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July 7, 2016

VIA ELECTRONIC FILING

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, NW
Washington, D.C. 20554

Re: ViaSat, Inc., GN Docket No. 14-177; IB Docket Nos. 15-256 & 97-95; RM-11664; and WT Docket No. 10-112

Dear Ms. Dortch:

In this proceeding, ViaSat, Inc. ("ViaSat") has advocated that the Commission ensure continued satellite operations in the bands under consideration while advancing sharing with terrestrial services by addressing the following four critical issues at its July 14 meeting:

- Protecting satellite receivers from interference caused by aggregate mobile wireless emissions toward the orbital arc from the 27.5-28.35 GHz band ("28 GHz Band");

- Allowing the co-primary deployment of "gateway-type" earth stations associated with already-authorized 28 GHz satellite networks;

- Adopting a reasonable and consistent framework for the deployment of additional individually-licensed earth stations on a co-primary basis in the 28 GHz and 37/39 GHz bands; and

- Allowing the deployment of blanket-licensed satellite user terminals on a secondary, non-interference basis in the 28 GHz and 37/39 GHz bands by employing Commission-proposed sharing techniques.

ViaSat emphasizes the critical need for the regulatory framework adopted in this proceeding to address each of these issues to facilitate continued the deployment and development of satellite broadband network technology that has enabled greater broadband competition to terrestrial services for the benefit of residential and enterprise users, as well as anchor institutions, and the extension of WiFi access to broadband on board aircraft. Important considerations related to each of these issues are detailed in the following sections of this letter.

I. PROTECTING 28 GHZ SATELLITE RECEIVERS

In its recent ex parte, ViaSat provided a number of reasons why the simulations on which 5G proponents rely do not form a sound basis for introducing mobile wireless uses into the 28 GHz Band, or concluding that the introduction of mobile services does not pose an interference threat into 28 GHz Band satellite receivers.[1]

ViaSat explained that one of the use cases described in the simulations involves a 5G base station pointed upward, toward the top floor or roof of a building, which could occur when a 5G operator is trying to serve mobile users inside or on top of that building. ViaSat also explained that such uses, as well as any other 5G uses that generate unwanted energy toward the orbital arc, pose a risk of both co-channel interference and adjacent channel interference into satellite receivers.[2] That is, the 5G uses could generate (i) interference into satellite receivers operating in the 28 GHz band (27.5-28.35 GHz), as well as (ii) interference into satellite receivers operating in the adjacent 28.35-28.6 GHz band. The 28 GHz band is allocated for satellite use on a co-primary basis, and is designated for licensing to satellite with priority over new mobile uses.[3] The adjacent part of the Ka band is both allocated for satellite use and licensed *on a primary basis* to satellite with priority over all other terrestrial uses.[4]

Thus, this use case presents interference into an undoubtedly primary satellite service. As detailed below, even a modest number of 5G base stations operating under this use case pose a threat of harmful interference to 28 GHz satellite receivers.

The following interference analysis focuses on the 5G use case assumed in the simulation submitted by wireless industry parties, involving a base station intentionally pointed up, toward the upper floors/roof of a nearby building that is 25 meters tall.[5]

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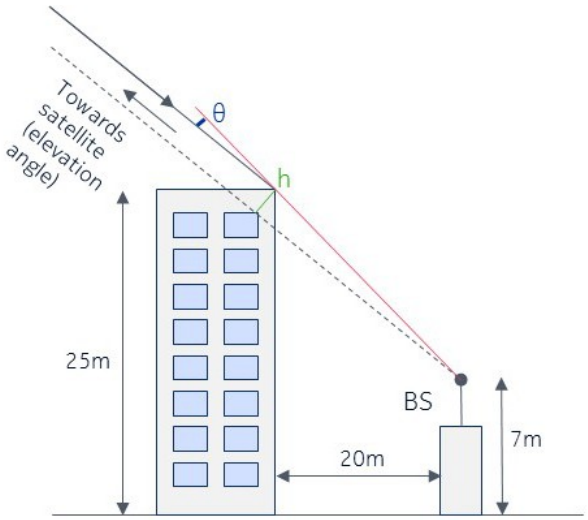
[1] Letter from ViaSat, Inc., to Chairman & Commissioners, FCC, *Ex Parte* Submission, Legal Status of Fixed Satellite Service in the 28 GHz Band; GN Docket No. 14-177; et al., at 18-22 & Exhibit 1 (July 1, 2016) ("ViaSat July 1 Letter").

[2] *Id.* at 20-21.

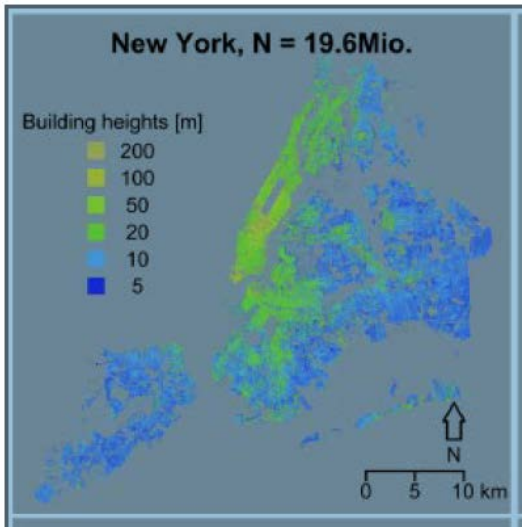
[3] *See* 47 C.F.R. § 2.106; *Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services*, First Report and Order, 11 FCC Rcd 19005 ¶¶ 42, 44 (1996) ("*28 GHz First Report and Order*") (establishing domestic licensing priority for FSS in the 28 GHz band "vis-a-vis any third service allocated domestically or internationally in the band").

[4] 47 C.F.R. § 2.106; *id.* § 25.202(a)(1) n.4; *28 GHz First Report and Order* ¶ 57.

[5] Letter from AT&T Services Inc., Ericsson, Nokia, Samsung Electronics America, T-Mobile USA, Inc., and Verizon to Secretary, FCC, GN Docket No. 14-177, *et al.*, at Exhibit A-2 (filed June 1, 2016) ("5G June 1 Letter"); AT&T Services Inc., Ericsson, Nokia, Samsung Electronics



In any given urban area, it is reasonable to assume that this use case could exist in at least a few dozen locations, if not more. Take the New York City metropolitan area, by way of example, which includes Manhattan, Brooklyn, Jersey City, Newark, Hoboken, West New York, and the other nearby urban areas that have buildings of this height.[6]



Take the relevant characteristics of a typical ViaSat Third Generation beam, which covers an area of approximately 31,000 square km, and is centered on the New York City

