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

In the Matter of	)	
	)	
ViaSat, Inc.	)	IBFS File No. SAT-PDR-20161115-00120

CONSOLIDATED OPPOSITION AND REPLY COMMENTS OF VIASAT, INC.

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CONSOLIDATED OPPOSITION[1] AND REPLY COMMENTS OF VIASAT, INC.

ViaSat, Inc. hereby provides a consolidated response to the separate pleadings filed by Hughes Network Systems, LLC ("HNS"), Inmarsat Inc., SES S.A. and O3b Limited ("SES/O3b"), Space Exploration Technologies Corp. ("SpaceX"), Space Norway AS, Telesat Canada, and WorldVu Satellites Limited ("OneWeb") in response to the portion of ViaSat's petition for declaratory ruling that relates to the pending Ka-band processing round (the "Petition").

I. INTRODUCTION AND SUMMARY

In its Petition, ViaSat seeks access to the United States for its non-geostationary satellite orbit ("NGSO") fixed-satellite service ("FSS") system, which will utilize portions of the Ka and V bands (the "VIASAT-NGSO" satellite network). Grant of such access would serve the public interest in several important respects—including by facilitating ViaSat's ongoing efforts to provide high-quality, innovative satellite-based broadband services to users in the United States.

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1 This pleading is styled, in part, as an "Opposition" because each of Inmarsat and Telesat purports to have filed a "Petition to Deny." Inmarsat's and Telesat's pleadings do not satisfy the statutory requirements for such petitions; namely, they are not supported by an appropriate affidavit (or declaration) attesting to "specific allegations of fact sufficient to show that the petitioner is a party in interest and that a grant of the application would be prima facie inconsistent" with the public interest, convenience, and necessity. *See* 47 U.S.C. § 309(d). As such, their pleadings may be treated as no more than informal comments.

No party questions the significant benefits that would arise from the implementation of ViaSat's proposed system.

HNS, Inmarsat, SES/O3b, and OneWeb urge the Commission to block ViaSat's plans to implement a particular element of that system—namely, ViaSat's proposed satellite-to-satellite links, which would use Ka-band spectrum to transmit information between the VIASAT-NGSO network and geostationary satellite orbit ("GSO") satellites. The Commission should reject such unfounded suggestions, because ViaSat's proposed satellite-to-satellite links: (i) are entirely consistent with the plain language of the Commission's definition of the FSS, as well as with existing FSS allocations in the Ka band; and (ii) will operate in a technical manner that is similar to other FSS links (*i.e.*, within specific geometries and technical limits), enabling compatible coexistence with other FSS operations, both GSO and NGSO.

OneWeb's comments on the power-flux density ("PFD") and equivalent power-flux density ("EPFD") analyses presented in ViaSat's Petition are unfounded and easily addressed. As demonstrated in ViaSat's Petition and further explained herein, the VIASAT-NGSO system will comply with applicable PFD and EPFD limits.

Space Norway, SpaceX, and Telesat ask the Commission to impose special conditions on the VIASAT-NGSO system in order to address the peculiarities of their proposed NGSO systems. But as the Commission is aware, its rules and policies provide a specific mechanism for addressing such spectrum sharing conflicts among NGSO systems where they arise in the context of a processing round—namely, using a spectrum assignment methodology (band segmentation) that has been "on the books" for almost 15 years, and that the Commission has proposed to refine by using it in additional band segments only during defined temporal "in-line events" between NGSO systems. No party provides any justification for abandoning use of such a spectrum assignment mechanism and instead compelling ViaSat to shoulder the entirety of the coexistence burden by imposing special conditions on ViaSat's operations.

For these reasons, and others set forth in the Petition and below, the Commission should grant the VIASAT-NGSO system access to the United States, without any of the conditions suggested by any of the commenters, and after allowing ViaSat to amend its application to take into account any rule changes effectuated through the pending NGSO rulemaking.

II. ATTEMPTED CRITICISMS OF VIASAT'S PROPOSED SATELLITE-TO-SATELLITE LINKS DO NOT BEAR SCRUTINY

A. ViaSat's Proposed Satellite-to-Satellite Links Are Consistent with the Definition of FSS

ViaSat's Petition explains that the VIASAT-NGSO satellite network will use 27.5-29.1 GHz and 29.5-30.0 GHz FSS "uplink" spectrum and 17.8-19.3 GHz and 19.7-20.2 GHz FSS "downlink" spectrum to support high-speed transmissions between the VIASAT-NGSO system and in-orbit GSO satellite networks (which would include, but not be limited to, GSO satellites operated by ViaSat itself). This spectrum will be used in the same direction of transmission as other FSS communications relative to GSO satellites—*i.e.*, transmissions from NGSO satellites to GSO satellites will occur in "uplink" band segments designated for use in the "Earth-to-space" direction, and transmissions from GSO satellites to NGSO satellites will occur in "downlink" band segments designated for use in the "space-to-Earth" direction.[2]

HNS, Inmarsat, and OneWeb assert that the satellite-to-satellite links proposed in ViaSat's Petition are somehow inconsistent with existing FSS allocations under the United States

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[2] Petition at 5.

Table of Frequency Allocations for the Ka band.[3] But even a cursory review of the plain language of the Commission's rules reveals the fallacious nature of these claims. As ViaSat detailed in its Petition, Sections 2.1 and 25.103 of the Commission's rules explicitly provide that the FSS may include satellite-to-satellite links.[4] As such, satellite-to-satellite links expressly may be operated within existing FSS allocations.

Although HNS, Inmarsat, and OneWeb acknowledge that satellite-to-satellite links are contemplated by the definition of the FSS (to which the Ka band is allocated),[5] they effectively ask the Commission to ignore the plain language of its own rules by treating ViaSat's satellite-to-satellite links as "inter-satellite links" in the Inter-Satellite Service ("ISS") that would have to be conducted in other frequency bands. For example, HNS asserts that "[t]he appropriate radio service ViaSat *should* be looking to utilize is the ISS . . . ,"[6] which is the same thing as saying that ViaSat should be planning to use different spectrum than the Ka band for its satellite-to-

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3 Comments of Hughes Network Systems, LLC, IBFS File No. SAT-PDR-20161115-00120, at 3 (June 26, 2017) ("HNS Comments"); Petition to Deny of Inmarsat, Inc., IBFS File No. SAT-PDR-20161115-00120, at 2-3 (June 26, 2017) ("Inmarsat Petition"); Comments of WorldVu Satellites Limited, IBFS File No. SAT-PDR-20161115-00120, at 2 (June 26, 2017) ("OneWeb Comments").

4 47 C.F.R. §§ 2.1 and 25.103.

5 *See* Inmarsat Petition at 2-3 (acknowledging that "the Commission's definition of FSS contemplates 'in some cases' inter-satellite links"); HNS Comments at 3 ("ViaSat is correct to note that satellite-to-satellite links are mentioned in the definition."); OneWeb Comments at 2 (acknowledging that "inter-satellite links are included within the Commission's definition of FSS 'in some cases'"). Inmarsat and OneWeb incorrectly reference "inter-satellite links," even though the FSS definition addresses "satellite-to-satellite links," as does ViaSat's Petition.

