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

In the Matter of	)	
	)	
Audacy Corporation	)	IBFS File No. SAT-LOA-20161115-00117
	)	Call Sign S2982
	)	
The Boeing Company	)	IBFS File No. SAT-LOA-20161115-00109
	)	Call Sign S2977
	)	
Karousel LLC	)	IBFS File No. SAT-LOA-20161115-00113
	)	Call Sign S2980
	)	
LeoSat MA, Inc.	)	IBFS File No. SAT-PDR-20161115-00112
	)	Call Sign S2979
	)	
O3b Limited	)	IBFS File Nos. SAT-MOD-20160624-00060
	)	and SAT-AMD-20161115-00116
	)	Call Sign S2935
	)	
Space Exploration Holdings, LLC	)	IBFS File No. SAT-LOA-20161115-00118
	)	Call Sign S2983
	)	
Space Norway AS	)	IBFS File No. SAT-PDR-20161115-00111
	)	Call Sign S2978
	)	
Telesat Canada	)	IBFS File No. SAT-PDR-20161115-00108
	)	Call Sign S2976
	)	
Theia Holdings A, Inc.	)	IBFS File No. SAT-LOA-20161115-00121
	)	Call Sign S2986

PETITION TO DENY OR IMPOSE CONDITIONS OF VIASAT, INC.

ViaSat, Inc. hereby petitions the Commission to deny or impose conditions on the above-captioned applications, which were filed in the pending non-geostationary-satellite orbit ("NGSO") processing round covering the Ku and Ka bands (the "Applications"). ViaSat is filing this petition in its capacity as an operator of Ka-band geostationary-satellite orbit ("GSO") networks. ViaSat does not take a position in these comments on the feasibility of allowing co-frequency operations among multiple NGSO systems in the Ka band using the "avoidance of in-

line interference" mechanism proposed in the pending NGSO rulemaking proceeding in IB Docket No. 16-408 (*i.e.,* the means of NGSO-NGSO spectrum sharing).[1]

As the Commission knows, ViaSat currently provides satellite broadband services using a fleet of Ka-band GSO satellites, and is expanding its existing capacity with additional GSO satellites featuring even more advanced capabilities. In this processing round, ViaSat has proposed to augment its GSO capabilities by implementing a new NGSO system, which would use spectrum in the Ka and V bands.[2]

ViaSat has previously raised concerns about the potential for NGSO operations in the Ka band to cause harmful interference into adjacent GSO operations. Among other things, ViaSat has explained that compliance with the equivalent power-flux density ("EPFD") limits that the Commission has proposed to apply to the Ka band, alone, would not adequately mitigate the potential for NGSO systems to cause such interference. ViaSat's concerns arise because those proposed EPFD limits: (i) are based on limits adopted by the International Telecommunication Union ("ITU") nearly two decades ago, without accounting for significant changes in the operating environment and the technologies associated with today's modern, high-capacity GSO networks; (ii) were based on the operation of 3.5 NGSO systems; (iii) do not address the impact of *aggregate uplink* interference from multiple NGSO systems—a critical omission given the many Ka-band NGSO systems proposed in this processing round; and (iv) do not address how the proposed aggregate downlink EPFD limit, or the aggregate uplink EPFD limit that must still be developed, would be apportioned across multiple NGSO systems and enforced.

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1 *See Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, Notice of Proposed Rulemaking, FCC 16-170, IB Docket No. 16-408, at ¶¶ 22-27 (Dec. 14, 2016) ("*NGSO NPRM*").

2 *See* IBFS File No. SAT-LOI-20161115-00120.