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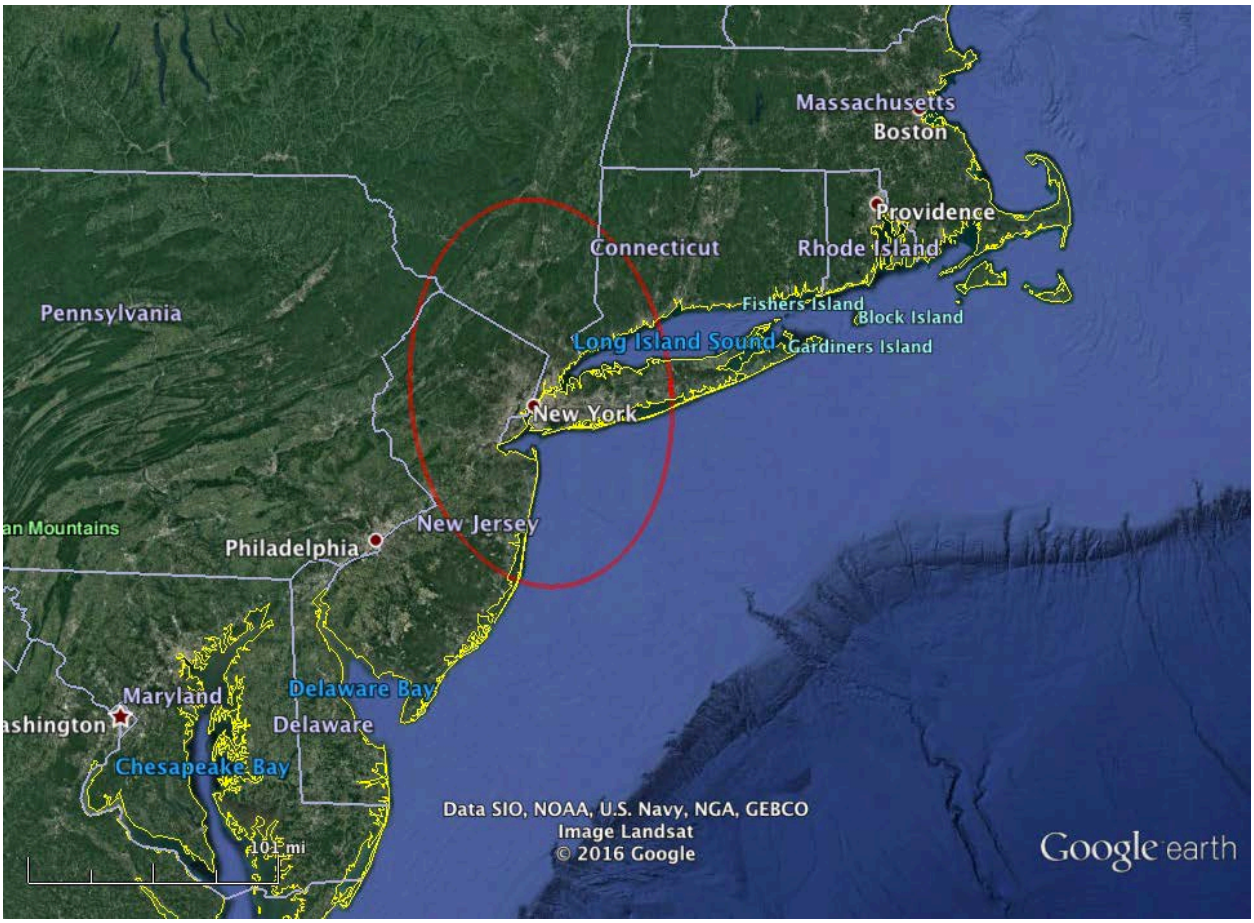
America, T-Mobile USA, Inc., and Verizon, Erratum to June 1, 2016 filing with missing pages, GN Docket No. 14-177 (filed July 5, 2016) ("5G July 5 Erratum").

[6] *See* Markus Schläpfer, Joey Lee, & Luís M. A. Bettencourt, *Urban Skylines: Building Heights and Shapes as Measures of City Size* 15 (Santa Fe Inst., Working Paper No. 2015-12-045, 2015), http://www.santafe.edu/media/workingpapers/15-12-045.pdf.

metropolitan area.[7] This type of beam would include the areas describe above, as well as many other neighboring areas.



Now assume that just thirty 5G transmitters of the type described above are deployed in this area. And, for this illustration, ignore the impact from all other 5G user terminals and base stations in this area, which would add to the resulting interference into 28 GHz satellite receivers, but factor in the impact of the relaxed out-of-band emissions mask that Qualcomm seeks.[8]

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[7] *See* Letter from ViaSat, Inc. to Secretary, FCC, GN Docket No. 14-177, *et al.*, Attachment 1 at 1 (filed Apr. 21, 2016) ("ViaSat April 21 Letter") (providing salient ViaSat Third Generation technical characteristics).

[8] *See* Letter from Qualcomm to Secretary, FCC, GN Docket No. 14-177, *et al.*, at 2 (filed May 9, 2016).

As the worksheet included in Exhibit 1 demonstrates,[9] these thirty 5G transmitters alone would cause 14 dB of interference into the ViaSat-3 receiver in the case of co-channel transmissions, and 5.3 dB in the case of adjacent channel transmissions. This would result in a 13.8 dB I/N in the co-channel case, and a 3.8 dB I/N in the adjacent channel case.[10]

Stated another way, *the level of co-channel interference from these thirty 5G transmitters is 39,711% greater than the -12.2 dB I/N level to which the Commission previously protected satellite networks from commercial mobile wireless services in an adjacent channel case,*[11] *and from other terrestrial services in a co-channel case.*[12] *The level of adjacent channel interference from these thirty 5G transmitters is 3,790% greater than that same protection level.* And both types of interference occur at levels that far exceed the 0 dB I/N that even 5G proponents suggested as a level of "acceptable" harm[13] that would never be expected under any reasonable 5G deployment.[14]

More critically, and as evidenced by the illustrative link budgets contained in Exhibit 1 for three different satellite-based broadband services, the satellite service links would not close

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[9] Exhibit 1, §1. Prior criticism of ViaSat's illustrative analysis regarding 5G user terminals, *see* 5G June 1 Letter at 3-5, is irrelevant to the base station scenario depicted here. Among other things, and as previously explained, that illustrative user terminal analysis was done in the complete absence of any data about 5G base stations at the time, but was based on the other information that had been selectively provided by 5G advocates during purported "sharing" discussions. *See* ViaSat April 21 Letter, Attachment 1 at 3; *see also* ViaSat July 1 Letter at 2-5.

[10] The analysis in Section 1 of Exhibit 1 calculates the I/N at the satellite receiver generated by the specified 5G base station operations. The analyses in Sections 2 and 3 of Exhibit 1 use those "I" and "N" values for purposes of calculating C/N and C/I values, and thus quantifying the resulting degradation to the satellite services in the link budgets. Sections 4 and 5 of Exhibit 1 provide "baseline" satellite service link budgets that do not account for the additional I/N generated by 5G.

[11] *See Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands*, Report and Order, FCC 03-15, 18 FCC Rcd 1962, Appendix C2 at §§ 1.14, 2.1.2 (2003) ("*L-Band ATC Report and Order*"); *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands*, Memorandum Opinion and Order and Second Order on Reconsideration, FCC 05-30, 20 FCC Rcd 4616 ¶ 43 (2005) ("*L-Band ATC Second Reconsideration Order*").

[12] *See Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Order on Reconsideration and Second Report and Order, 31 FCC Rcd 5011 ¶ 265 (2016) ("*3.5 GHz Second Report and Order*").

[13] Letter from AT&T Services Inc., Nokia, Samsung Electronics America, T-Mobile USA, Inc., and Verizon to Secretary, FCC, GN Docket No. 14-177, *et al.*, Ex. 2 at 16, 21-24 (filed May 12, 2016).

[14] *See id.; see also* 5G June 1 Letter; 5G July 5 Erratum.

in the presence of this level of interference.[15] This is the case whether the interference is generated into satellite receivers operating in the 28 GHz Band (co-channel interference),[16] or whether the interference is generated into satellite receivers operating in the adjacent 28.35-28.6 GHz band designated for satellite on a primary basis (adjacent channel interference).[17] In other words, the intended satellite service could not be provided, as it would be seriously degraded, obstructed or interrupted. The satellite service would suffer demonstrably harmful interference in this scenario, which, as noted above, ignores the interference generated by all other 5G user terminals and base stations in this area—interference that would exacerbate the situation.[18]

This is precisely why ViaSat and the rest of the satellite industry have been urging the Commission to adopt suitable constraints to prevent this situation from ever happening,[19] *as the Commission has done in the past when introducing new terrestrial services into bands that already were being used to provide critical satellite services.*[20]

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[15] These link budgets are illustrative and expressly are not exhaustive of every contemplated satellite service. For example, they do not address uses cases involving small aperture antennas used for mobile applications, that are uplink limited and that operate very close to the satellite receiver noise floor.

[16] *See* Exhibit 1, §2.

[17] *See id.*, §3.

[18] This analysis soundly rebuts the prior mistaken 5G claims about the level of interference into satellite receivers, *see, e.g.*, Letter from AT&T Services Inc., Nokia, Samsung Electronics America, T-Mobile USA, Inc., and Verizon to Secretary, FCC, GN Docket No. 14-177, *et al.*, at 2-3 (filed May 6, 2016), which are based on a series of unsubstantiated assumptions, *see* ViaSat July 1 Letter at 18-22, and which are not based on the salient ViaSat Third Generation characteristics used here.