6 HNS Comments at 3 (emphasis added). HNS attempts to justify its position by asserting that "there are no studies or technical references that support the generic use of FSS allocations, including in the Ka band, for inter-satellite communications." *Id*. But nothing in the Commission's rules requires an applicant to provide studies or technical references in order to utilize an existing allocation, particularly, as here, where the use would be consistent with the expected operating environment, as demonstrated further in Exhibit A hereto.

satellite links. That argument makes no more sense than saying that even though TTAC operations can be conducted in FSS-allocated Ka-band spectrum, they really should be conducted in spectrum allocated specifically for "space operations," such as the 2 GHz band. The Commission's rules explicitly recognize *both* FSS satellite-to-satellite links *and* ISS inter-satellite links as communications links that may be used to facilitate communications between satellites, in the different spectrum bands allocated for the FSS and the ISS. Thus, ViaSat has every right to exercise its own judgment in choosing the spectrum band segments in which it seeks to operate and requesting a suitable market access authorization.[7]

Equally unavailing is Inmarsat's unsupported assertion that the operation of ViaSat's proposed satellite-to-satellite links would constitute a "non-conforming use."[8] As discussed above, ViaSat's satellite-to-satellite links will conform to the Ka-band FSS allocations found in the United States Table of Frequency Allocations. Furthermore, as ViaSat explained in its Petition, the proposed satellite-to-satellite links will involve transmissions in the same directions (*i.e.*, away from the Earth and toward space; from space toward the Earth) anticipated under the Commission's rules, in a manner consistent with the directional designations of the FSS allocations for the Ka band.[9]

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[7] This is particularly true given that ViaSat's proposed satellite-to-satellite links will communicate with spacecraft outside the VIASAT-NGSO system, and thus would not be the type of *intra-system* links contemplated by the Commission in previous discussions of "inter-satellite links." *See, e.g., Space Station Licensing Rule and Policies*, 18 FCC Rcd 10760, at ¶ 125 (2003) ("*Space Station Licensing Reform Order*").

[8] Inmarsat Petition at 3.

[9] Such designations refer to the *direction* of contemplated transmissions, and not the location of end-points. *See, e.g.,* 47 C.F.R. § 25.202 (specifying EPFD limits for the space-to-Earth and Earth-to-space *directions*).

In short, no party establishes that ViaSat's proposed satellite-to-satellite links are inconsistent with either the FSS definition or the United States Table of Frequency Allocations.[10] The Commission's rules do not allow operators to dictate the system design decisions of their competitors or foreclose the introduction of new system features that are consistent with the Commission's regulatory framework. The Commission should not countenance the efforts of HNS, Inmarsat, and OneWeb to achieve a contrary result.

B. ViaSat's Proposed Satellite-to-Satellite Links Will Be Compatible with the Spectrum Uses of Other Satellite Operators

Contrary to the assertions of HNS, Inmarsat, OneWeb, and SES/O3b,[11] ViaSat's Petition established that its proposed satellite-to-satellite links will be able to coexist with other NGSO and GSO operations. Among other things, ViaSat's Petition provides specific technical information with respect to the proposed satellite-to-satellite links and clearly states that ViaSat will use "antenna and transmitting facilities on the MEO-to-GSO payload that are compliant with the Section 25.138 off-axis [EIRP] density mask" and that are capable of "ensuring a 3-sigma

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[10] Inmarsat wrongly suggests that ViaSat "acknowledges that operation of these links may not be contemplated by the Commission's rules." Inmarsat Petition at 3. Inmarsat mischaracterizes ViaSat's Petition, which: (i) emphatically states that the proposed satellite-to-satellite links are consistent with the definition of FSS and also (ii) seeks a waiver, to the extent one is necessary, as a precautionary measure. Petition at 6 & n.6. The request for such a waiver "in an abundance of caution" is particularly understandable given the rigid procedural rules applicable to NGSO processing rounds, which some parties may argue would preclude other parties from seeking waivers after the relevant cut-off date. Notably, no commenter has suggested that such a waiver would be inconsistent with the public interest in ViaSat's case.

[11] *See* HNS Comments at 4 (asserting that ViaSat "has not provided a technical analysis to demonstrate that there would not be harmful interference to other GSO and NGSO satellite systems operating on a co-channel basis in the same bands with its proposed ISS use"); Inmarsat Petition at 3 ("ViaSat fails to provide analysis that would provide any assurance to the Commission or GSO FSS operators that the MEO-to-GSO link would not cause interference to other GSO networks licensed to provide service to the U.S. or other countries."); *see also* OneWeb Comments at 3-5; Comments of SES S.A. and O3b Limited, IBFS File No. SAT-PDR-20161115-00120, at 4-5 (June 26, 2017).

antenna pointing error is less than 0.2 degrees," thus ensuring compatibility with the well-defined 2-degree spacing environment that governs communications with GSO satellites.[12] In contrast, no party provides any technical analysis demonstrating that ViaSat's proposed satellite-to-satellite links would pose any actual risk of harmful interference to other satellite systems.

Nevertheless, ViaSat takes this opportunity to expand upon its previous analysis and provide supplemental technical information to the Commission. Attached hereto as Exhibit A is a technical analysis providing additional background on ViaSat's proposed satellite-to-satellite links and how they will operate. As detailed therein, the operation of ViaSat's satellite-to-satellite links will occur at times when a given ViaSat NGSO satellite is within the pre-existing Earth coverage footprint of the corresponding GSO satellite. Stated differently, satellite-to-satellite link operations with a given GSO satellite will occur within the cone of coverage projected from that GSO satellite with respect to the Earth, and thus will be "focused" on that GSO satellite much like any two-degree-compliant earth station communicating with that GSO satellite.[13] Among other things, this will: (i) limit the potential for interference into other NGSO systems; (ii) ensure that ViaSat's NGSO satellites operate within the technical envelope of a typical VSAT terminal, including the service area of other VSATs in the target GSO satellite's coverage area; and (iii) preclude any need to change the coverage area or beam design of the target GSO satellite.

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12 Petition, Attachment A, at 7-11 and 22.

13 *See* Exhibit A at 2-3.

III. ONEWEB'S CLAIMS ABOUT THE VIASAT-NGSO SYSTEM ARE MERITLESS

In its comments, OneWeb criticizes aspects of the PFD and EPFD analyses presented in ViaSat's Petition. Each of OneWeb's three specific criticisms is addressed below.[14] As a threshold matter, though, ViaSat reiterates that the Commission's rules do not allow operators like OneWeb to dictate the system design decisions of their competitors. Similarly, the Commission's rules do not allow operators like OneWeb to determine what levels of "spectral density" an operator uses as it trades off providing a desired level of service with the obligation to share spectrum responsibly with other spectrum users. Indeed, since 2003, the Commission no longer conducts "beauty contests" in the processing-round context, where it would compare one system against the other, but rather allows market forces to operate after it licenses all qualified applicants while seeking to facilitate their coexistence.[15] As such, OneWeb's arguments simply have no legal relevance to the Commission's consideration of ViaSat's Petition, even if those arguments otherwise had merit (which they do not).

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[14] As a general matter, and as discussed in the Technical Annex included in ViaSat's Petition, the ViaSat Network Operations Center ("NOC") will manage the channel/beam mappings for each satellite. The NOC will take into consideration the protection of GSO networks (EPFD limits) and coexistence with other NGSO systems (band segmentation as required and coordination agreements) when computing the channel/beam mappings. This ensures that the VIASAT-NGSO system is in full compliance with all applicable Commission and ITU requirements—including those intended to facilitate the coexistence of NGSO systems and GSO networks.

[15] *See Space Station Licensing Reform Order* ¶¶ 32 (concluding that "dividing the available spectrum equally among the qualified applicants is the best way of issuing licenses for NGSO-like satellite systems quickly and fairly" and 40-41 (refusing to adopt any system of preferences in the selection of licensees).

A. OneWeb Misconstrues ViaSat's $EPFD_{down}$ Analysis

OneWeb references certain PFD masks used in ViaSat's $EPFD_{down}$ analysis as the basis for (wrongly) claiming that the VIASAT-NGSO system would be spectrally inefficient.[16] Namely, OneWeb references a single PFD mask, for a VIASAT-NGSO satellite at 10 degrees latitude.[17] As the Commission is aware, NGSO satellites operating near the equatorial plane need to protect GSO operations, and thus face certain operational constraints in that region of the NGSO orbit. Thus, a PFD mask for an NGSO satellite at a 10-degree latitude will generally imply a less-intensive use of spectrum "throughput" than a PFD mask for a satellite at higher latitudes. For this reason, OneWeb's decision to focus on the 27 dB signal span reflected in the PFD mask at 10 degrees latitude is highly misleading. Critically, that signal span is *not* indicative of the overall performance of the VIASAT-NGSO system.