Following the end of the pleading cycle in the NGSO rulemaking proceeding on April 10, 2017, many of the applicants in this processing round submitted additional technical information with respect to EPFD compliance.[3] ViaSat's analysis of the Applications, as supplemented with this additional technical information, suggests that the NGSO operations proposed in each Application, when evaluated in isolation, should not pose a risk of harmful interference to ViaSat's existing and future Ka-band GSO operations as long as *actual and authorized* NGSO operations are limited to the parameters specified in the Applications. The Commission can therefore ensure that GSO networks are adequately protected from *any single* proposed NGSO system by providing each applicant authority based on precisely what it has requested in the underlying Application—*but not more*. At the same time, the Commission can address the continuing risk of harmful interference from the simultaneous co-frequency operation of multiple NGSO systems by: (i) conditioning any grant of authority on the outcome of the pending NGSO rulemaking proceeding in IB Docket No. 16-408; and (ii) making clear that, unless and until suitable aggregate limits and related enforcement mechanisms are adopted, each and every NGSO operator is responsible for immediately implementing whatever technical or operational changes are necessary to protect GSO operations from harmful interference.

I. BACKGROUND

ViaSat and Its GSO Operations. ViaSat is a leading provider of communications solutions to U.S. businesses, consumers, and government users across a wide range of technologies, both satellite and terrestrial. ViaSat currently provides satellite broadband services using an existing fleet of GSO satellites operating in the Ka band, including the ViaSat-1

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[3] *See* Letter from The Boeing Company to FCC, IBFS File No. SAT-LOA-20161115-00109 (Apr. 11, 2017); Letter from LeoSat MA, Inc. to FCC, IBFS File No. SAT-LOI-20161115-00112 (May 15, 2017); Letter from O3b Limited to FCC, IBFS File No. SAT-AMD-20161115-00116 (May 22, 2017); Letter from Telesat Canada to the FCC, IBFS File No. SAT-PDR-20161115-00108 (Apr. 14, 2017).

satellite[4] which has significantly increased capacity compared with then-existing legacy satellite technology. In addition, ViaSat is authorized to serve the U.S. market using Ka-band GSO FSS system designs that represent the next step in the evolution of ViaSat's technology and will support even greater speeds and capacity.[5] ViaSat-2, which was launched successfully on June 1, 2017 and will be brought into service later this year, will support peak speeds of 100-plus Mbit/s and have approximately 300 Gbit/s of capacity. ViaSat expects to further advance the state-of-the-art in the near term with even more advanced GSO network designs.

Commission Efforts To Develop EPFD Limits for the Ka Band. EPFD limits fall into two principal categories: single-entry limits focused on the potential impact of a single NGSO system on GSO networks, and aggregate limits intended to contain the risk of harmful interference from the cumulative impact of multiple NGSO systems operating simultaneously on a co-frequency basis. In its ongoing NGSO rulemaking proceeding in IB Docket No. 16-408, the Commission has proposed to adopt EPFD limits for portions of the Ka band.[6] The proposed limits are based on those adopted by the ITU nearly twenty years ago and reflected in Article 22 of the ITU Radio Regulations. As ViaSat has demonstrated in that rulemaking proceeding, significant, open, and unresolved issues remain about those limits—including issues grounded in the inadequate protection that the EPFD limits proposed in the *NPRM* would provide to modern, high-capacity GSO networks.

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4 *See* ViaSat, Inc., Call Sign S2747, IBFS File Nos. SAT-LOI-20080107-00006, *et al.* (granted Aug. 18, 2009) (authorizing U.S. market access in the Ka band at 115º W.L.).

5 *See* ViaSat, Inc., Call Sign S2917, IBFS File Nos. SAT-LOI-20140204-00013, *et al.* (granted June 18, 2014) (authorizing U.S. market access in the Ka band at 89º W.L.); Call Sign S2952, IBFS File No. SAT-LOI-20160208-00014 (granted Oct. 5, 2016) (authorizing U.S. market access in the Ka band at 79º W.L.); Call Sign S2953, IBFS File No. SAT-LOI-20160208-00015 (granted Oct. 25, 2016) (authorizing U.S. market access in the Ka band at 109º W.L.).

6 *See NGSO NPRM* ¶ 23.