[19] *See, e.g.*, ViaSat April 21 Letter at 2-3; Letter from ViaSat to Secretary, FCC, GN Docket No. 14-177, *et al.*, at 2 (filed June 20, 2016); Letter from EchoStar Satellite Operating Corporation, Hughes Network Systems, LLC and Alta Wireless, Inc., OneWeb, Ltd., O3b Limited, ViaSat, Inmarsat Mobile Networks, Inc., and SES Americom, Inc. to Secretary, FCC, GN Docket No. 14-177, *et al.*, Attachment at 5 (filed June 9, 2016) (proposing the adoption of an aggregate skyward emission envelope for mobile services or alternatively adopting rules regarding mobile network parameters such as antenna downtilt, power control, off-axis EIRP, and side-lobe suppression).

[20] *See, e.g.*, *L-Band ATC Report and Order* ¶ 167 (imposing limits on the number and power levels of terrestrial stations to constrain aggregate interference into satellite receivers); *L-Band ATC Second Reconsideration Order* ¶¶ 41-47 (changing to a simplified, aggregate interference limit from terrestrial transmitters, to protect satellite receivers); *3.5 GHz Second Report and Order* ¶ 240 (establishing parameters for protection of satellite earth station receivers from terrestrial transmitters).

II. ENABLING DEPLOYMENT OF GATEWAY-TYPE EARTH STATIONS FOR COMMISSION-AUTHORIZED 28 GHZ SATELLITES

ViaSat urges the Commission to ensure that the Order in this proceeding allows the already-planned deployment of "gateway-type" earth station facilities for 28 GHz satellite networks that the Commission has already authorized, and regardless of the restrictions under any "one-per-county" rules that generally may apply to 28 GHz earth station deployment going forward. The Commission authorized the ViaSat-2 and ViaSat-3 networks in December 2013 and June 2014, respectively—years before the inception of the Spectrum Frontiers NPRM.[21] ViaSat has invested and committed billions of dollars on these 28 GHz networks (and on ViaSat-1, which also operates at 28 GHz Band) in reliance on these authorizations and the 20-year old band plan for the 28 GHz Band. Notably, the process by which the Commission granted those authorizations is open to all types of applicants, including incumbent terrestrial broadband providers.

These Commission authorizations require that ViaSat-2 and ViaSat-3 be launched and brought into operation by 2017 and 2019, respectively, with compliance with that deadline secured by $6 million in performance bonds that ViaSat has posted, and that would be forfeited if this deadline is not met. Bringing the satellites into operation requires the deployment and operation of "gateway-type" earth stations that aggregate customer traffic and provide interconnection to the Internet, requiring huge fiber connectivity (*e.g.*, 10-100 Gbps). However, it is not possible to seek Commission licenses for these earth stations (which are specific to ViaSat-2 and ViaSat-3) more than approximately one year before the associated satellite is launched. The reason is that Commission rules require that a licensed earth station be brought into operation in accordance with its authorized parameters within one year of grant.[22] And while the required location of an earth station may be established early on, many of the relevant operating parameters specified in the license application often are not fully established until much later in the long development period for a satellite network. If an earth station is not certified as having been brought into operation in time, its license will be cancelled for failure to comply with the license terms. Therefore, the filing of a gateway earth station application must coincide with the date that is about one year before the expected launch and operation of the satellite with which it will communicate. And, by that time, the associated satellite has been almost fully constructed, launch arrangements have been made, and hundreds of millions of dollars have been invested in the network.

ViaSat-2 is almost completely constructed. Based on ViaSat-2's scheduled commencement of commercial service in mid-2017, ViaSat filed thirty-six gateway-type earth station applications for ViaSat-2 earlier this year, which request, among other things, a license to operate at 28 GHz. The locations and application file numbers of those earth stations are listed in Exhibit 2. The locations cannot be changed. Those earth stations are a critical part of

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[21] ViaSat-2 a/k/a ViaSat 70º W.L., Stamp Grant, IBFS File No. SAT-LOI-20130319-00040 (Dec. 12, 2013); ViaSat-3 a/k/a ViaSat-KA 89º W.L., Stamp Grant, IBFS File Nos. SAT-LOI-20140204-00013, SAT-AMD-20140218-00023 (June 18, 2014).

[22] *See* 47 C.F.R. § 25.133(a)(1).

enabling ViaSat-2 to provide approximately double the capability of ViaSat's first-generation broadband satellite, and offer broadband service at speeds of up to 100 Mbps, transforming the broadband ecosystem for millions of Americans.

ViaSat-3 is under construction, with an expected launch in 2019. As ViaSat has previously explained, ViaSat's third-generation satellites will be capable of providing over 1 Terabyte per second of total throughput, each having the capacity of all 400 commercial satellites currently in orbit or under construction, and will support broadband of up to 1 Gbps, rivaling the best fiber connections available in the country. These third-generation satellite networks utilize hundreds of gateway-type earth stations to enable this level of service, just as terrestrial services require additional and smaller cell sites to extend service and increase network capacity.[23] These earth stations will be significantly smaller than traditional gateway earth stations.[24] ViaSat's smaller earth stations operate at lower power levels and can fit in urban areas, where fiber connectivity is readily available at reasonable cost, without impeding mobile wireless deployment. ViaSat's testing has confirmed that this type of earth station, when located on the top of a two-story building, generated no measurable RF emissions on the ground or anywhere near the building. Thus, there is no realistic threat of interference to 5G operations. While it is a critical part of the ViaSat network that the ViaSat-3 gateway-type facilities be deployed as planned, it is not practical to file the requisite earth station applications before the expected release of an Order in this proceeding.

For these reasons, CTIA's recent suggestion that the timing of the ViaSat-2 earth station applications was driven by this proceeding demonstrates CTIA's lack of understanding of the Commission's rules and the practical realities of satellite network deployment.[25] The number of ViaSat-2 earth station applications is driven by the Commission-authorized design of that satellite, and nothing more.[26]

III. DEPLOYMENT OF 28 GHZ AND 37/39 GHZ SATELLITE USER TERMINALS ON A SECONDARY, NON-INTERFERENCE BASIS

With much of the recent advocacy having focused of the first three issues identified above, ViaSat urges the Commission to also address the fourth critical issue: allowing the deployment of blanket-licensed satellite user terminals on a secondary, non-interference basis in the 28 GHz and 37/39 GHz bands. The Commission can do so by adopting Section 30.205, as

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[23] Comments of ViaSat, Inc., GN Docket No. 14-177, *et al.* at 5 (filed Jan. 28, 2016) ("ViaSat Comments").

[24] ViaSat Notice of *Ex Parte* Presentation re: Meeting with Commissioner O'Rielly, GN Docket No. 14-177, *et al.*, Attachment at 3 (July 5, 2016) (illustrating the small size of ViaSat latest gateway-type earth stations).

[25] *See* Letter from CTIA to Secretary, FCC, GN Docket No. 14-177, et al., at 2 (filed July 5, 2016) (noting the number of 28 GHz Band satellite network filings since the adoption of the Spectrum Frontiers NPRM).

[26] *Cf. id.* at n.4.

proposed in the Notice of Proposed Rulemaking,[27] thus ensuring the availability of information that would allow blanket-licensed satellite user terminals to operate, on a secondary, non-interference basis, where, when, and as, 5G use of the same spectrum is not occurring.[28]

Critically, the information sharing requirements in proposed Section 30.205 include the salient technical information regarding mobile wireless operations that would be required to enable satellite operators to "work around" mobile wireless deployment and to use otherwise underused spectrum without causing harmful interference.

For these reasons, ViaSat urges the Commission to adopt proposed Section 30.205 and also provide in its July 14 decision for blanket-licensed satellite user terminals to be licensed on a secondary, non-interference basis and to (i) transmit in the 28 GHz Band on the condition that they not cause harmful interference into 5G operations, and (ii) receive in the 37/39 band without claiming interference protection from 5G operations. No additional rules beyond those proposed in new Section 30.205 should be required to enable such sharing.