OneWeb's suggestion that the VIASAT-NGSO system would only operate at peak PFD over "a small fraction of its service area" is similarly wrong and misleading.[18] For reasons similar to those discussed above, the PFD mask at 10 degrees latitude reflects the need for a VIASAT-NGSO satellite at that location to protect GSO satellite networks near the equatorial plane. The PFD levels employed by the system will increase as any given VIASAT-NGSO satellite moves away from the equatorial plane.

B. ViaSat's $EPFD_{up}$ Analysis Is Accurate

ViaSat's $EPFD_{up}$ analysis necessarily makes certain assumptions about the number of users simultaneously transmitting within any given satellite footprint. OneWeb asserts that these

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16 OneWeb Comments at 6.

17 *Id.* at 5-6.

18 *Id.*

assumptions are "unrealistically optimistic," resulting in calculated $EPFD_{up}$ levels that are unreasonably low.[19] In particular, OneWeb alleges that ViaSat does not account for "the use of multiple steerable beams on ViaSat's NGSO satellites, which provide the capability to concentrate all their beam coverage over restricted geographic regions."[20]

As an initial matter, ViaSat does not intend to operate its system in the manner suggested by OneWeb. As such, the scenario about which OneWeb speculates is not realistic or relevant. In any event, the $EPFD_{up}$ analysis included in ViaSat's Petition is conservative. ViaSat's decision to deliberately increase the assumed number of simultaneous co-frequency uplink transmissions reflects this conservative approach. Indeed, ViaSat's $EPFD_{up}$ analysis assumes 20 simultaneous co-frequency uplink beams per ViaSat satellite. Any given ViaSat satellite, however, actually will only support 16 Ka-band uplink spot beams (8 in each polarization) in *total*. Furthermore, ViaSat's $EPFD_{up}$ analysis is based on a case in which two ViaSat satellites serve a given area with co-frequency beams, even though ViaSat intends to operate its system such that only one satellite will serve an area at a given time. The result is that ViaSat's $EPFD_{up}$ actually overstates the level of expected power by a factor of over 2.[21]

C. ViaSat Has Demonstrated that the VIASAT-NGSO System Will Comply with Applicable PFD Limits

OneWeb suggests that ViaSat has provided an insufficient demonstration that it will comply with applicable ITU PFD limits, particularly at elevation angles under 25 degrees.[22]

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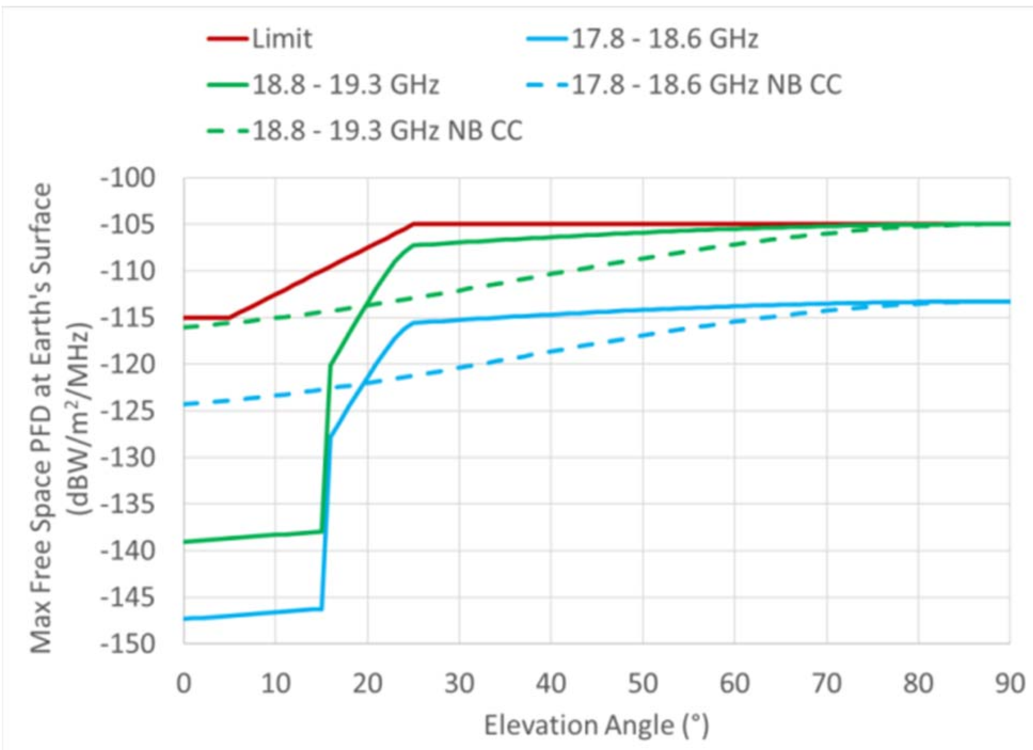
19 *Id.* at 7.

20 *Id.*

21 ViaSat performed its analysis under these very conservative assumptions in order to ensure sufficient margin to account for non-uniform beam pointing and compensate for certain limitations in EPFD software.

22 OneWeb Comments at 8.

ViaSat's Petition already includes the technical information required by the Commission's rules. Nevertheless, ViaSat takes this opportunity to provide additional information to respond to OneWeb. More specifically, the following figure shows the maximum free-space PFD generated by the VIASAT-NGSO system at the Earth's surface as a function of elevation angle. The applicable Section 25.208 limit is shown along with curves for ViaSat's wideband service beams and narrowband control channel ("NB CC") in the 17.8-18.6 GHz and 18.8-19.3 GHz band segments. As reflected in the graph, VIASAT-NGSO will comply with the applicable PFD limits in all cases.



IV. ANY *ACTUAL* INTER-NGSO-SYSTEM INCOMPATIBILITIES SHOULD BE RESOLVED THROUGH SPECTRUM ASSIGNMENT METHODOLOGIES

Space Norway, SpaceX, and Telesat assert that their proposed NGSO systems would be incompatible with the VIASAT-NGSO system. Accordingly, they suggest that the Commission should impose special conditions on ViaSat, or otherwise require ViaSat to alter its proposed

NGSO operations, to allow the operations of other NGSOs to proceed on an unimpeded basis. In doing so, Space Norway, SpaceX and Telesat ignore the Commission's long-established NGSO spectrum assignment framework, which: (i) explicitly anticipates the possibility that different operators will propose different system designs, and that some of those designs will not be fully compatible with each other; and (ii) establishes band segmentation as the mechanism for ensuring radiofrequency compatibility between "conflicting" system designs. Those commenters also ignore the Commission's proposal to modify that baseline processing rule and use band segmentation across the Ka band only during certain defined "in line events" between NGSO systems.[23]

A. There Is No Basis for Imposing Conditions on the VIASAT-NGSO System to Accommodate Space Norway

Space Norway has proposed to operate a highly elliptical orbit ("HEO") NGSO system that would employ very large beams and employ only two spacecraft. Space Norway claims that this proposed system would be incompatible with the VIASAT-NGSO system, and suggests that ViaSat should be compelled to alter or constrain its operations to accommodate the Space Norway system.[24] Notably, Space Norway has taken a similar position with respect to other applications in this processing round, in each case suggesting that low earth orbit ("LEO") and

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23 *See Space Station Licensing Reform Order* ¶¶ 32-33 (adopting band-segmentation as the default mechanism for resolving mutual exclusivity in NGSO processing rounds in order to facilitate competitive entry and shared use of available spectrum bands); 47 C.F.R. §§ 25.157 (codifying default mechanism) and 25.261 (adopting the "avoidance of in-line interference" mechanism for certain Ka-band segments, but establishing band segmentation as the default mechanism for resolving in-line events when they occur); *see also Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters,* Notice of Proposed Rulemaking, 31 FCC Rcd 13651, at ¶ 23 (2016).