ViaSat's Concerns with the Proposed EPFD Limits. ViaSat has raised specific concerns regarding the adequacy of the EPFD limits proposed by the Commission in its ongoing NGSO rulemaking proceeding. As ViaSat has explained in comments and reply comments filed in that proceeding (and attached hereto as Exhibits B and C, and thereby incorporated into the record of these application proceedings), those limits: (i) are based on the assumption that no more than 3.5 NGSO systems will be operating on a co-frequency basis (not the eleven systems with about 4,000 satellites proposed in this Ka-band processing round); and (ii) do not take into account the significant technological changes in GSO networks over the past two decades, which make them more spectrally efficient. While there is good reason to question the adequacy of those limits even without a more granular analysis, ViaSat has demonstrated that even a single NGSO system operating at the maximum Article 22 EPFD uplink limit could cause as much as 3.2 dB in noise floor degradation to ViaSat's currently authorized GSO satellites.[7] ViaSat has also expressed concerns that the Commission: (i) has not proposed *any* aggregate EPFD limits in the uplink direction; and (ii) has not proposed mechanisms to enforce and otherwise ensure compliance with aggregate EPFD limits in *any* direction.[8]

II. THE COMMISSION SHOULD REQUIRE PROPOSED NGSO SYSTEMS TO OPERATE IN ACCORDANCE WITH THE TECHNICAL PARAMETERS SPECIFIED IN THE UNDERLYING APPLICATIONS

Certain of the Applications, as initially filed, did not include fulsome information with respect to the uplink and downlink EPFD levels that would result from proposed operations. The Commission subsequently requested that the relevant applicants submit additional showings with respect to EPFD compliance; responsive information was not provided until after the end of the

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7 *See* Reply Comments of ViaSat, Inc., IB Docket No. 16-408, at 9-10 (Apr. 10, 2017).

8 *See* Comments of ViaSat, Inc., IB Docket No. 16-408, at 12-15 (Feb. 27, 2017); Reply Comments of ViaSat, Inc., IB Docket No. 16-408, at 6-15 (Apr. 10, 2017).

pleading cycle in the NGSO rulemaking proceeding.[9] With the benefit of this supplemental information, ViaSat has been able to more fully evaluate the interference potential posed by each of the NGSO systems proposed in the Applications, based on the information underlying those Applications and the stated parameters of the proposed systems.

Based on this review, ViaSat believes that the NGSO operations proposed in each Application—when considered in isolation—are unlikely to generate harmful interference to ViaSat's existing and proposed GSO operations. More specifically, the proposed NGSO systems would either operate sufficiently below the single-entry EPFD limits specified in Article 22—mitigating the risk of harmful interference into GSO operations that would result from operations at or near the Article 22 limits—and/or would maintain sufficient angular isolation from the GSO arc, so as to adequately protect co-frequency GSO operations. Consequently, ViaSat believes that the Applications can be granted while adequately protecting ViaSat's existing and future GSO networks, as long as any grant of authority is based on operations as proposed in the Applications, including EPFD levels and angular isolation from the GSO arc (the relevant parameters in each Application are summarized in Exhibit A).[10]

Until recently, this would have been a routine condition in any grant of authority—whether a grant of a license or market access—based on decades of Commission precedent.[11]

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9 *See* n.3, *supra*.

10 As noted in Exhibit A, several applicants did not specify isolation angles. As a result, in those cases ViaSat has been unable to fully evaluate whether proposed operations, once implemented, would provide adequate protection to its GSO operations. The Commission should require those applicants to provide additional information to enable that evaluation.

11 *See, e.g.,* Stamp Grant, IBFS File No. SAT-MOD-20161025-00102 (reissued Jan. 1, 2017) (modification of SES Americom's authorization for AMC-3); Stamp Grant, IBFS File No. SAT-MOD-2016-0722-00067 (granted Sep. 8, 2016) (modification of DISH authorization for EchoStar 18); Stamp Grant, IBFS File No. SAT-PPL-20160722-00064 (Apr. 6, 2017) (addition of HISPASAT 30W 6 to the Permitted List).