IV. FRAMEWORK FOR LICENSING ADDITIONAL INDIVIDUALLY-LICENSED 28 GHZ AND 37/39 GHZ EARTH STATIONS

In addition to accommodating the gateway-type earth stations of authorized 28 GHz satellite networks, ViaSat has urged the Commission to facilitate the deployment of other individually-licensed 28 GHz and 37/39 GHz earth stations (including for future satellite networks) on a co-primary, protected basis vis-a-vis new mobile wireless services. If the Commission adopts rules that limit such additional, protected earth station deployment to one location per county, ViaSat urges the Commission not to adopt the type of co-location requirements proposed by EchoStar Satellite Operating Corporation, Hughes Network Systems, LLC, and Alta Wireless, Inc. (collectively, "EchoStar").

In particular, EchoStar urges:

> "To the extent the FCC limits the number of FSS earth station sites in a UMFU license area by requiring FSS satellite operators to share a single location in a terrestrial license area, the FCC must adopt minimal requirements to ensure that sharing of these sites among operators is feasible."[29]

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[27] *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, GN Docket No. 14-177, *et al.*, Notice of Proposed Rulemaking, FCC 15-138 ¶ 147 & Appendix A, § 30.205. (rel. Oct. 23, 2015).

[28] *See* ViaSat Comments at 18; Reply Comments of ViaSat, GN Docket No. 14-177, *et al.* at 15 (filed Feb. 26, 2016); ViaSat April 21 Letter at 4.

[29] Letter from EchoStar to Secretary, FCC, Requirements for a Successful Sharing Regime Between the UMFU and Individually Licensed Earth Stations; *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services, et al.*, GN Docket No. 14-177, *et al.*, at 1 (June 27, 2016) ("EchoStar June 27 Letter").

EchoStar suggests that the Commission do so by (i) requiring that the first earth station licensee at that location acquire sufficient real estate to accommodate additional satellite operators in the future, and (ii) prohibiting the first earth station licensee from "acting in a manner that limits the use of this facility by other FSS operators."[30]

First and foremost, EchoStar's proposal raises serious constitutional issues. As the United States Court of Appeals for the D.C. Circuit has held, mandating physical colocation of competitors can violate the Fifth Amendment's prohibition on takings without just compensation.[31]

Even if there were not a constitutional barrier to EchoStar's proposal, the proposal is unworkable because it is not reasonable to expect that co-location generally would occur as a business matter. EchoStar itself previously recognized this fact:

- "[E]arth station siting is driven by factors that are unique to each operator, including satellite design, network design, or customer requirements;"
- "[T]here is no basis for assuming that co-location of 28 GHz FSS earth stations would be a practical option in most cases;" and
- "Mandating that earth stations be co-located and placed in pre-designated areas that bear no relation to technical or customer needs will severely undermine the satellite industry's ability to serve the Commission's broadband connectivity objectives."[32]

EchoStar is correct in explaining that co-locating earth stations of different satellite networks cannot be assumed to be a "default" solution, even when the different networks are controlled by the same company. Thus, EchoStar's co-location proposal would fail to accommodate the varying business needs of different satellite networks, and it also would threaten to undermine other important Commission policies.

Even if mandating co-location somehow could accommodate the business needs of multiple satellite networks, EchoStar's proposal would not work as a practical matter. Among other things, different earth station types have different physical and operational requirements. For example, the types of small gateway-type earth stations that ViaSat plans to use for its next-

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[30] *Id.*

[31] *See Bell Atlantic Telephone Companies v. FCC*, 24 F.3d 1441 (D.C. Cir. 1994) (vacating requirement for LECs to provide physical co-location for competitive access providers as a violation of the Takings Clause).

[32] Letter from EchoStar and others to Secretary, FCC, GN Docket No. 14-177, *et al.*, at 2 (June 10, 2016).

generation networks[33] have very small footprints, may be subject to zoning preemption,[34] do not require in-ground foundations, do not present aesthetic concerns, and thus are able to be located in places (like on the roof of a small building) where it simply is not physically possible to co-locate the much larger gateway-type facilities used by other satellite operators.[35] Thus, any requirement that the operator of a small earth station obtain enough real estate to support the much larger facilities of all other satellite networks would effectively negate the significant benefits of using the smaller earth station (lower cost, easier to obtain real estate rights, simpler to deploy, etc.).

Moreover, EchoStar's proposal threatens to make 28 GHz earth station deployment *less compatible* with 5G deployment. By way of example, and as explained above, ViaSat's testing has confirmed that when one of its new 28 GHz gateway-type earth stations is located on the top of a building, there are no measurable RF emissions on the ground anywhere near the building; thus, there is no threat of interference to 5G operations. The same would not be true if certain types of larger gateway earth stations (which have large RF incompatibility zones[36]) were operating alongside that ViaSat earth station on a co-located basis.

Finally, different earth stations have different terrestrial backhaul requirements, and the backhaul capabilities at a given location that are available or are constructed to accommodate the needs of one earth station operator likely will not accommodate the backhaul requirements of all other satellite networks in the future.

For these and other reasons, it also incorrect (as EchoStar asserts) that requiring, or even encouraging, the co-location of 37/39 GHz earth stations at 28 GHz earth station sites necessarily would be "most efficient" or "enable FSS operators to capture operational synergies."[37]

In any event, EchoStar's proposal is impermissibly vague and would offer no meaningful guidance about how an earth station licensee would comply with such a requirement. Namely, an earth station operator would not know in advance what type and amount of real estate and telecommunication infrastructure would be needed to support co-location of an indeterminate

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[33] ViaSat Notice of *Ex Parte* Presentation re: Meeting with Commissioner O'Rielly, GN Docket No. 14-177, *et al.*, Attachment at 3 (July 5, 2016) (illustrating the small size of ViaSat latest gateway-type earth stations).

[34] *See* 47 C.F.R. § 25.104.

[35] *See, e.g.*, *Inmarsat Mobile Networks, Inc.*, 30 FCC Rcd 2770 ¶ 12 (2015) (authorizing 13.2 meter diameter earth station, Call Sign E120072); O3B Limited, Call Sign E100088, File Nos. SES-LIC-20100723-00952, SES-MOD-20140814-00652 (Jan 22, 2015) (authorizing 7.3 meter diameter earth station); HNS License Sub, LLC, Call Sign E150076, File No. SES-LIC-20150604-00332 (Dec. 7, 2015) (authorizing 9.2 meter diameter earth station).

[36] *See, e.g.*, Letter from SES Americom, Inc. to Secretary, FCC, GN Docket No. 14-177, Attachment 2 at 2 (filed May 5, 2016).

[37] EchoStar June 27 Letter at 2.

number of other satellite networks, using earth stations of varying size, with different data throughput requirements, and possibly operating in additional frequency bands in the future.

In sum, EchoStar's proposal to mandate the co-location of earth stations in certain instances would impose significant restrictions on EchoStar's competitors, but would not accommodate the varying business needs of different satellite networks. EchoStar's proposal would not be good policy and, more fundamentally would not be sustainable as a matter of law.

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Please contact the undersigned if you have any questions.

