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August 13, 2018

VIA ELECTRONIC FILING

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Viasat, Inc., *Ex Parte* Response to Submissions in IBFS File No. SAT-PDR-20161115-00120

Dear Ms. Dortch:

Viasat, Inc. ("Viasat") responds to various submissions regarding the Ka band satellite-to-satellite links described in Viasat's above-referenced petition for declaratory ruling ("Petition") for the VIASAT-NGSO system. As Viasat has explained, those links enable transmissions by the VIASAT-NGSO MEO spacecraft to and from GSO spacecraft, much in the same way as Ka-band VSATs currently communicate with Ka-band GSO spacecraft operating in the Fixed Satellite Service ("FSS"). Viasat comprehensively addressed all of the issues raised in the formal pleading cycle regarding these satellite-to-satellite links in its July 7, 2017 Consolidated Opposition and Reply Comments ("Viasat Opposition and Reply"). However, a few parties continue to repeat the same arguments in their renewed requests to defer consideration or deny authority for this aspect of Viasat's NGSO system.

I. VIASAT DOES NOT SEEK ACCESS TO SPECTRUM FOR THE INTER-SATELLITE SERVICE

As an initial matter, Hughes Network Services, LLC ("Hughes") and Inmarsat Inc. ("Inmarsat") resort to incorrectly characterizing what Viasat proposes as Inter-Satellite Service ("ISS") links, and thus arguing that Viasat's request is outside the scope of the current processing round and cannot be granted.[1] Hughes's advocacy is part of a larger campaign to prevent others

[1] *See Ex Parte* Submission of Hughes Network Services, LLC and Inmarsat, Inc., File No. SAT-PDR-20161115-00120, Attachment at 1-2 (filed Oct. 18, 2017) ("Hughes/Inmarsat Joint *Ex Parte*"); *see also Ex Parte* Submission of EchoStar Satellite Operating Corporation and Hughes Network Systems, LLC, File No. SAT-PDR-20161115-00120, Attachment at 1 (filed Mar. 8, 2018) ("Hughes March 8 *Ex Parte*").

from making new and spectrally-efficient use of FSS spectrum that Hughes is required to share with other satellite operators.[2]

The reality is that Viasat has proposed Ka band operations that, as detailed below, are consistent with permitted FSS use of the band. This capability is expected to be used to support U.S. service, including communications with U.S.-licensed spacecraft.[3] As Viasat has explained, the entire purpose of its proposed links is to enable communications with existing (and future) satellite networks through VSAT-like stations on its MEO spacecraft that would communicate with GSO spacecraft, using the same spectrum that those GSO spacecraft otherwise use today for communications with earth stations. Viasat's proposal would increase spectrum efficiency by:

- expanding the service capabilities of those GSO spacecraft without altering their technical designs or adversely changing the RF operating environment, and

- enabling new types of NGSO connectivity that allow offloading of data-intensive traffic that can be carried more efficiently to and from Earth over GSO systems with inherently greater available throughput.

Notably, Inmarsat is reportedly doing something very similar with its GSO spacecraft—using them to communicate with LEO spacecraft.[4] And in doing so, Inmarsat is not using ISS-

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[2] *See* Comments of EchoStar Satellite Operating Corporation and Hughes Network Systems, LLC, *Streamlining Licensing Procedures for Small Satellites*, IB Docket No. 18-86, at 6-7 (filed July 9, 2018). Despite the plain language in ITU Radio Regulation 1.21 and Sections 2.1 and 25.103 of the Commission's rules permitting satellite-to-satellite links in FSS spectrum, Hughes urges in the rulemaking proceeding regarding small satellites: "The Commission should not permit ISLs to operate in spectrum that is not allocated for Inter-Satellite Service (ISS) use." *Id.* at 6.

[3] Inmarsat claims that the Commission does not have jurisdiction over this portion of the VIASAT-NGSO system. *See* Inmarsat, Inc., Written *Ex Parte* Presentation, File No. SAT-PDR-20161115-00120, at 2 (filed Nov. 20, 2017) ("Inmarsat November 20 *Ex Parte*").