24 Comments of Space Norway AS, IBFS File No. SAT-PDR-20161115-00120, at 3-4 (June 26, 2017).

MEO systems should shoulder the entirety of the sharing burden with Space Norway's HEO system.[25]

Essentially, Space Norway asks LEO and MEO systems to protect Space Norway's NGSO system by applying, with respect to Space Norway's NGSO system, the Article 22 $EPFD_{down}$ limits (Table 22-1C) that otherwise apply only with respect to GSO satellites. To satisfy such a requirement, which otherwise does not exist, MEO and LEO systems would have to create an exclusion zone around Space Norway's HEO satellites, much as NGSOs have to create an exclusion zone around the GSO arc in order to satisfy Article 22 limits.[26]

Space Norway provides no justification for abandoning the band-segmentation approach reflected in the Commission's existing rules and policies for NGSO-like systems. Notably, the Commission's approach is architecture-agnostic, treating MEO, LEO, and HEO systems in a similar fashion. Under this approach, Space Norway would at worst have access to its fair share of spectrum in impacted band segments—*e.g.,* one-half of otherwise-available spectrum in the event of incompatibility with ViaSat's NGSO system, a result that equitably shares the burdens of coexistence.

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25 *See* Comments of Space Norway AS, IBFS File Nos. SAT-PDR-20161115-00112 (LeoSat); SAT-AMD-20161115-00116 (O3b); SAT-LOA-20161115-00118 (SpaceX); SAT-PDR-20161115-00108 (Telesat); SAT-LOA-20161115-00121 (Theia).

26 If Space Norway's approach were extended to other HEO systems, such as the proposed Ka-band systems of Boeing and Karousel, MEO and LEO Ka-band systems also would have to create exclusion zones around those other networks, meaning that large geographic areas would exist where the MEO and LEO systems could not operate with HEO NGSO systems on a shared, co-frequency basis, and where only HEO systems effectively would have access to spectrum. That proposal is fundamentally inconsistent with both the band-segmentation rules that currently exist, and the proposal to utilize band segmentation in additional band segments only during defined in-line events.

B. There Is No Basis for Compelling ViaSat to Change the VIASAT-NGSO System Design as Suggested by SpaceX

SpaceX criticizes ViaSat's chosen NGSO system design because it allegedly would be incompatible with that proposed by SpaceX. More specifically, SpaceX argues that, as a consequence of ViaSat's orbital altitude (8,200 km as compared to SpaceX's 1,110 km), ViaSat's uplink emissions would cause interference into any SpaceX NGSO satellite passing through a ViaSat earth station's main beam or sidelobe.[27] Importantly, SpaceX does not establish that this unwanted energy would have any actual impact on the performance of SpaceX's system, which incorporates high levels of satellite diversity.

To the extent that SpaceX is alleging that its system is truly incompatible with ViaSat's system, this mutual exclusivity can and should be resolved through the Commission's existing band-segmentation procedures (as they may be modified through the "avoidance of in-line interference" mechanism). SpaceX itself acknowledges that the Commission's band-segmentation procedures would normally apply in that scenario.[28] Even so, SpaceX inexplicably suggests that it would be appropriate for the Commission to eschew those procedures and instead compel adjustments in ViaSat's system design in order to accommodate SpaceX.[29]

There is no basis for such a result—particularly as the record strongly suggests that SpaceX's chosen system design is responsible for any unwanted energy it may experience.

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27 Comments of Space Exploration Technologies Corp., IBFS File No. SAT-PDR-20161115-00120, at 4-8 (June 26, 2017) ("SpaceX Comments"). There are significant reasons to question the accuracy of SpaceX's analysis. For example, SpaceX mischaracterizes ViaSat's system as "using Ku and Ka band spectrum" and presents diagrams purporting to illustrate ViaSat's Ku-band footprint and the potential for in-line events between ViaSat's Ku-band beams and SpaceX satellites—even though the VIASAT-NGSO system *will not operate in the Ku band*.

28 *Id.* at 2.

29 *Id.* at 9.

Tellingly, SpaceX filed similar comments with respect to the NGSO systems proposed by Boeing, Karousel, Space Norway, LeoSat, and Telesat Canada.[30] In each case, SpaceX alleges that its uplink beams would suffer interference from the uplinks of those other NGSO operators. This alone suggests that, to the extent any incompatibility actually exists: (i) SpaceX is the source of any incompatibility; and (ii) it would be most efficient to require SpaceX to adjust its system design to eliminate that incompatibility.

C. Telesat's Criticisms of the VIASAT-NGSO System Design Are Unfounded

Telesat asserts that the ViaSat and Telesat NGSO systems are incompatible in that simultaneous, co-frequency operation of both systems is expected to result in frequent in-line events. Telesat further asserts that ViaSat's Petition should be denied because Telesat has priority over ViaSat at the ITU.[31] Telesat's assertions are misguided. As the Commission has made clear, all applicants in a given processing round have co-equal licensing priority, without regard to ITU priority.[32] As noted above, the Commission has established a specific mechanism for addressing circumstances in which two or more NGSO systems are mutually exclusive—band segmentation, whether alone or in conjunction with the "avoidance of in-line interference" mechanism. Telesat provides no justification for summarily and arbitrarily abandoning this mechanism in favor of one grounded in ITU priority.

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30 *See* Comments of Space Exploration Technologies Corp., IBFS File Nos. SAT-LOA-20161115-00109 (Boeing); SAT-LOA-20161115-00113 (Karousel); SAT-PDR-20161115-00112 (LeoSat); SAT-PDR-20161115-00111 (Space Norway); and SAT-PDR-20161115-00108 (Telesat).

31 Petition to Deny of Telesat Canada, IBFS File No. SAT-PDR-20161115-00120, at 3 (June 26, 2017).

32 *See Space Station Licensing Reform Order* ¶¶ 40-41 (specifically declining to adopt any system of preferences for use in choosing among applicants in a given processing round).

V. CONCLUSION

ViaSat's Petition establishes that granting the VIASAT-NGSO system access to the United States would serve the public interest, convenience, and necessity. No party has suggested—let alone demonstrated—otherwise. Many of the technical issues raised simply ignore longstanding Commission rules and policies and attempt to hobble ViaSat to the advantage of other applicants in this processing round. Those arguments are impermissible and non-cognizable attempts to redesign the VIASAT-NGSO system, and also are substantively flawed. Accordingly, the Commission should grant the VIASAT-NGSO system access to the United States, without any of the conditions suggested by any of the commenters, and after allowing ViaSat to amend its application to take into account any rule changes effectuated through the pending NGSO rulemaking.

Respectfully submitted,

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July 7, 2017

Exhibit A:
Supplemental Technical Explanation of VIASAT-NGSO Satellite-to-Satellite Links

This exhibit provides additional technical information regarding the VIASAT-NGSO system's satellite-to-satellite (*i.e.*, NGSO-to-GSO) links, and the NGSO-to-GSO payload that will facilitate the operation of those links.

As described in the Technical Annex of ViaSat's Petition, the technical operating characteristics of the NGSO-to-GSO payloads on the VIASAT-NGSO satellites will closely resemble those of typical VSAT earth stations in ViaSat's GSO satellite networks. In a typical ViaSat fixed VSAT network, ViaSat VSAT earth stations first acquire reception of the downlink signal originating from the relevant hub side gateway or satellite access node (SAN) serving that location. This outbound or forward link transmission contains information that tells the VSAT site which frequencies are available for it to use for its uplink carrier and when it can burst into the MF-TDMA return link. This is also true for the earth stations in motion (ESIMs) that already operate within ViaSat GSO networks. Information in the forward link transmission from the SAN is used to update the coverage maps and satellite ephemeris database in the ESIM's modem and antenna controllers so they know which beams/frequencies to use on each satellite within the ViaSat network and about any coverage limitations, etc. As the ESIMs travel, they automatically switch frequencies, data rate, polarization, and even satellites as appropriate. Where geographic coverage limitations are encountered, the ESIM automatically stops transmitting until it moves outside a restricted location and/or back inside the satellite network's defined coverage.