Respectfully submitted,

/s/
John P. Janka
Elizabeth R. Park

Exhibits

cc:
Chairman Tom Wheeler
Commissioner Mignon Clyburn
Commissioner Jessica Rosenworcel
Commissioner Ajit Pai
Commissioner Michael O'Rielly

Legal Advisors
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Nancy Zaczek
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IB
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Robert Nelson
Jose Albuquerque
Chip Fleming
Kal Krautkramer

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Jonathan Sallet

EXHIBIT 1

5G Base Station Interference Into 28 GHz Satellite Receivers

EXHIBIT 1
Section 1
Aggregate Interference Worksheet

Frequency	28250	MHz
Lambda	0.01062	m
Meter square area gain	50.470	dB/(m^2)
	Satellite Receiver Protection Values	
Satellite	VS 3rd Gen	
Total receiving noise temperature	650.0	K
Noise floor (No) at receiver input	-200.472	dBW/Hz
Delta T/T protection criteria	6	%
Equivalent I/N	-12.218	dB
Max interference (Io) at input to meet prot criteria	-212.691	dBW/Hz
Satellite antenna gain	61	dBi
Interference density (Io) at antenna input	-273.691	dBW/Hz
Meter square area gain	50.470	dB/(m^2)
Equivalent power flux density at GSO	-163.221	dBW/(m^2*MHz)
Spreading loss	162.636	dB(m^2)
Equivalent EIRP density at ground level	-0.585	dBW/MHz
	Base Stations Pointing toward Upper Floor/Roof and Aligned with GSO	
Transmitters operating co-frequency in beam	30	
Individual 5G transmitter on-axis EIRP density	68	dBm/100 MHz
Individual 5G transmitter on-axis EIRP density	-42	dBW/Hz
Off-axis gain reduction toward GSO	3	dB
Aggregate 5G EIRP density to GSO in beam area	-30.229	dBW/Hz
	Co-channel 5G Impact To Satellite Receiver (28 GHz)	
Atmospheric losses	1.3	dB
Spreading loss	162.636	dB(m^2)
Equivalent power flux density at GSO	-194.165	dBW/(m^2*Hz)
Interference density (Io) at antenna input	-244.635	dBW/Hz
Linear to circular polarization loss	3	dB
Interference density (Io) at receiver input	-186.635	dBW/Hz
Equivalent I/N from co-channel transmissions	13.837	dB
Delta T/T from co-channel transmissions	2419.568	%
Satellite receiver (28 GHz) noise increase from co-channel transmissions	14.013	dB
	Adjacent Channel 5G Impact To Satellite Receiver (28.35 GHz)	
Scenario A - Current Part 101.111 Rules		
Reduction at band edge required by Part 101.111	31	dB for a 100 MHz channel
Equivalent I/N (28.35 GHz) from adjacent-channel transmissions	-17.163	dB
Delta T/T from adjacent-channel transmissions	1.9219	%
Satellite receiver (28.35 GHz) noise increase from adjacent-channel transmissions	0.0827	dB
Scenario B - Proposed Qualcomm OOBE Limits		
Proposed OOB reduction at band edge per Qualcomm May 9 ex parte	10	dB
Equivalent I/N from adjacent-channel transmissions	3.837	dB
Delta T/T from adjacent-channel transmissions	241.9568	%
Satellite receiver (28.35 GHz) noise increase from adjacent-channel transmissions	5.3397	dB

EXHIBIT 1
Section 2
Co-Channel Interference

Co-Channel Interference to 20M0G7D Link

General:	**Units**	**Clear Sky**	**Rain Faded**
Emission Designator		20M0G7D	20M0G7D
Data Rate	kbit/s	45000.0	45000.0
Modulation		8-PSK	8-PSK
Coding Rate		0.7500	0.7500
Carrier Bandwidth	kHz	20000	20000
Uplink Frequency	GHz	28.10	28.10
Downlink Frequency	GHz	18.30	18.30
Uplink:			
Tx E/S Antenna Diameter	m	0.75	0.75
Tx E/S Power to Antenna	W	2.8	2.8
Tx E/S Antenna Gain	dBi	44.4	44.4
Tx E/S EIRP per Carrier	dBW	48.8	48.8
Tx E/S Antenna Pointing Loss	dB	0.5	0.5
Atmospheric and Rain Losses	dB	1.3	4.1
Free Space Loss	dB	213.6	213.6
G/T toward Tx E/S	dB/K	32.9	32.9
C/I - Intra-system	dB	19.3	19.3
Downlink:			
EIRP per Carrier towards Rx E/S	dBW	39.2	37.1
Atmospheric and Rain Losses	dB	0.9	3.7
Free Space Loss	dB	209.9	209.9
Rx E/S Antenna Pointing Loss	dB	0.6	0.6
Rx E/S Antenna Diameter	m	7.3	7.3
Rx E/S Antenna Gain	dBi	61.5	61.5
Rx E/S G/T	dB/K	38.0	36.6
System Noise Temp (LNA+Sky)	K	250	349
C/I - Intra-system	dB	18.7	18.7
End-to-End:			
C/N - Thermal Uplink	dB	18.37	15.57
C/I Up - ASI (adjacent satellite interference)	dB	16.47	13.67
C/I Up - 5G	dB	4.50	1.70
C/N - Thermal Downlink	dB	17.89	11.54
C/I Down - ASI (adjacent satellite interference)	dB	28.00	28.00
C/(N+I) - Total Actual	dB	3.62	0.74
C/N - Required	dB	10.12	10.12
Margin	dB	-6.50	-9.38

Co-Channel Interference to 10M0G7D Link

General:	Units	Clear Sky	Rain Faded
Emission Designator		10M0G7D	10M0G7D
Data Rate	kbit/s	22500.0	22500.0
Modulation		8-PSK	8-PSK
Coding Rate		0.7500	0.7500
Carrier Bandwidth	kHz	10000	10000
Uplink Frequency	GHz	28.10	28.10
Downlink Frequency	GHz	18.30	18.30
Uplink:			
Tx E/S Antenna Diameter	m	0.75	0.75
Tx E/S Power to Antenna	W	2.8	2.8
Tx E/S Antenna Gain	dBi	44.4	44.4
Tx E/S EIRP per Carrier	dBW	48.8	48.8
Tx E/S Antenna Pointing Loss	dB	0.5	0.5
Atmospheric and Rain Losses	dB	1.3	4.1
Free Space Loss	dB	213.6	213.6
G/T toward Tx E/S	dB/K	32.9	32.9
C/I - Intra-system	dB	19.3	19.3
Downlink:			
EIRP per Carrier towards Rx E/S	dBW	39.2	37.1
Atmospheric and Rain Losses	dB	0.9	3.7
Free Space Loss	dB	209.9	209.9
Rx E/S Antenna Pointing Loss	dB	0.6	0.6
Rx E/S Antenna Diameter	m	7.3	7.3
Rx E/S Antenna Gain	dBi	61.5	61.5
Rx E/S G/T	dB/K	38.0	36.6
System Noise Temp (LNA+Sky)	K	250	349
C/I - Intra-system	dB	18.7	18.7
End-to-End:			
C/N - Thermal Uplink	dB	21.4	18.6
C/I Up - ASI (adjacent satellite interference)	dB	19.5	16.7
C/I Up - 5G	dB	7.5	4.7
C/N - Thermal Downlink	dB	20.9	14.5
C/I Down - ASI (adjacent satellite interference)	dB	28.0	28.0
C/(N+I) - Total Actual	dB	6.4	3.6
C/N - Required	dB	10.1	10.1
Margin	dB	-3.75	-6.51

Co-Channel Interference to 5M00G7D Link

General:	Units	Clear Sky	Rain Faded
Emission Designator		5M00G7D	5M00G7D
Data Rate	kbit/s	8750.0	8750.0
Modulation		8-PSK	8-PSK
Coding Rate		0.5833	0.5833
Carrier Bandwidth	kHz	5000	5000
Uplink Frequency	GHz	28.10	28.10
Downlink Frequency	GHz	18.30	18.30
Uplink:			
Tx E/S Antenna Diameter	m	0.75	0.75
Tx E/S Power to Antenna	W	2.8	2.8
Tx E/S Antenna Gain	dBi	44.4	44.4
Tx E/S EIRP per Carrier	dBW	48.8	48.8
Tx E/S Antenna Pointing Loss	dB	0.5	0.5
Atmospheric and Rain Losses	dB	1.3	6.7
Free Space Loss	dB	213.6	213.6
G/T toward Tx E/S	dB/K	32.9	32.9
C/I - Intra-system	dB	19.3	19.3
Downlink:			
EIRP per Carrier towards Rx E/S	dBW	36.2	30.0
Atmospheric and Rain Losses	dB	0.9	5.6
Free Space Loss	dB	209.9	209.9
Rx E/S Antenna Pointing Loss	dB	0.6	0.6
Rx E/S Antenna Diameter	m	7.3	7.3
Rx E/S Antenna Gain	dBi	61.5	61.5
Rx E/S G/T	dB/K	38.0	35.5
System Noise Temp (LNA+Sky)	K	250	395
C/I - Intra-system	dB	18.7	18.7
End-to-End:			
C/N - Thermal Uplink	dB	25.5	20.1
C/I Up - ASI (adjacent satellite interference)	dB	23.6	18.2
C/I Up - 5G	dB	11.6	6.2
C/N - Thermal Downlink	dB	22.0	8.6
C/I Down - ASI (adjacent satellite interference)	dB	28.0	28.0
C/(N+I) - Total Actual	dB	9.6	3.7
C/N - Required	dB	7.2	7.2
Margin	dB	2.41	-3.53