[4] *See* Debra Werner, "Inmarsat and AVI's satellite data-relay service exists stealth mode after months of secret, in-space tests," SpaceNews (Feb. 22, 2017), available at https://spacenews.com/after-months-of-secret-in-space-testing-inmarsat-avis-satellite-data-relay-service-exits-stealth-mode/; "Addvalue and Inmarsat Sign Agreement to Launch Inter-satellite Data Relay Service," Cision PR Newswire (Aug. 10, 2017), available at https://www.prnewswire.com/news-releases/addvalue-and-inmarsat-sign-agreement-to-launch-inter-satellite-data-relay-service-a-worlds-first-commercial-on-demand-communications-service-to-support-leo-satellite-operations-300503157.html; Press Release, "Continuous connectivity to low earth orbiting satellites enables a new level of satellite efficiency and commercial possibility" (June 28, 2018), available at https://www.addvaluetech.com/media/continuous-connectivity-to-low-earth-orbiting-satellites-enables-a-new-level-of-satellite-efficiency-and-commercial-possibility/.

allocated spectrum. Rather, it is using the very same spectrum that it historically has used for communications in the Earth-to-space and space-to-Earth directions.

Moreover, it bears emphasis that a given spectrum use may fit within more than one category of service. Indeed, both ITU Radio Regulation 1.21 and the corresponding provision in the Commission's rules specifically provides that satellite-to-satellite links may operate *in either the FSS or the ISS:* "in some cases [the Fixed Satellite Service] includes satellite-to-satellite links, *which may also* be operated in the inter-satellite service."[5] Furthermore, Section 25.279 of the Commission's rules, which addresses the ISS, explicitly provides that the availability of the ISS for "inter-satellite" links "***does not preclude the use of other frequencies for such purposes as provided for in several service definitions, e.g., FSS.***"[6]

In this case, Viasat seeks to use FSS-designated spectrum in the Ka band for such purposes. Likewise, feeder links for MSS systems may be operated either in MSS spectrum or in FSS spectrum. No one could reasonably argue that a request for MSS feeder links to a GSO spacecraft in the Ka band should be rejected for consideration simply because feeder links also could be accommodated in an MSS band like the L band. Similarly, no one can reasonably argue that ISS bands must be used for a space-to-space communications even though FSS (or MSS) bands could be used for the same purpose, within the existing technical envelope of FSS (or MSS) network operations.

II. VIASAT'S SATELLITE-TO-SATELLITE LINKS ARE CONSISTENT WITH THE FSS ALLOCATION

In the Petition, Viasat described the FSS satellite-to-satellite links that will operate between the spacecraft in the VIASAT-NGSO constellation and GSO satellite networks in portions of the Ka band, and explained how these links will be consistent with the FSS allocations for those portions of the Ka band.[7] The definition of FSS in the Commission's rules provides that the service includes satellite-to-satellite communications,[8] and Viasat's proposed use of the Ka band would occur in the same directions of transmission as those specified in the allocation table (that is, to and from space, with reference to the direction of the Earth from a given spacecraft).[9]

Moreover, Viasat's spectrum use would serve the same purpose as that of a VSAT on an airplane. That is, Viasat would use the Ka band to send communications to and from an aggregation point on the MEO spacecraft to a GSO spacecraft, just as a VSAT on an airplane

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[5] 47 C.F.R. § 2.103.

[6] 47 C.F.R. § 25.279(a) (emphasis added).

[7] Viasat, Inc., Petition for Declaratory Ruling, File No. SAT-PDR-20161115-00120, Attachment A at 22-27 (filed Nov. 15, 2016) ("Petition").

[8] *See* 47 C.F.R. §§ 2.1 and 25.103.

[9] *See* Consolidated Opposition and Reply Comments of Viasat, Inc., File No. SAT-PDR-20161115-00120, at 7, A-1 (filed July 7, 2017) ("Viasat Opposition and Reply").

sends communications to and from the aggregation point on the airplane. Furthermore, and as Viasat has explained, the transmissions to and from the GSO spacecraft would be entirely within the same technical envelope as a VSAT operating on an airplane within the Earth's atmosphere. There is no principled basis for arguing for a different result in this case.[10]

