given e.i.r.p. density in the direction of the horizon.

A larger antenna may have greater gain reduction in the direction of the horizon, but a smaller antenna using more power but transmitting over a wider bandwidth may produce a lower e.i.r.p. density.

Smaller antenna facilities are often more easily screened by nearby buildings or by RF fencing designed to block energy in the direction of an unintended receiver.

The PFD generated by an earth station at some distance may be calculated by dividing the e.i.r.p. density toward the horizon from the earth station by the spreading out of energy in free space according to the following formula:

$$PFD = \frac{e.i.r.p.}{4\pi d^2} \quad (5)$$

Alternatively, the required distance can be calculated by dividing the e.i.r.p. toward the horizon by any expected mitigating losses such as blockage from nearby buildings, RF screening fences, etc. and then by the power flux density limit and then adjusting the equation above.

$$d = \sqrt{\frac{e.i.r.p.}{PFD \times losses \times 4\pi}} \quad (6)$$

In the following table, while only the e.i.r.p. density toward the horizon is provided for the given earth station facilities, it can be assumed that the antenna size requirements for the newer generation high capacity satellites will be progressively smaller and more effectively mitigated with respect to RF shielding.

Facility Type	Units	VS-1 AIF	VS-2 AIF	VS-3 AIF
Density toward horizon	dB(W/MHz)	-37.5	-41.4	-31.0
Other attenuation	dB	10.0	10.0	20.0
Boundary limit in flux density	dB(W/(m^2/MHz))	-106.2	-106.2	-106.2
Compatibility distance	m	241.7	154.3	161.0

Table 1: Distance to Boundary Limit for Aggregation and Interconnection Facilities

DECLARATION

I, Daryl T. Hunter, hereby make the following declarations under penalty of perjury. I understand that this Declaration will be submitted to the Federal Communications Commission.

1. I am Senior Director, Regulatory Affairs of ViaSat, Inc.

2. I have reviewed the foregoing Comments of ViaSat, Inc., and the information contained therein is true and correct to the best of my knowledge, information and belief.

Daryl T. Hunter, P.E.

Executed January 28, 2016