EXHIBIT 1
Section 3
Adjacent Channel Interference

Adjacent-Channel Interference to 20M0G7D Link

General:	**Units**	**Clear Sky**	**Rain Faded**
Emission Designator		20M0G7D	20M0G7D
Data Rate	kbit/s	45000.0	45000.0
Modulation		8-PSK	8-PSK
Coding Rate		0.7500	0.7500
Carrier Bandwidth	kHz	20000	20000
Uplink Frequency	GHz	28.35	28.35
Downlink Frequency	GHz	18.55	18.55
Uplink:			
Tx E/S Antenna Diameter	m	0.75	0.75
Tx E/S Power to Antenna	W	2.8	2.8
Tx E/S Antenna Gain	dBi	44.4	44.4
Tx E/S EIRP per Carrier	dBW	48.8	48.8
Tx E/S Antenna Pointing Loss	dB	0.5	0.5
Atmospheric and Rain Losses	dB	1.3	4.1
Free Space Loss	dB	213.6	213.6
G/T toward Tx E/S	dB/K	32.9	32.9
C/I - Intra-system	dB	19.3	19.3
Downlink:			
EIRP per Carrier towards Rx E/S	dBW	39.2	37.1
Atmospheric and Rain Losses	dB	0.9	3.7
Free Space Loss	dB	209.9	209.9
Rx E/S Antenna Pointing Loss	dB	0.6	0.6
Rx E/S Antenna Diameter	m	7.3	7.3
Rx E/S Antenna Gain	dBi	61.5	61.5
Rx E/S G/T	dB/K	38.0	36.6
System Noise Temp (LNA+Sky)	K	250	349
C/I - Intra-system	dB	18.7	18.7
End-to-End:			
C/N - Thermal Uplink	dB	18.37	15.57
C/I Up - ASI (adjacent satellite interference)	dB	16.47	13.67
C/I Up - 5G	dB	14.50	11.70
C/N - Thermal Downlink	dB	17.89	11.54
C/I Down - ASI (adjacent satellite interference)	dB	28.00	28.00
C/(N+I) - Total Actual	dB	9.37	6.28
C/N - Required	dB	10.12	10.12
Margin	dB	-0.75	-3.84

Adjacent-Channel Interference to 10M0G7D Link

General:	Units	Clear Sky	Rain Faded
Emission Designator		10M0G7D	10M0G7D
Data Rate	kbit/s	22500.0	22500.0
Modulation		8-PSK	8-PSK
Coding Rate		0.7500	0.7500
Carrier Bandwidth	kHz	10000	10000
Uplink Frequency	GHz	28.35	28.35
Downlink Frequency	GHz	18.55	18.55
Uplink:			
Tx E/S Antenna Diameter	m	0.75	0.75
Tx E/S Power to Antenna	W	2.8	2.8
Tx E/S Antenna Gain	dBi	44.4	44.4
Tx E/S EIRP per Carrier	dBW	48.8	48.8
Tx E/S Antenna Pointing Loss	dB	0.5	0.5
Atmospheric and Rain Losses	dB	1.3	4.1
Free Space Loss	dB	213.6	213.6
G/T toward Tx E/S	dB/K	32.9	32.9
C/I - Intra-system	dB	19.3	19.3
Downlink:			
EIRP per Carrier towards Rx E/S	dBW	39.2	37.1
Atmospheric and Rain Losses	dB	0.9	3.7
Free Space Loss	dB	209.9	209.9
Rx E/S Antenna Pointing Loss	dB	0.6	0.6
Rx E/S Antenna Diameter	m	7.3	7.3
Rx E/S Antenna Gain	dBi	61.5	61.5
Rx E/S G/T	dB/K	38.0	36.6
System Noise Temp (LNA+Sky)	K	250	349
C/I - Intra-system	dB	18.7	18.7
End-to-End:			
C/N - Thermal Uplink	dB	21.4	18.6
C/I Up - ASI (adjacent satellite interference)	dB	19.5	16.7
C/I Up - 5G	dB	17.5	14.7
C/N - Thermal Downlink	dB	20.9	14.5
C/I Down - ASI (adjacent satellite interference)	dB	28.0	28.0
C/(N+I) - Total Actual	dB	11.5	8.8
C/N - Required	dB	10.1	10.1
Margin	dB	1.35	-1.29

Adjacent-Channel Interference to 5M00G7D Link

General:	Units	Clear Sky	Rain Faded
Emission Designator		5M00G7D	5M00G7D
Data Rate	kbit/s	8750.0	8750.0
Modulation		8-PSK	8-PSK
Coding Rate		0.5833	0.5833
Carrier Bandwidth	kHz	5000	5000
Uplink Frequency	GHz	28.35	28.35
Downlink Frequency	GHz	18.55	18.55
Uplink:			
Tx E/S Antenna Diameter	m	0.75	0.75
Tx E/S Power to Antenna	W	2.8	2.8
Tx E/S Antenna Gain	dBi	44.4	44.4
Tx E/S EIRP per Carrier	dBW	48.8	48.8
Tx E/S Antenna Pointing Loss	dB	0.5	0.5
Atmospheric and Rain Losses	dB	1.3	6.7
Free Space Loss	dB	213.6	213.6
G/T toward Tx E/S	dB/K	32.9	32.9
C/I - Intra-system	dB	19.3	19.3
Downlink:			
EIRP per Carrier towards Rx E/S	dBW	36.2	30.0
Atmospheric and Rain Losses	dB	0.9	5.6
Free Space Loss	dB	209.9	209.9
Rx E/S Antenna Pointing Loss	dB	0.6	0.6
Rx E/S Antenna Diameter	m	7.3	7.3
Rx E/S Antenna Gain	dBi	61.5	61.5
Rx E/S G/T	dB/K	38.0	35.5
System Noise Temp (LNA+Sky)	K	250	395
C/I - Intra-system	dB	18.7	18.7
End-to-End:			
C/N - Thermal Uplink	dB	25.5	20.1
C/I Up - ASI (adjacent satellite interference)	dB	23.6	18.2
C/I Up - 5G	dB	21.6	16.2
C/N - Thermal Downlink	dB	22.0	8.6
C/I Down - ASI (adjacent satellite interference)	dB	28.0	28.0
C/(N+I) - Total Actual	dB	13.3	6.7
C/N - Required	dB	7.2	7.2
Margin	dB	6.05	-0.52

EXHIBIT 1
Section 4
Baseline Link Budgets Used for Co-Channel Case (Without 5G Interference)