The NGSO-to-GSO payloads will also operate at the same data rates, at the same power levels, and within the same footprint beams as a typical VSAT/ESIM. The VIASAT-NGSO satellites are expected to use antennas of similar size class to a typical VSAT/ESIM and, in the examples that follow, a 75 cm class antenna has been assumed. As the VIASAT-NGSO satellites travel through their orbit and pass within the coverage of a ViaSat GSO satellite, the receiver of the NGSO-to-GSO payload will lock to the same downlink signal of the forward/outbound transmission as a normal VSAT/ESIM and will download any required updates to its databases prior to attempting to transmit up to the target GSO satellite. These updates will include any coverage or operational restrictions for the NGSO-to-GSO link.

The operation of the NGSO-to-GSO links will occur within the coverage areas of the target GSO satellites. Assume, by way of example, a GSO satellite with visible Earth coverage. The operation of the NGSO-to-GSO links communicating with that particular GSO satellite will occur within the cone of coverage projected from that GSO satellite to the Earth. This is depicted graphically in Figure 1, where the coverage area of the GSO satellite on Earth is depicted by the cone. The VIASAT-NGSO satellites outside the "coverage cone" and marked with an X in the link will not communicate with that GSO satellite when they are outside that cone of coverage. But if those VIASAT-NGSO satellites were within the "coverage cone" of another GSO satellite, they could communicate with that other GSO satellite.

For the NGSO-to-GSO payloads, the transmission levels required to produce a signal at the target satellite with the desired signal to noise ratio are similar to those of a typical VSAT or ESIM. Actually, the NGSO-to-GSO link has slightly less path loss and no atmospheric losses to overcome, so the resulting transmitted e.i.r.p. density is about 3.5 dB lower than for a typical VSAT or ESIM. With respect to adjacent GSO satellites, the NGSO-to-GSO payloads actually generate less unwanted energy than a typical VSAT or ESIM due to the larger off-axis angle from MEO altitude toward the adjacent GSO spacecraft.

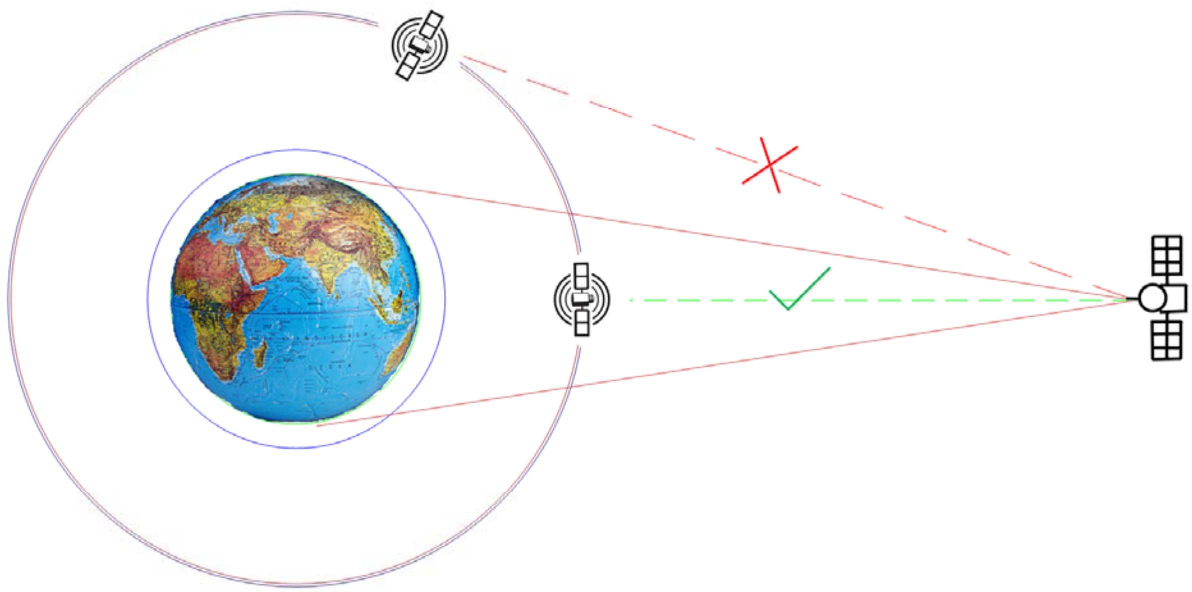

Figure 1 – Operational Coverage Area For NGSO-to-GSO Links

In Tables 1 and 2, a simple Earth-to-space link is presented for both a fixed VSAT and for an NGSO-to-GSO satellite-to-satellite link. Table 1 shows that the transmitted power required from a NGSO-to-GSO payload is about 3.5 dB less than for a typical fixed VSAT on the ViaSat-2 network. Table 2 shows a similar Earth-to-space link but this time examining the I/N at potential victim satellites. Note that because the MEO orbit of 8200 km altitude is closer to GSO, 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 than for a VSAT/ESIM on the Earth. The potential adjacent satellites examined were Inmarsat's GX satellite at 55º W, the EchoStar/HNS Jupiter 2 satellite at 97.1º W, the EchoStar XVII satellite at 107.1º W, and a notional GSO satellite separated by only 2 degrees from a ViaSat target GSO. In each case, the target ViaSat satellite for the satellite-to-satellite link was selected to be the closest in longitude to the adjacent GSO satellite so as to make the off-axis angle between the VIASAT-NGSO satellite and the adjacent GSO as small as possible. In the case of Inmarsat GX, the ViaSat-2 satellite at 69.9º W was used as the target satellite, and in the case of Jupiter 2, ViaSat-3 at 89º W was used as the target. For the EchoStar XVII analysis, WildBlue-1 at 111.1º W was used as the target satellite.

	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

	NGSO		GX 55 W	Jupiter 2	Echo XVII	2 Deg Sat	
Antenna input power	11.3						W
Symbol rate	160.0						MBd
Antenna input density	-11.5						dBW/MHz
Off-axis angle to victim			22.5	40.1	6.1	3.1	deg
75 cm antenna gain			-1.8	-8.1	9.4	16.9	dBi
EIRP density			-13.3	-19.6	-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	-230.0	-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	53.0	dBi
Interference at sat receiver (I)			-182.8	-177.0	-159.6	-152.1	dBW/MHz
Satellite noise			690.0	1250.0	1250.0	1250.0	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	-137.6	dBW/MHz
Interference to noise at rx (I/N)			-42.6	-39.4	-22.0	-14.5	dB

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

In Table 2, it is assumed that, for each of the adjacent spacecraft, the maximum on-axis gain value has been used for the receiving antenna at the satellite. This is 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 the case of OneWeb and O3b, their orbits fall below that of the VIASAT-NGSO orbit by 7000 km and 200 km, respectively. Because the antenna for the NGSO-to-GSO link will be located on the side of the spacecraft facing the GSO orbit, the off-axis angle toward each of the two lower orbits will be nearly 180 degrees and in addition to the off-axis gain reduction in that direction, signals in the direction of the lower orbits will be further attenuated by the body of the spacecraft, which is between the antenna and the lower orbits.

Similarly, the Earth-facing antennas on the OneWeb and O3b spacecraft are assumed to be nearly 180 degrees off-axis toward the VIASAT-NGSO satellites. There may be additional blockage in the direction of the VIASAT-NGSO satellite by the OneWeb or O3b spacecraft body, but,in any case, with each antenna pointed nearly 180 degrees from the other, any interference from the NGSO-to-GSO link will be very small.

To further verify the above calculations for the interference from the VIASAT-NGSO satellite's NGSO-to-GSO links, as well as the presumed lack of signal coupling in the case of OneWeb and O3b, Visualyse simulations were developed to validate the lack of interference.

In the case of Inmarsat, a variety of tracking scenarios were examined where ViaSat-2 was set up as the target satellite so as to provide the least off-axis gain discrimination toward the Inmarsat GX satellite at 55º W – see Figures 2 and 3 for a 2D and 3D depiction of the satellites in the simulation and the related links. The simulation was set up to look at the interference into a single GX spot beam, while the NGSO orbits were propagated over a 30-day simulation period. As show in Figure 4, the worst-case I/N reported by Visualyse was -45.6 dB. The simulation was repeated for a number of different spot beam locations, with no difference observed in the worst-case I/N.