Hughes and Inmarsat acknowledge that the Commission's definition of the FSS provides for satellite-to-satellite links,[11] but Hughes argues that satellite-to-satellite links are not permitted unless the FSS allocation in the U.S. Table of Frequency Allocations ("U.S. Table") specifies "space-to-space" communications.[12] As Viasat has noted previously, such parentheticals are properly understood to refer to the *direction* of permissible communications. Thus, satellite-to-satellite transmissions are fully consistent with the relevant FSS allocation as long as the allocation parenthetical (if any) refers to the direction in which those transmissions "point"—*i.e.*, in the case of an "Earth-to-space" allocation, transmissions must be away from the Earth and toward outer space, and in the case of a "space-to-Earth" allocation, transmissions must be away from outer space and toward the Earth. Notably, other aspects of the Commission's rules operate in similar fashion—*e.g.,* many technical limits are based on the direction of contemplated transmissions, as opposed to the location of end-points.[13]

Viasat is *not* proposing some type of lateral space-to-space link, as is suggested by Hughes's argument. Again, what is proposed are transmissions in the Earth-to-space and space-to-Earth directions that fall entirely within the technical envelope of existing Ka-band VSAT operations on airplanes. Indeed, this situation is very different from the Teledesic and Motorola Ka-band NGSO examples that Inmarsat and Hughes cite to support their requests to defer consideration.[14] Those cases dealt with lateral space-to-space communications within FSS networks that specifically requested access to ISS-allocated spectrum in the 59-64 GHz range that could not be used for that purpose because of interference risks with respect to U.S. government users.[15] Thus, those cases are inapposite because the applicants sought frequency assignments in separate ISS bands that were not available because of interference concerns.

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[10] *Ex Parte* Submission of Hughes Network Systems, LLC, File No. SAT-PDR-20161115-00120, at 2 (filed May 4, 2018) ("Hughes May 4 *Ex Parte*") (recognizing the "space-to-Earth" and "Earth-to-space" parenthetical notations in the table of allocations but not acknowledging that Viasat's proposal is fully consistent with this sense of directionality).

[11] *See* Inmarsat Reply to Viasat Opposition, File No. SAT-PDR-20161115-00120, at 2 (filed July 14, 2017) ("Inmarsat Reply"); Comments of Hughes Network Systems, LLC, File No. SAT-PDR-20161115-00120, at 3 (filed June 26, 2017).

[12] *See* Hughes May 4 *Ex Parte*.

[13] *See, e.g.,* 47 C.F.R. § 25.202 (specifying EPFD limits for the space-to-Earth and Earth-to-space directions).

[14] Inmarsat Reply at 3; Hughes March 8 *Ex Parte*, Attachment at 1; Hughes/Inmarsat Joint *Ex Parte*, Attachment at 2.

[15] *See Teledesic Corporation*, Order and Authorization, 12 FCC Rcd 3154 ¶¶ 20-21 (1997); *Comm, Inc. (Motorola)*, Order and Authorization, 12 FCC Rcd 23001 ¶¶ 25-26, 28 (1997).

Moreover, those applicants did not propose to utilize the opportunity for satellite-to-satellite links in FSS spectrum under Radio Regulation 1.21, nor did they propose to operate those links in the same Earth-to-space and space-to-Earth directions as the other systems in the then-pending Ka-band processing round.

For these reasons, and those provided in the Petition and in the Viasat Opposition and Reply, Viasat's MEO-to-GSO links should be evaluated for compatibility with other Ka-band operations proposed in the current NGSO processing round; consideration should not be deferred as Hughes and Inmarsat request.

In conceding that satellite-to-satellite links are part of the FSS, Inmarsat asserts that the Commission "must still carefully consider technical and regulatory matters to ensure that the proposed use is compatible with other operations."[16] That is precisely why Viasat has provided extensive technical demonstrations, both in its Petition and in its Opposition and Reply, to demonstrate such compatibility—a demonstration that at least one satellite operator has recognized as adequate.[17] Below, Viasat provides additional technical showings to further illustrate compatibility. Based on these detailed technical demonstrations, the Commission can and should grant authority for Viasat's proposed MEO-to-GSO operations when it grants the Petition.

III. VIASAT HAS FULLY DEMONSTRATED COMPATIBILITY OF THE SATELLITE-TO-SATELLITE LINKS WITH OTHER GSO AND NGSO OPERATIONS

Hughes, Inmarsat SES S.A. and O3b Limited ("SES/O3b") maintain in various submissions that Viasat has not provided sufficient analysis on GSO and NGSO protection.[18] It is apparent from the face of their submissions that they are ignoring the detailed technical demonstrations in Viasat's Petition and its Opposition and Reply. In contrast, OneWeb acknowledges that Viasat's analysis shows how operators in the spectrum will be protected, and, as a result, it withdrew its previous opposition.[19] SpaceX agrees that NGSOs are unlikely to be affected as long as Viasat's system is subject to the same coexistence regime as other NGSO operations, which it obviously would be.[20] Moreover, Viasat has proposed to operate its MEO-

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[16] Inmarsat Reply at 2.