Co-Channel with No 5G Interference to 20 M0G7D Link

General:	**Units**	**Clear Sky**	**Rain Faded**
Emission Designator		20M0G7D	20M0G7D
Data Rate	kbit/s	45000.0	45000.0
Modulation		8-PSK	8-PSK
Coding Rate		0.7500	0.7500
Carrier Bandwidth	kHz	20000	20000
Uplink Frequency	GHz	28.10	28.10
Downlink Frequency	GHz	18.30	18.30
Uplink:			
Tx E/S Antenna Diameter	m	0.75	0.75
Tx E/S Power to Antenna	W	2.8	2.8
Tx E/S Antenna Gain	dBi	44.4	44.4
Tx E/S EIRP per Carrier	dBW	48.8	48.8
Tx E/S Antenna Pointing Loss	dB	0.5	0.5
Atmospheric and Rain Losses	dB	1.3	4.1
Free Space Loss	dB	213.6	213.6
G/T toward Tx E/S	dB/K	32.9	32.9
C/I - Intra-system	dB	19.3	19.3
Downlink:			
EIRP per Carrier towards Rx E/S	dBW	39.2	37.1
Atmospheric and Rain Losses	dB	0.9	3.7
Free Space Loss	dB	209.9	209.9
Rx E/S Antenna Pointing Loss	dB	0.6	0.6
Rx E/S Antenna Diameter	m	7.3	7.3
Rx E/S Antenna Gain	dBi	61.5	61.5
Rx E/S G/T	dB/K	38.0	36.6
System Noise Temp (LNA+Sky)	K	250	349
C/I - Intra-system	dB	18.7	18.7
End-to-End:			
C/N - Thermal Uplink	dB	18.37	15.57
C/I Up - ASI (adjacent satellite interference)	dB	16.47	13.67
C/I Up - 5G	dB	999.00	999.00
C/N - Thermal Downlink	dB	17.89	11.54
C/I Down - ASI (adjacent satellite interference)	dB	28.00	28.00
C/(N+I) - Total Actual	dB	10.96	7.75
C/N - Required	dB	10.12	10.12
Margin	dB	0.84	-2.37

Co-Channel with No 5G Interference to 10M0G7D Link

General:	Units	Clear Sky	Rain Faded
Emission Designator		10M0G7D	10M0G7D
Data Rate	kbit/s	22500.0	22500.0
Modulation		8-PSK	8-PSK
Coding Rate		0.7500	0.7500
Carrier Bandwidth	kHz	10000	10000
Uplink Frequency	GHz	28.10	28.10
Downlink Frequency	GHz	18.30	18.30
Uplink:			
Tx E/S Antenna Diameter	m	0.75	0.75
Tx E/S Power to Antenna	W	2.8	2.8
Tx E/S Antenna Gain	dBi	44.4	44.4
Tx E/S EIRP per Carrier	dBW	48.8	48.8
Tx E/S Antenna Pointing Loss	dB	0.5	0.5
Atmospheric and Rain Losses	dB	1.3	4.1
Free Space Loss	dB	213.6	213.6
G/T toward Tx E/S	dB/K	32.9	32.9
C/I - Intra-system	dB	19.3	19.3
Downlink:			
EIRP per Carrier towards Rx E/S	dBW	39.2	37.1
Atmospheric and Rain Losses	dB	0.9	3.7
Free Space Loss	dB	209.9	209.9
Rx E/S Antenna Pointing Loss	dB	0.6	0.6
Rx E/S Antenna Diameter	m	7.3	7.3
Rx E/S Antenna Gain	dBi	61.5	61.5
Rx E/S G/T	dB/K	38.0	36.6
System Noise Temp (LNA+Sky)	K	250	349
C/I - Intra-system	dB	18.7	18.7
End-to-End:			
C/N - Thermal Uplink	dB	21.4	18.6
C/I Up - ASI (adjacent satellite interference)	dB	19.5	16.7
C/I Up - 5G	dB	999.0	999.0
C/N - Thermal Downlink	dB	20.9	14.5
C/I Down - ASI (adjacent satellite interference)	dB	28.0	28.0
C/(N+I) - Total Actual	dB	12.7	10.1
C/N - Required	dB	10.1	10.1
Margin	dB	2.59	0.00

Co-channel with No 5G Interference to 5M00G7D Link

General:	Units	Clear Sky	Rain Faded
Emission Designator		5M00G7D	5M00G7D
Data Rate	kbit/s	8750.0	8750.0
Modulation		8-PSK	8-PSK
Coding Rate		0.5833	0.5833
Carrier Bandwidth	kHz	5000	5000
Uplink Frequency	GHz	28.10	28.10
Downlink Frequency	GHz	18.30	18.30
Uplink:			
Tx E/S Antenna Diameter	m	0.75	0.75
Tx E/S Power to Antenna	W	2.8	2.8
Tx E/S Antenna Gain	dBi	44.4	44.4
Tx E/S EIRP per Carrier	dBW	48.8	48.8
Tx E/S Antenna Pointing Loss	dB	0.5	0.5
Atmospheric and Rain Losses	dB	1.3	6.7
Free Space Loss	dB	213.6	213.6
G/T toward Tx E/S	dB/K	32.9	32.9
C/I - Intra-system	dB	19.3	19.3
Downlink:			
EIRP per Carrier towards Rx E/S	dBW	36.2	30.0
Atmospheric and Rain Losses	dB	0.9	5.6
Free Space Loss	dB	209.9	209.9
Rx E/S Antenna Pointing Loss	dB	0.6	0.6
Rx E/S Antenna Diameter	m	7.3	7.3
Rx E/S Antenna Gain	dBi	61.5	61.5
Rx E/S G/T	dB/K	38.0	35.5
System Noise Temp (LNA+Sky)	K	250	395
C/I - Intra-system	dB	18.7	18.7
End-to-End:			
C/N - Thermal Uplink	dB	25.5	20.1
C/I Up - ASI (adjacent satellite interference)	dB	23.6	18.2
C/I Up - 5G	dB	999.0	999.0
C/N - Thermal Downlink	dB	22.0	8.6
C/I Down - ASI (adjacent satellite interference)	dB	28.0	28.0
C/(N+I) - Total Actual	dB	13.9	7.2
C/N - Required	dB	7.2	7.2
Margin	dB	6.74	0.00

EXHIBIT 1
Section 5
Baseline Link Budgets Used for Adjacent Channel Case (Without 5G Interference)

Adjacent-Channel with No 5G Interference to 20M0G7D Link

General:	**Units**	**Clear Sky**	**Rain Faded**
Emission Designator		20M0G7D	20M0G7D
Data Rate	kbit/s	45000.0	45000.0
Modulation		8-PSK	8-PSK
Coding Rate		0.7500	0.7500
Carrier Bandwidth	kHz	20000	20000
Uplink Frequency	GHz	28.35	28.35
Downlink Frequency	GHz	18.55	18.55
Uplink:			
Tx E/S Antenna Diameter	m	0.75	0.75
Tx E/S Power to Antenna	W	2.8	2.8
Tx E/S Antenna Gain	dBi	44.4	44.4
Tx E/S EIRP per Carrier	dBW	48.8	48.8
Tx E/S Antenna Pointing Loss	dB	0.5	0.5
Atmospheric and Rain Losses	dB	1.3	4.1
Free Space Loss	dB	213.6	213.6
G/T toward Tx E/S	dB/K	32.9	32.9
C/I - Intra-system	dB	19.3	19.3
Downlink:			
EIRP per Carrier towards Rx E/S	dBW	39.2	37.1
Atmospheric and Rain Losses	dB	0.9	3.7
Free Space Loss	dB	209.9	209.9
Rx E/S Antenna Pointing Loss	dB	0.6	0.6
Rx E/S Antenna Diameter	m	7.3	7.3
Rx E/S Antenna Gain	dBi	61.5	61.5
Rx E/S G/T	dB/K	38.0	36.6
System Noise Temp (LNA+Sky)	K	250	349
C/I - Intra-system	dB	18.7	18.7
End-to-End:			
C/N - Thermal Uplink	dB	18.37	15.57
C/I Up - ASI (adjacent satellite interference)	dB	16.47	13.67
C/I Up - 5G	dB	999.00	999.00
C/N - Thermal Downlink	dB	17.89	11.54
C/I Down - ASI (adjacent satellite interference)	dB	28.00	28.00
C/(N+I) - Total Actual	dB	10.96	7.75
C/N - Required	dB	10.12	10.12
Margin	dB	0.84	-2.37