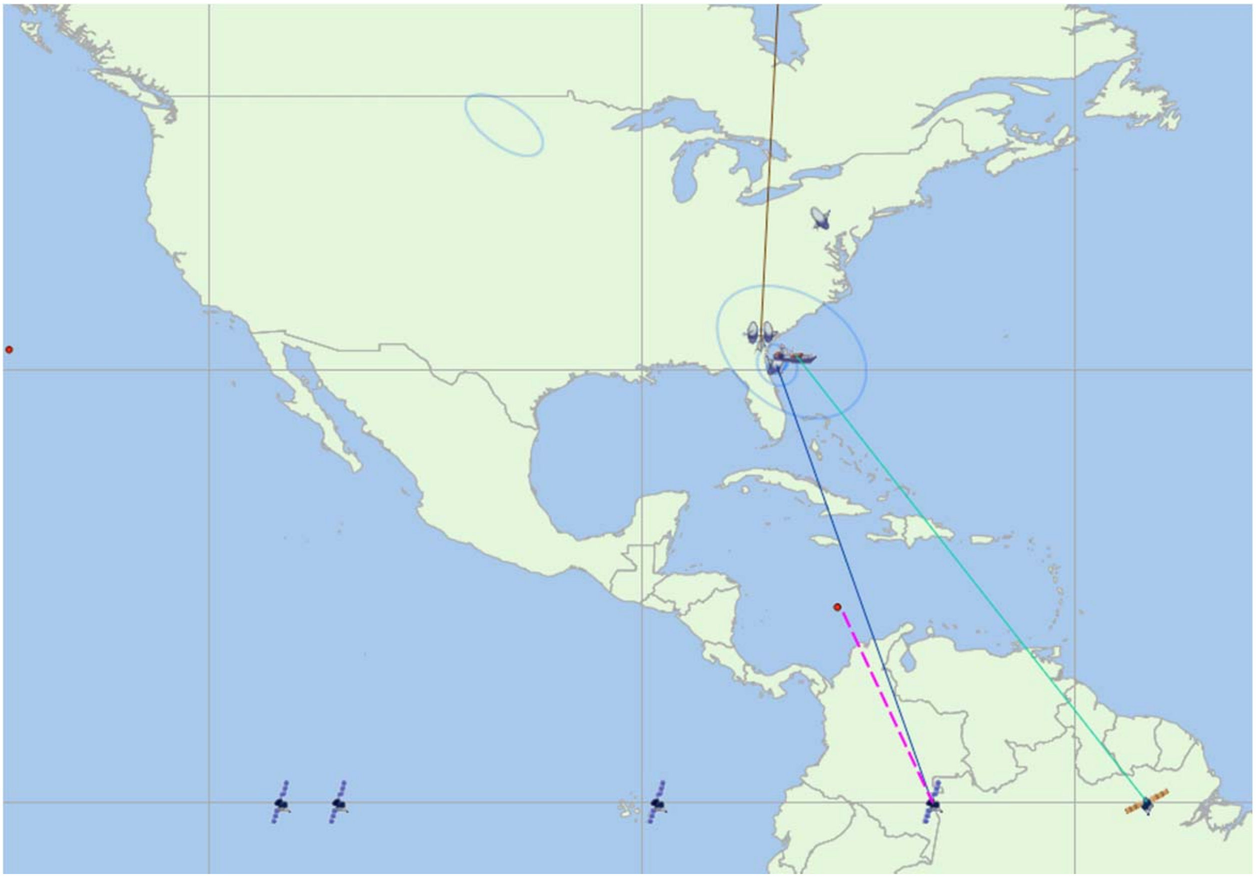

Figure 2 – Visualyse 2D simulation view for Inmarsat scenario showing NGSO-to-GSO link

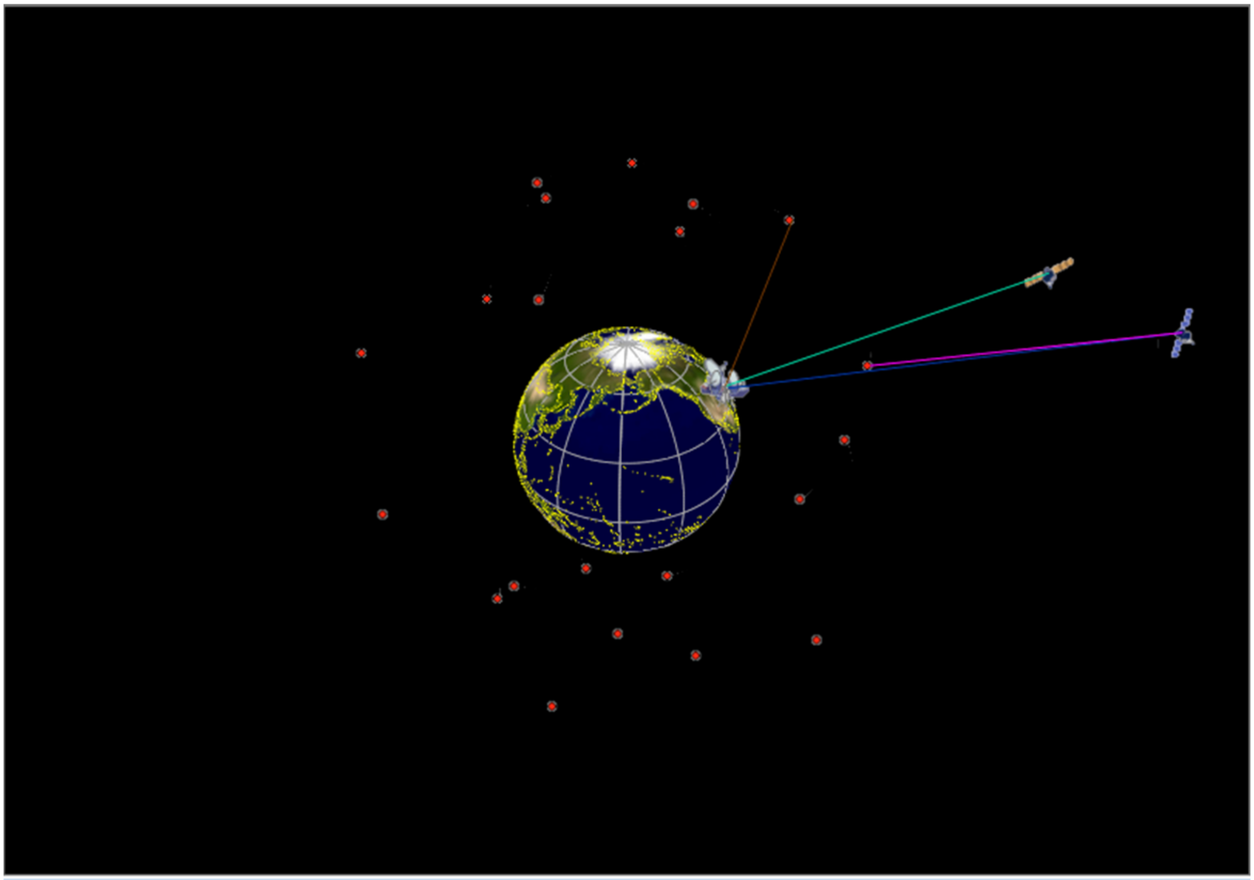

Figure 3 – Visualyse 3D simulation view with Inmarsat GX, ViaSat-2, and NGSO-to-GSO link