Among other things, this is a typical condition in the authority provided in ViaSat's GSO authorizations.[12] But in authorizing the OneWeb NGSO system on June 22, 2017, the Commission created significant uncertainty by appearing to authorize OneWeb to operate at Article 22 EPFD limits—even though OneWeb itself had proposed to operate at far lower limits[13] and agreed that these issues should be left for determination in the pending NGSO rulemaking.[14] As noted above, NGSO operations at (or even near) the Article 22 EPFD limits, and not with the power density levels and angular isolation from the GSO arc reflected in the Applications and summarized in Exhibit A, would create a significant risk of harmful interference into ViaSat's GSO operations. Thus, any Commission action authorizing such operations would be contrary to the public interest, convenience, and necessity and the requirements of the Communications Act.[15]

Fortunately, the Commission can avoid the potential for harmful interference into GSO operations by simply authorizing the applicants to operate just as they have proposed. Among other things, this approach would preserve the Commission's ability to fully explore the merits of the issue in the context of the ongoing NGSO rulemaking proceeding without adversely affecting any applicant in the current processing round. At the same time, this approach would

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12 *See, e.g.,* Stamp Grant, IBFS File No. SAT-LOI-20140204-00013 (reissued Mar. 23, 2017) (market access at 89° W.L.); Stamp Grant, IBFS File No. SAT-LOI-20160208-00014 (granted Oct. 5, 2016) (market access at 79° W.L.); Stamp Grant, SAT-LOI-20160208-00015 (granted Oct. 25, 2016) (market access at 109° W.L.).

13 OneWeb's application was based on operating at power levels that were 7 dB lower than the Article 22 $EPFD_{\uparrow}$ limits. In authorizing OneWeb, the Commission appears to have allowed OneWeb to operate at power density levels toward the GSO arc that are 7 dB higher, up to the ITU Article 22 EPFD limits. *See WorldVu Satellites Limited*, Order and Declaratory Ruling, IBFS File No. SAT-LOI-20160428-00041, FCC 17-77, at ¶ 23.h & n.72 (Jun. 22, 2017) ("*OneWeb Order*").

14 *See* Letter from OneWeb to FCC, IBFS File No. SAT-LOI-20160428-00041 (June 16, 2017).

15 *See* 47 U.S.C. § 307.

sidestep potential legal challenges that would undoubtedly arise if the Commission were to authorize NGSO operations that pose a significant risk of harmful interference and that are far different than the operations proposed in the underlying Applications. *That* approach would be: (i) fundamentally inconsistent with decades of practice and precedent; and (ii) contrary to the notice requirements of the Communications Act and the Commission's implementing rules.[16]

III. THE COMMISSION SHOULD ADDRESS THE ONGOING RISK OF *AGGREGATE* INTERFERENCE THROUGH APPROPRIATE CONDITIONS

In the ongoing NGSO rulemaking proceeding, ViaSat has emphasized the need to adequately manage the risk of aggregate interference into GSO networks resulting from the simultaneous co-channel operations of multiple NGSO systems. As ViaSat has noted, there currently are no limits in the U.S. or internationally for aggregate uplink EPFD, and there are no mechanisms to apportion the aggregate EPFD among all of the co-frequency Ka-band NGSO networks that come into operation. Moreover, there is no means to enforce any aggregate EPFD limits that are adopted. ViaSat and others have urged the Commission to address these matters expeditiously given their critical importance to the integrity of GSO operations.[17]

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16 *See* 47 U.S.C. § 309(b) (generally requiring the Commission to provide 30-days' notice of any application "or substantial amendment thereof" prior to grant); 47 C.F.R. § 25.151(d) (providing that satellite applications generally will not be granted "until the expiration of a period of thirty days following the issuance of the public notice listing the application, or any major amendment thereto"); 47 C.F.R. § 25.116(b) (defining "major amendment" to include any change that "increases the potential for interference").