[17] *See* Reply Comments of WorldVu Satellites Limited, File No. SAT-PDR-20161115-00120, at 4 (filed July 14, 2017) ("OneWeb Reply").

[18] *See, e.g.,* Hughes March 8 *Ex Parte*, Attachment at 1; Inmarsat November 20 *Ex Parte* at 1; Inmarsat Reply at 3-4; Reply of SES S.A. and O3b Limited, File No. SAT-PDR-20161115-00120, *et al*., at 6 (filed July 14, 2017) ("SES/O3b Reply").

[19] *See* OneWeb Reply at 4.

[20] *See* Comments of Space Exploration Holdings, LLC, File No. SAT-PDR-20161115-00120, *et al*., at 13 (filed July 17, 2017). Hughes seems to acknowledge that conditions could be imposed to ensure these limits and parameters are met. *See* Hughes Network Services, LLC, Written *Ex Parte* Presentation, File No. SAT-PDR-20161115-00120, at 3 (filed Nov. 3, 2017) ("Hughes

to-GSO links only within the coverage area of the target GSO satellite and not when the MEO satellites are beyond the limb of the earth, as detailed in Viasat's technical analyses in the Petition and in its Opposition and Reply. Therefore, Hughes's illustration of GSO satellites communicating with MEO satellites outside of this area is entirely irrelevant to the case at hand.[21]

While SES claims that Viasat has not included a two-degree analysis,[22] Viasat actually has included such a demonstration both in the Petition and the supplemental technical demonstration in Viasat's Opposition and Reply. These showings explain that GSO networks adjacent to the target GSO satellite will be protected because the EIRP density of transmissions from NGSO satellites up to the GSO satellite will be in the range of 3.5 dB lower than earth station terminals operating in the Ka band with the GSO satellite at the same symbol rate.[23] This reduction results from the path loss differential between that of a traditional VSAT earth station and that of a MEO satellite, each transmitting to a GSO spacecraft. In other words, a transmitting antenna on a MEO spacecraft within the cone of coverage or communication range of the GSO satellite will be much closer to the GSO satellite than earth stations at or just above the earth's surface. Therefore, the power necessary to close the link from a MEO spacecraft is lower than that required for a traditional VSAT earth station. In addition, the topocentric angles for off-axis signals from the MEO satellite toward the GSO satellites adjacent to the target GSO satellites will be larger than two degrees (as illustrated in the attached technical exhibit), thereby reducing the off-axis energy toward adjacent satellites even further. Moreover, because the EIRP density of transmissions from NGSO satellites up to the GSO satellite will be lower than that of Ka band VSATs operating with GSO satellites, NGSO systems operating at orbits that are higher than GSO satellites also will be protected.[24]

Because the MEO-to-GSO link transmissions from the VIASAT-NGSO spacecraft will be directed toward the target GSO satellite, a two-degree spacing analysis is entirely appropriate for evaluating protection of other GSO systems. Nevertheless, in order to address claims by Hughes, Inmarsat and SES/O3b that EPFD limits should still apply,[25] the attached technical analysis demonstrates the $EPFD_{up}$ limits are met. Notably, that technical analysis shows that Inmarsat's claim of $EPFD_{up}$ exceedence is a result of a calculation error.[26]

November 3 *Ex Parte*"); Hughes Network Services, LLC, Written *Ex Parte* Presentation, File No. SAT-PDR-20161115-00120, at 1 (Nov. 21, 2017).

[21] *See* Hughes November 3 *Ex Parte* at 3.

[22] *See* SES/O3b Reply at 6.

[23] *See* Petition, Attachment A at 21-22; Viasat Opposition and Reply, Exhibit A, at A-2, A-3.

[24] Although SES and O3b raised this as an issue, *see* SES/O3b Reply at 6, neither Space Norway nor Audacy, the two systems that operate at higher altitudes, raised concerns with Viasat's proposed operations.

[25] *See* Hughes/Inmarsat Joint *Ex Parte*, Attachment at 2-3; SES/O3b Reply at 6.