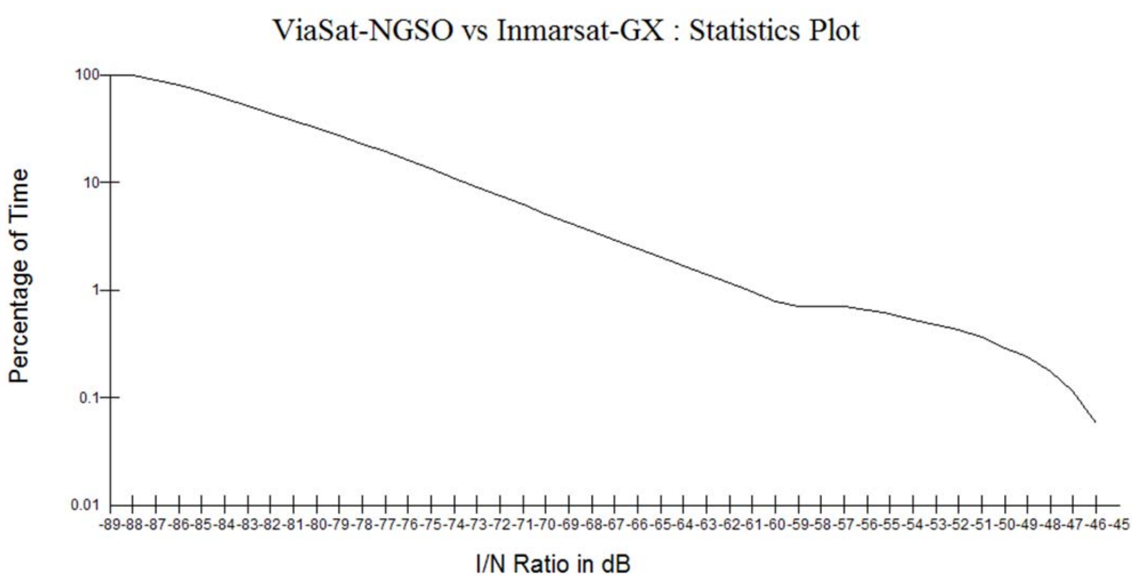

Figure 4 – NGSO-to-GSO link I/N into Inmarsat GX as a percentage of time

Similarly, the simulation for EchoStar/HNS was configured to use the worst-case closest ViaSat satellite to the adjacent EchoStar/HNS satellite. In this case, WildBlue-1 at 111.1º W was the target GSO satellite and EchoStar XVII at 107.1º W was the adjacent spacecraft, because this combination represented the smallest orbital separation of the various ViaSat/EchoStar parings. After a 30-day simulation period, the worst-case reported I/N into one of the spot beams was -22.6 dB. Figure 5 shows the I/N into EchoStar XVII as a percentage of time. As was the case with Inmarsat GX, moving the location of the adjacent satellite's spot beam about the coverage area did not change the worst-case I/N or the distribution as a percentage of time.

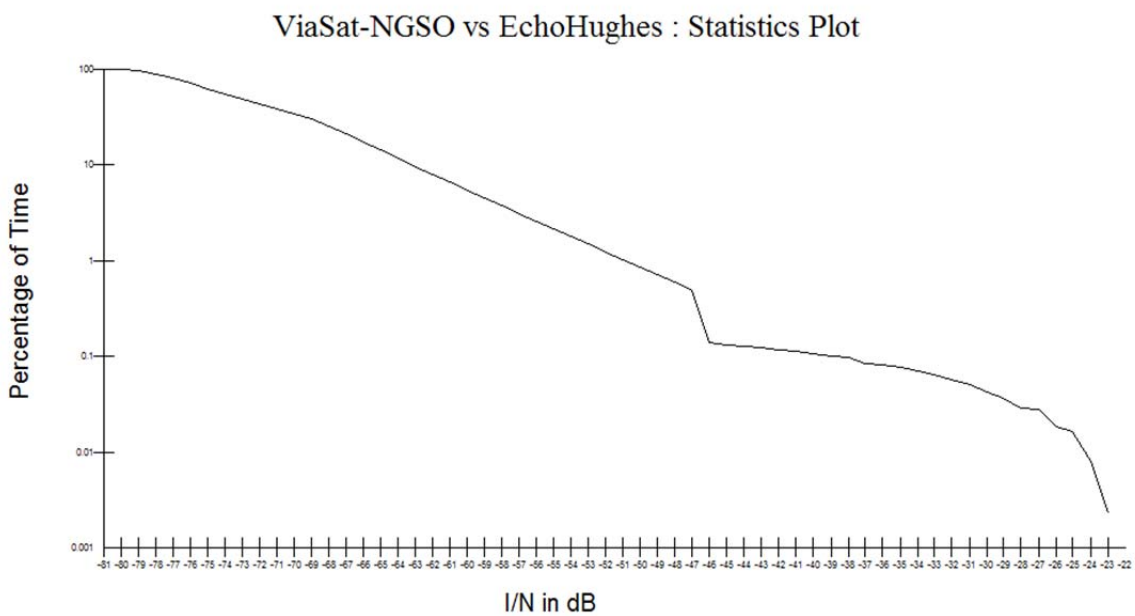

Figure 5 – NGSO-to-GSO link I/N into OneWeb as a percentage of time

As expected for the LEO and MEO NGSO systems with lower altitude than the VIASAT-NGSO satellites, and with the antennas of each system pointed in opposite directions, the I/N values reported by Visualyse were considerably lower than for the GSO satellites above. The worst-case I/N observed for OneWeb was for all practical purposes immeasurable at -86.5 dB, and for O3b with the shorter path loss between systems, the worst-case I/N observed was somewhat higher at -51.9 dB, but still vanishingly small. Figure 6 shows the Visualyse 3D simulation view for OneWeb and Figure 8 shows a similar 3D view for O3b. In each of the views, the red dots represent the VIASAT-NGSO satellites and the blue dots represent the other NGSO satellites. A green line is used to represent the desired link between the other NGSO system's earth station and satellite. The blue line represents a link between a ViaSat earth station and GSO satellite. A brown line represents a ViaSat earth station to VIASAT-NGSO link. A magenta line represents a ViaSat NGSO satellite's NGSO to GSO link. Figures 7 and 9 show the resulting I/N from the ViaSat NGSO-to-GSO links into the other NGSO system as a percentage of time.