Adjacent-Channel with No 5G Interference to 10M0G7D Link

General:	Units	Clear Sky	Rain Faded
Emission Designator		10M0G7D	10M0G7D
Data Rate	kbit/s	22500.0	22500.0
Modulation		8-PSK	8-PSK
Coding Rate		0.7500	0.7500
Carrier Bandwidth	kHz	10000	10000
Uplink Frequency	GHz	28.35	28.35
Downlink Frequency	GHz	18.55	18.55
Uplink:			
Tx E/S Antenna Diameter	m	0.75	0.75
Tx E/S Power to Antenna	W	2.8	2.8
Tx E/S Antenna Gain	dBi	44.4	44.4
Tx E/S EIRP per Carrier	dBW	48.8	48.8
Tx E/S Antenna Pointing Loss	dB	0.5	0.5
Atmospheric and Rain Losses	dB	1.3	4.1
Free Space Loss	dB	213.6	213.6
G/T toward Tx E/S	dB/K	32.9	32.9
C/I - Intra-system	dB	19.3	19.3
Downlink:			
EIRP per Carrier towards Rx E/S	dBW	39.2	37.1
Atmospheric and Rain Losses	dB	0.9	3.7
Free Space Loss	dB	209.9	209.9
Rx E/S Antenna Pointing Loss	dB	0.6	0.6
Rx E/S Antenna Diameter	m	7.3	7.3
Rx E/S Antenna Gain	dBi	61.5	61.5
Rx E/S G/T	dB/K	38.0	36.6
System Noise Temp (LNA+Sky)	K	250	349
C/I - Intra-system	dB	18.7	18.7
End-to-End:			
C/N - Thermal Uplink	dB	21.4	18.6
C/I Up - ASI (adjacent satellite interference)	dB	19.5	16.7
C/I Up - 5G	dB	999.0	999.0
C/N - Thermal Downlink	dB	20.9	14.5
C/I Down - ASI (adjacent satellite interference)	dB	28.0	28.0
C/(N+I) - Total Actual	dB	12.7	10.1
C/N - Required	dB	10.1	10.1
Margin	dB	2.59	0.00

Adjacent-Channel with No 5G Interference to 5M00G7D Link

General:	Units	Clear Sky	Rain Faded
Emission Designator		5M00G7D	5M00G7D
Data Rate	kbit/s	8750.0	8750.0
Modulation		8-PSK	8-PSK
Coding Rate		0.5833	0.5833
Carrier Bandwidth	kHz	5000	5000
Uplink Frequency	GHz	28.35	28.35
Downlink Frequency	GHz	18.55	18.55
Uplink:			
Tx E/S Antenna Diameter	m	0.75	0.75
Tx E/S Power to Antenna	W	2.8	2.8
Tx E/S Antenna Gain	dBi	44.4	44.4
Tx E/S EIRP per Carrier	dBW	48.8	48.8
Tx E/S Antenna Pointing Loss	dB	0.5	0.5
Atmospheric and Rain Losses	dB	1.3	6.7
Free Space Loss	dB	213.6	213.6
G/T toward Tx E/S	dB/K	32.9	32.9
C/I - Intra-system	dB	19.3	19.3
Downlink:			
EIRP per Carrier towards Rx E/S	dBW	36.2	30.0
Atmospheric and Rain Losses	dB	0.9	5.6
Free Space Loss	dB	209.9	209.9
Rx E/S Antenna Pointing Loss	dB	0.6	0.6
Rx E/S Antenna Diameter	m	7.3	7.3
Rx E/S Antenna Gain	dBi	61.5	61.5
Rx E/S G/T	dB/K	38.0	35.5
System Noise Temp (LNA+Sky)	K	250	395
C/I - Intra-system	dB	18.7	18.7
End-to-End:			
C/N - Thermal Uplink	dB	25.5	20.1
C/I Up - ASI (adjacent satellite interference)	dB	23.6	18.2
C/I Up - 5G	dB	999.0	999.0
C/N - Thermal Downlink	dB	22.0	8.6
C/I Down - ASI (adjacent satellite interference)	dB	28.0	28.0
C/(N+I) - Total Actual	dB	13.9	7.2
C/N - Required	dB	7.2	7.2
Margin	dB	6.74	0.00

EXHIBIT 2
ViaSat-2 Earth Station Site Locations

City	Latitude	Longitude	Call Sign	File Number
Albuquerque	35 05 37.5N	106 38 45.2W	E160089	SES-LIC-20160610-00516
Columbus	39 53 20.9N	082 55 58.7W	E160099	SES-LIC-20160610-00529
Portland	44 57 17.4N	123 00 57.6W	E160118	SES-LIC-20160610-00548
Denver	39 32 57.3N	104 51 52.4W	E160093	SES-LIC-20160610-00523
Des Moines	41 34 46.0N	093 35 43.3W	E160091	SES-LIC-20160610-00520
Carlsbad	33 07 41.2N	117 15 54.9W	E160092	SES-LIC-20160610-00522
Ft. Hancock	31 26 29.0N	106 05 01.2W	E160119	SES-LIC-20160610-00549
Chiefland	29 28 19.4N	082 51 34.6W	E160120	SES-LIC-20160610-00550
Hammonton	39 37 01.3N	074 49 20.6W	E160121	SES-LIC-20160610-00551
Houston	29 46 15.4N	095 20 45.6W	E160122	SES-LIC-20160610-00553
Raleigh	35 49 48.5N	078 36 34.9W	E160124	SES-LIC-20160610-00552
Tucson	32 12 57.5N	110 57 42.0W	E160117	SES-LIC-20160610-00547
Charlotte	35 38 56.1N	080 40 04.9W	E160116	SES-LIC-20160610-00546
Oklahoma City	35 24 21.5N	096 55 23.9W	E160123	SES-LIC-20160610-00554
Omaha	41 56 27.8N	096 27 52.0W	E160113	SES-LIC-20160610-00544
Rapid City	44 04 20.7N	103 09 38.2W	E160111	SES-LIC-20160610-00541
Nashville	36 06 11.2N	086 45 18.7W	E160115	SES-LIC-20160610-00545
Bozeman	45 40 33.4N	111 08 33.8W	E160109	SES-LIC-20160610-00539
Indianapolis	39 44 29.2N	086 09 07.1W	E160108	SES-LIC-20160610-00538
Las Vegas	36 08 33.7N	115 04 38.1W	E160110	SES-LIC-20160610-00540
San Antonio	29 26 18.32N	098 30 25.32W	E160098	SES-LIC-20160610-00528
Dallas	32 22 01.36N	096 38 15.28W	E160090	SES-LIC-20160610-00519
Salt Lake City	41 14 17.82N	111 59 28.47W	E160112	SES-LIC-20160610-00542
Minneapolis	44 51 03.77N	093 35 53.87W	E160107	SES-LIC-20160610-00537
Milwaukee	43 00 52.28N	088 27 58.70W	E160106	SES-LIC-20160610-00536
Birmingham	33 29 58.56N	086 49 13.43W	E160105	SES-LIC-20160610-00535
Reno	39 22 55.17N	120 04 54.56W	E160104	SES-LIC-20160610-00534
San Jose	37 43 16.58N	121 30 38.33W	E160114	SES-LIC-20160610-00543
Kansas City	38 44 35.79N	093 52 42.81W	E160103	SES-LIC-20160610-00533
St Louis	38 15 53.50N	090 24 45.13W	E160102	SES-LIC-20160610-00532
Little Rock	34 45 44.56N	092 15 36.14W	E160101	SES-LIC-20160610-00531
Detroit	42 19 30.09N	083 04 11.71W	E160100	SES-LIC-20160610-00530
Virginia Beach	36 50 17.55N	076 20 00.66W	E160097	SES-LIC-20160610-00527
Augusta	33 28 28.61N	081 58 21.88W	E160094	SES-LIC-20160610-00524
Pittsburgh	40 25 30.18N	079 58 11.06W	E160096	SES-LIC-20160610-00526
Scranton	41 18 59.30N	075 42 54.04W	E160095	SES-LIC-20160610-00525

Note: an additional four antenna site locations for Atlanta, GA, Memphis, TN, McAllen, TX, and Boston, MA are still being finalized, and the associated earth station applications will be filed shortly.

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 technical information contained in ViaSat's July 7, 2016 Letter, and it is true and correct to the best of my knowledge, information and belief.

/s/
Daryl T. Hunter, P.E.

Executed July 7, 2016