[26] *See* Inmarsat Reply at 4.

IV. THERE IS NO PROCEDURAL REASON TO DEFER OR DENY VIASAT'S REQUEST

As detailed above, Hughes's request to defer consideration of Viasat's use of satellite-to-satellite links until "studies or technical references that support the general use of FSS allocations for inter-satellite communications"[27] is wholly unwarranted because the record contains more than an adequate basis to conclude that Viasat's proposal is entirely consistent with the operations of GSO and other NGSO networks.

Similarly, Inmarsat's suggestion that Viasat's satellite-to-satellite links on VIASAT-NGSO should be deferred until the Commission has adopted rules is baseless. The Commission has regularly authorized new spectrum uses before rules were adopted, including mobile applications of the FSS (*i.e.*, maritime, aeronautical and land mobile) when there were no specific rules at the time.[28] Where, as here, the existing operating environment would be unchanged, there is no valid reason to forestall innovation by requiring years of rulemaking proceedings. In fact, the Commission has granted authorizations for NGSO and other satellite operations without delaying such action for the resolution of technical issues that would apply more broadly.[29]

Finally, it bears emphasis that no party has made a valid policy argument why Viasat's request should not be granted, nor has anyone explained why Viasat's request for a waiver of the Commission's rules to the extent necessary should not be granted.[30] Notably, the Commission has granted numerous waivers of the U.S. Table to enable the operation of VSATs on airplanes,

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[27] Hughes Networks Systems, LLC, *Ex Parte* Submission, Attachment at 1 (filed Aug. 2, 2017).

[28] *See, e.g.*, *Boeing Company,* Order and Authorization, 16 FCC Rcd 22645 (2001) (granting a waiver of the U.S. Table to allow the operation of aeronautical earth stations in the Ku band); Raysat Antenna Systems, LLC, Order and Authorization, 23 FCC Rcd 1985 (2008) (granting a waiver to allow the operation of earth stations mounted on vehicles in the Ku band); *Mobile Satellite-Based Communications by Crescomm Transmission Services, Inc. and Qualcomm Incorporation*, Order, 11 FCC Rcd 10944 (1996) (granting a waiver to allow the operation of earth stations aboard ships in the C and Ku bands).

[29] *See, e.g., Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, Report and Order, 32 FCC Rcd 7809, ¶ 35 (2017) (adopting ITU EPFD limits in the 17.8-30 GHz frequency range while acknowledging that such limits may not be appropriate for "most advanced modern GSO networks"); *WorldVu Satellites Limited*, Order and Declaratory Ruling, 32 FCC Rcd 5366, ¶¶ 11-12 (2017) (authorizing OneWeb's NGSO network prior to the resolution of sharing issues in the then-pending NGSO Rulemaking proceeding).

[30] Viasat requested a waiver of the Commission's rules to the extent necessary to allow the proposed satellite-to-satellite links. Petition at 6 n.6; see also Viasat Opposition and Reply at 6 n.10. Thus, Hughes's assertion that Viasat has not requested a waiver is inaccurate. *See* Hughes March 8 *Ex Parte*, Attachment at 1.

even though such a use of the Ka band is not yet formally recognized as an application of the FSS.[31]

* * * * *

For these reasons, Viasat respectfully requests that the Commission consider and grant authority for Viasat's satellite-to-satellite links contemporaneously with the grant of authority for the VIASAT-NGSO system, and to reject requests by Hughes and Inmarsat to deny or defer consideration of this aspect of Viasat's Petition.

Respectfully submitted,

/s/

John P. Janka
Elizabeth R. Park
Jarrett S. Taubman

Attachment

cc: Jose Albuquerque
Kathyrn Medley
Stephen Duall
Alan Thomas

[31] *See, e.g.*, Viasat, Inc., File No. SES-LIC-20120427-00404, Call Sign E120075 (granted July 17, 2013) (authorizing aeronautical earth stations in the Ka band); ISAT US Inc., File No. SES-LIC-20141030-00832, Call Sign E140114 (granted Aug. 11, 2015) (authorizing aeronautical earth stations in the Ka band pursuant to a waiver); ISAT US Inc., File No. SES-LIC-20140224-00098, Call Sign E140029 (granted Sept. 29, 2015) (granting waiver for maritime earth stations in the Ka band).