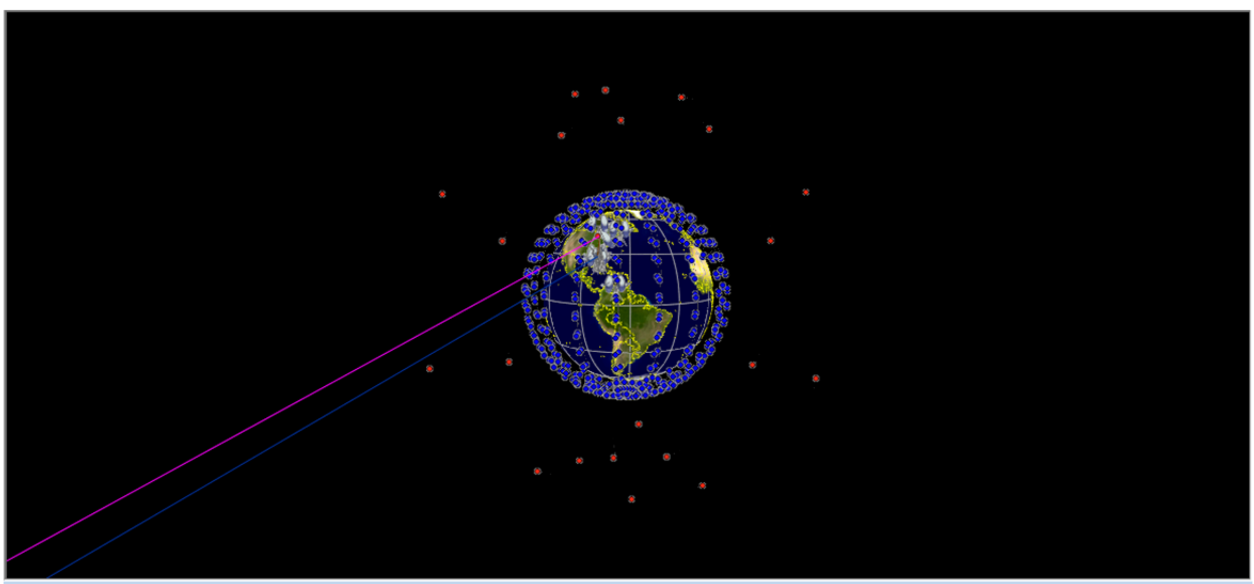

Figure 6 – Visualyse 3D simulation view with OneWeb and active NGSO-to-GSO link

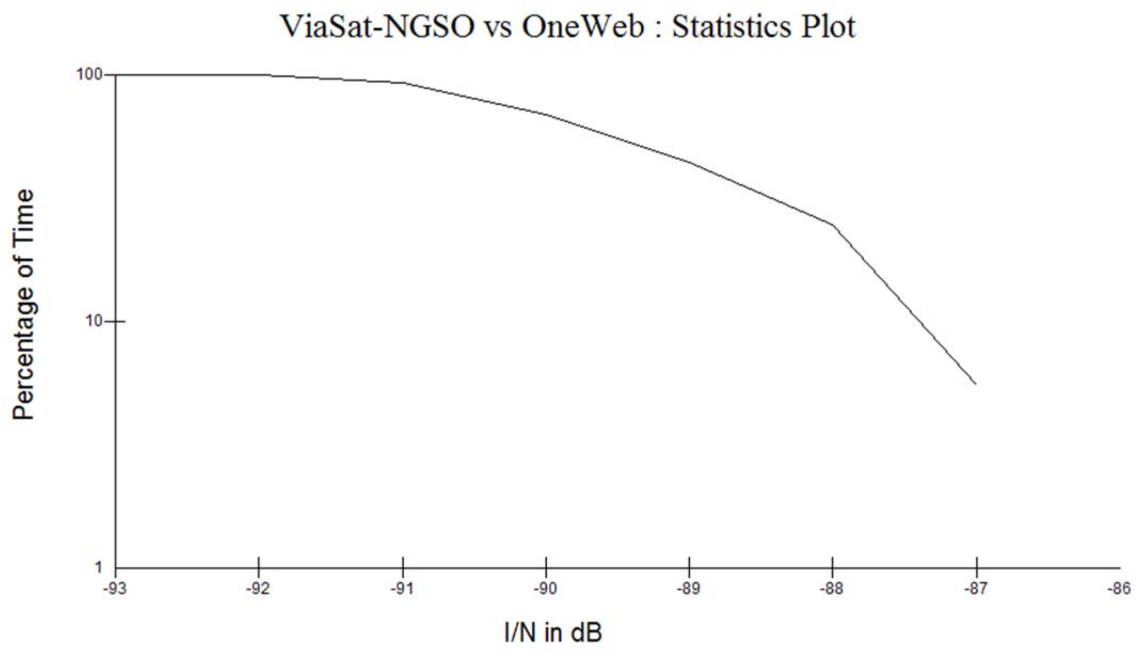

Figure 7 – NGSO-to-GSO link I/N into OneWeb as a percentage of time

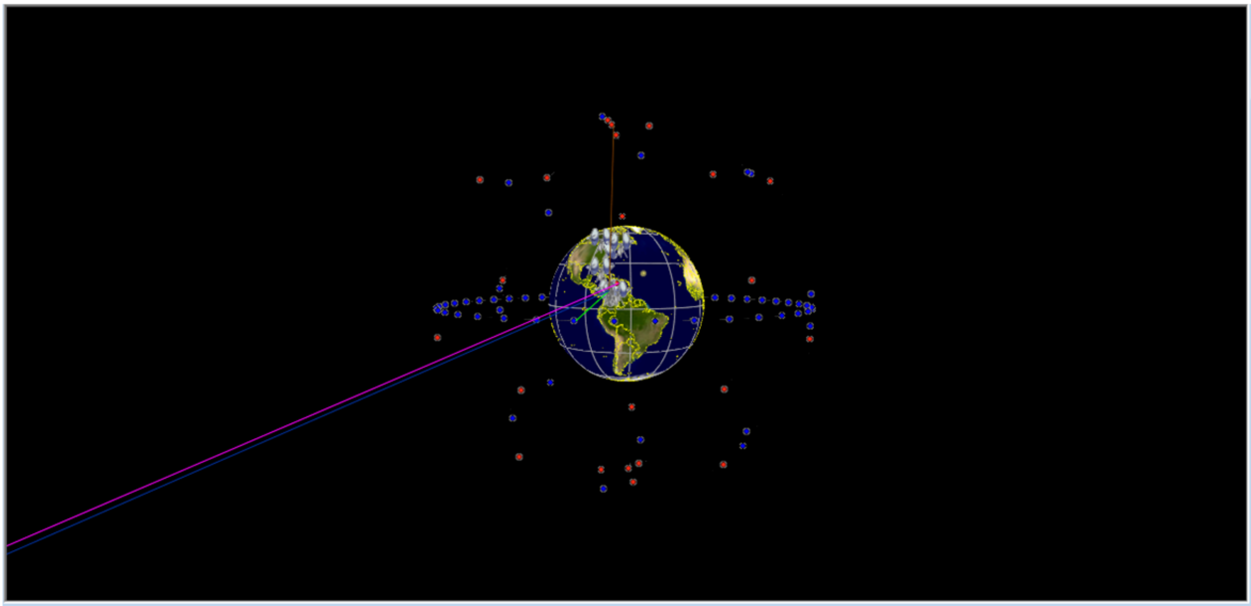

Figure 8 – O3b Visualyse 3D view of O3B system and active NGSO-to-GSO link

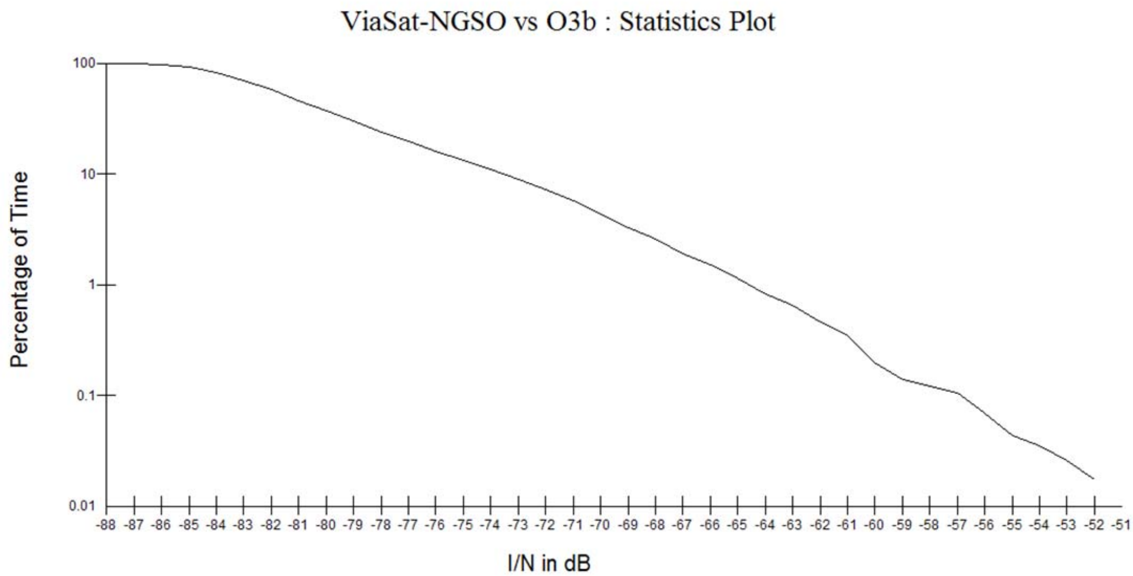

Figure 9 – NGSO-to-GSO link I/N into O3b as a function of time

DECLARATION

I hereby declare that I am the technically qualified person responsible for preparation of the engineering information contained in the foregoing Consolidated Opposition and Reply Comments of ViaSat, Inc., 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 pleading, and that it is complete and accurate to the best of my knowledge, information and belief.

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July 7, 2017

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I, Jarrett S. Taubman, hereby certify that on this 7th day of July, 2017, I served true and correct copies of the foregoing Consolidated Opposition and Reply Comments of ViaSat, Inc. via first-class mail upon the following:

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