Exhibit A

In this exhibit, Viasat supplements its previous analysis included with its July 7, 2017 Opposition and Reply[1] showing that Viasat's proposed satellite-to-satellite links in the VIASAT-NGSO network would be compatible with other GSO spacecraft in a two-degree environment. This exhibit adds a specific analysis of the SPACEWAY 3 satellite at 95º W.L. and a notional satellite spaced two degrees away at 93º W.L. as the target, in order to address Hughes's reference in its November 3, 2017 *ex parte* to the SPACEWAY 3 GSO satellite. Because the MEO-to-GSO link transmissions from the VIASAT-NGSO spacecraft will be directed toward the target GSO satellite, a two-degree spacing analysis is appropriate for evaluating the protection of other GSO satellites. However, this analysis also includes a demonstration of compliance with EPFD limits to address arguments by Hughes, Inmarsat and SES/O3b with respect to EPFD limits.

Table 1 presents two simple Earth-to-space links, one for a typical fixed VSAT and one for an NGSO-to-GSO satellite-to-satellite link using the same antenna and transmitted bandwidth. Table 1 shows that the transmitted power (EIRP density) required from a NGSO-to-GSO payload on a MEO satellite is about 3.5 dB less than for a typical fixed VSAT on the ViaSat-2 network. The difference in required transmit power is due to the lower free space path loss given the reduced distance between the MEO and GSO satellites over that of an earth station to a GSO satellite, and also because there is no atmospheric loss for the NGSO-to-GSO satellite-to-satellite link.

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[1] Consolidated Opposition and Reply Comments of Viasat, Inc., File No. SAT-PDR-20161115-00120 (filed July 7, 2017).

	Fixed VSAT		NGSO	
Antenna input power	25.0		11.3	W
Symbol rate	160.0		160.0	MBd
Antenna input density	-8.1		-11.5	dBW/MHz
75 cm antenna gain	44.5		44.5	dBi
EIRP density	36.4		33.0	dBW/MHz
GSO altitude (nadir)	35786.0		27586.0	km
Path loss	212.7		210.5	dB
Atmospheric loss	1.2		0.0	dB
Power density at GSO	-177.5		-177.5	dBW/MHz
Satellite antenna gain	61.0		61.0	dBi
Signal at satellite receiver (S)	-116.5		-116.5	dBW/MHz
Satellite noise	1050.0		1050.0	K
Satellite G/T	30.8		30.8	dB/K
Thermal noise at receiver (N)	-138.4		-138.4	dBW/MHz
Signal to noise at receiver (S/N)	21.9		21.9	dB

Table 1 – NGSO-to-GSO link e.i.r.p. density calculation

As depicted in Figures 1 and 2, because the MEO orbit of 8200 km altitude is closer to GSO than an earth station on the Earth's surface, the effective off-axis angle between two GSO satellites is larger than the topocentric angle from the Earth's surface. This results in increased off-axis gain reduction toward those GSO satellites, compared with a VSAT/ESIM on the Earth.

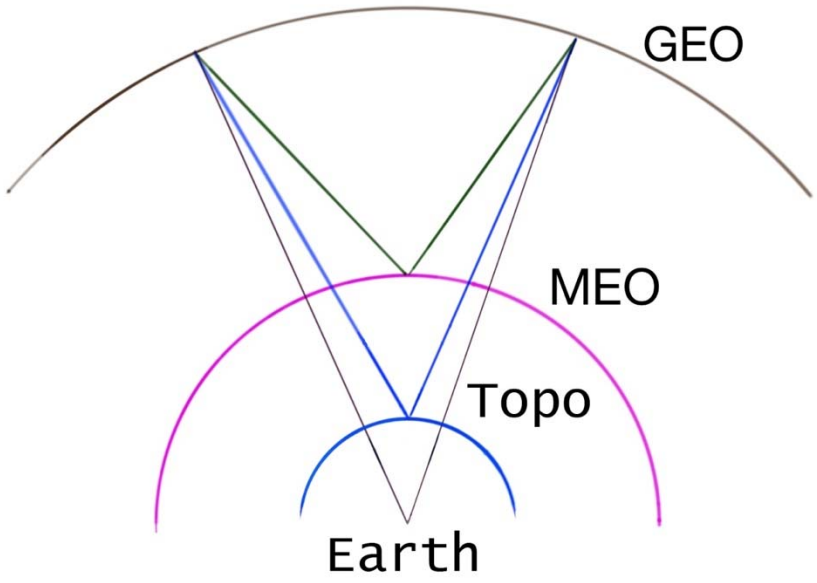

Figure 1 – Geocentric vs Topocentric vs Meocentric angles

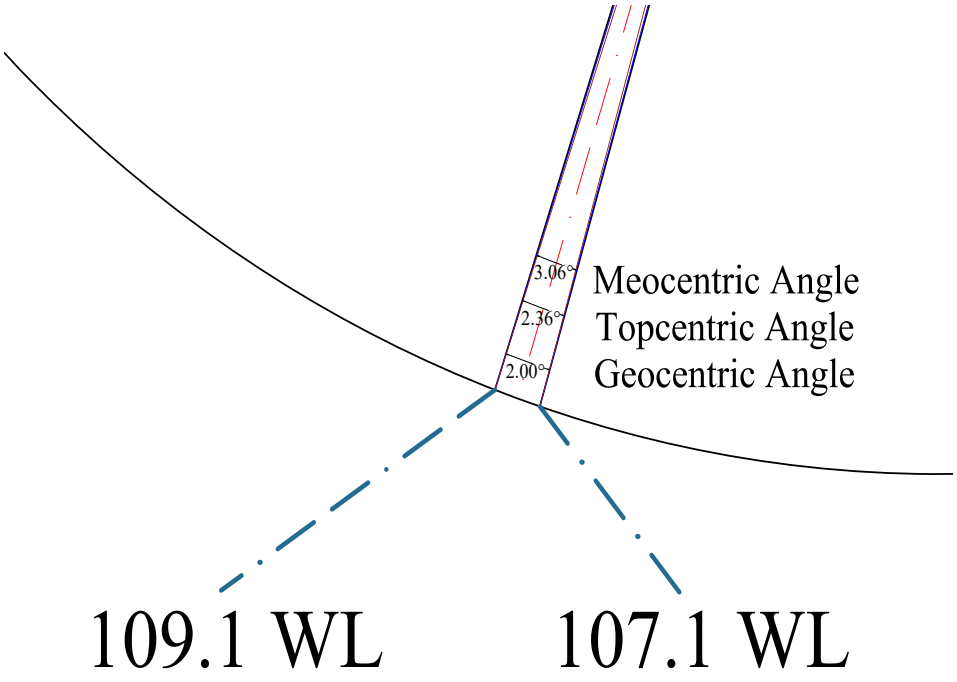

Figure 2 – Two degree Geocentric vs Topocentric vs Meocentric angles

Table 2 shows a NGSO to GEO Earth-to-space link similar to the Earth-to-space link described in Table 1 above, but in this case examines the I/N at potential adjacent GSO satellites.

The potential adjacent GSO satellites examined were Inmarsat's GX satellite at 55º W.L., the EchoStar/HNS Jupiter 2 satellite at 97.1º W.L., the EchoStar XVII satellite at 107.1º W.L., and the SPACEWAY 3 GSO satellite at 95º W.L. In each case, the target Viasat satellite for the satellite-to-satellite link was selected to be the closest in longitude to the examined GSO satellite so as to consider the smallest off-axis angle between the VIASAT-NGSO satellite and the adjacent GSO. In the case of Inmarsat GX, the ViaSat-2 satellite at 69.9º W.L. was used as the target satellite, and in the case of Jupiter 2, ViaSat-3 at 89º W.L. was used as the target.[2] In the case of EchoStar XVII, WildBlue-1 at 111.1º W.L. was used as the target satellite, and in the case of SPACEWAY 3, a notional satellite at 93º W.L. was used as the target.

	NGSO		GX 55 W	Jupiter 2	Echo XVII	SPACEWAY 3	
Antenna input power	11.3						W
Symbol rate	160.0						MBd
Antenna input density	-11.5						dBW/MHz
Geocentric angle between VS GEO and victim			14.9	8.1	4.0	2.0	
Off-axis angle to victim			22.5	12.4	6.1	3.1	deg
75 cm antenna gain to victim			-1.8	4.7	9.4	16.9	dBi
EIRP density			-13.3	-6.8	-2.1	5.3	dBW/MHz
GSO altitude (nadir)			27586.0	27586.0	27586.0	27586.0	km
Path loss			210.5	210.5	210.5	210.5	dB
Atmospheric loss			0.0	0.0	0.0	0.0	dB
Power density at GSO			-223.8	-217.3	-212.6	-205.1	dBW/MHz
Off-axis angle towards transmitter			0	0	0	0	deg
Satellite antenna gain			41.0	53.0	53.0	50.1	dBi
Interference at sat receiver (I)			-182.8	-164.3	-159.6	-155.0	dBW/MHz
Satellite noise			690.0	1250.0	1250.0	650.0	K
Satellite G/T			12.6	22.0	22.0	22.0	dB/K
Thermal noise at receiver (N)			-140.2	-137.6	-137.6	-140.5	dBW/MHz
Interference to noise at rx (I/N)			-42.6	-26.6	-22.0	-14.5	dB

Table 2 – NGSO-to-GSO link I/N calculations

[2] The analysis of Jupiter 2 in the analysis included in Viasat's Opposition and Reply was based on ViaSat-2 at 69.9º W.L.

In Table 2, for each of the adjacent spacecraft, the maximum on-axis gain value has been used for the receiving antenna at the satellite based on the assumption that the NGSO-to-GSO link falls within an area of peak gain of the adjacent spacecraft. The resulting I/N in each case is less than -12.2 dB, and in most cases considerably so. Accordingly, the rise in thermal noise at the victim is less than 6% delta T/T in all cases.

In its 14 July, 2017 Reply, Inmarsat states that "An earth station transmitting from a ViaSat MEO satellite to a GSO target satellite at the levels specified in 25.138(a) would result in a PFD level of approximately -149 dBW/m2/40/kHz at a GSO satellite two-degrees away from the target satellite" and asserts that the satellite-to-satellite links would exceed the $EPFD_{up}$ levels in Table 22-2 of the Radio Regulations. Inmarsat does not explain how it calculated this value, but by simply taking the maximum allowed EIRP density of 18.5 -25 x log (theta) dBW/40 kHz and inserting 2 degrees for theta and then subtracting ~160 dB-m^2 for spreading loss, the -149 dBW/(m^2*40 kHz) value results. The problem is that as discussed above, theta for this purpose is not 2 degrees from the Viasat MEO satellite to a GSO satellite that is spaced at a geocentric angle of 2 degrees from Viasat's target GSO satellite. Rather, theta is the meocentric theta angle between the two GSO satellites, which is 3.1 degrees.

Further, Viasat has proposed to operate at a reduced power as shown in Table 1 above such that the S/N at the target Viasat GSO satellite is the same for signals transmitted by the Viasat NGSO as for those transmitted by Viasat's other typical earth stations. This difference as shown in Table 1 is a reduced power output of about 3.5 dB, which again results from the difference in path loss for the NGSO station when compared to an earth station transmitting to the same target GSO satellite. When this reduction is taken into consideration and a typical operational symbol rate is used, the resulting PFD is considerably lower.

Performing the above calculation again using 3.1 degrees for theta and the reduced input power from Table 1 results in a maximum PFD of -168.4 dBW/(m^2*40 kHz).

Table 3 shows the power flux density (PFD) produced by the NGSO satellite at a GSO satellite operating at a geocentric separation angle of 2 degrees from the desired target Viasat GSO satellite when typical transmission characteristics are used.

Input power	11.3	W	
Antenna gain	44.5	dBi	
Off-axis angle to 2 deg Sat	3.1	deg	
Off-axis gain reduction	27.6	dB	
Bandwidth	160	MHz	
MEO to GEO distance	27586	km (at nadir)	
Spreading loss	159.8	dB-m^2	
PFD	-168.4	dBW/(m^2*40 kHz)	

Table 3 PFD at GSO satellite spaced 2° (geocentric) from desired target GSO

The PFD of -168.4 dBW/(m^2*40 kHz) is 6.4 dB lower than the epfd limit of -162 dBW/(m^2*40 kHz) in Table 22-2 of Article 22 of the ITU Radio Regulations, satisfying that limit with ample margin.

DECLARATION

I hereby declare that I am the technically qualified person responsible for preparation of the engineering information contained in the foregoing *Ex Parte* Response to Submissions in IBFS File No. SAT-PDR-20161115-00120 of Viasat, Inc. ("*Ex Parte* Response"), that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted with this *Ex Parte* Response, and that it is complete and accurate to the best of my knowledge, information and belief.

/s/

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