17 *See generally* n.8, *supra*; *see also* Letter from O3b to FCC, IB Docket No. 16-408, Att. (May 4, 2017) (noting that it is "important for the Commission to develop a mechanism to ensure that the aggregate EPFD limits into GSO FSS systems are not exceeded" so as to "ensure that the proliferation of NGSO systems does not risk incumbent and future GSO operations"); Reply Comments of EchoStar Satellite Operating Corporation and Hughes Network Systems, LLC, IB Docket No. 16-408, at 8 (Apr. 10, 2017) ("There is a high likelihood that compliance by individual NGSO systems with single entry EPFD limits will be insufficient . . ."); Reply Comments of Inmarsat Inc., IB Docket No. 16-408, at 6 (Apr. 10, 2017) (agreeing with ViaSat's position).

Appropriate limits and enforcement mechanisms can and should be developed through the ongoing NGSO rulemaking proceeding. ViaSat therefore requests that the Commission manage the risk of harmful interference into GSO operations by imposing the following conditions on the grant of each Application:

- ***First***, the Commission should explicitly condition each Application grant on the outcome of the pending NGSO rulemaking proceeding in IB Docket No. 16-408. More specifically, the Commission should require each authorized operator to comply with the rules, policies, and procedures adopted in and through the rulemaking—including by immediately implementing any changes to system design, operations, and deployment that may be necessary to ensure such compliance.

- ***Second***, unless and until aggregate EPFD limits are adopted in both the uplink and downlink directions, a means is developed to apportion those limits among multiple NGSO systems, and suitable enforcement mechanisms are adopted, the Commission should make clear that *each* authorized NGSO system operator is responsible for ensuring that GSO operators do not suffer harmful interference resulting from the simultaneous co-frequency operations of multiple NGSO systems. More specifically, the Commission should explicitly provide that: (i) compliance with any applicable single-entry EPFD limit, in and of itself, may not be sufficient to satisfy an NGSO operator's underlying obligation to protect GSO operations (*e.g.,* maintaining a suitable angular isolation from the GSO arc may also be required); (ii) NGSO operators are responsible for immediately implementing further reductions in power density, angular isolation, or other system or operational modifications as necessary to protect GSO operations; and (iii) in the event of harmful interference, each and every NGSO operator contributing to such interference may be held jointly[18] and severally responsible by the Commission and affected GSO operators.[19]

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[18] The *OneWeb Order* included a condition requiring OneWeb to "cooperate with other NGSO FSS operators in order to ensure that all authorized operations jointly comport" with applicable $EPFD_{\downarrow}$ limits. *OneWeb Order* ¶ 25.a. This condition : (i) does not address the potential for harmful interference resulting from *uplink* operations; (ii) requires only that OneWeb "cooperate" with other NGSO operators, without making clear that OneWeb (and those other operators) have substantive obligations to protect GSO operations with priority; and (iii) does not require OneWeb to cure harmful interference into such GSO operations if it should arise.

[19] ViaSat believes these conditions should also apply in band segments, like 18.8-19.3 GHz and 28.6-29.1 GHz, that the Commission has proposed to make available to GSO and NGSO operations on a coequal basis.

IV. CONCLUSION

For the reasons provided above, the Commission should deny each Application unless it grants them conditioned in the manner described herein. More specifically, should the Commission be inclined to grant any of the Applications, such grants should authorize the relevant NGSO systems to operate in the manner proposed by the Applications themselves—and not in a manner that varies from, or otherwise exceeds, the parameters specified therein.

In addition, the Commission should address the continuing risk of *aggregate* interference into GSO operations by: (i) requiring each authorized operator to comply with the rules, policies, and procedures adopted in and through the pending NGSO rulemaking—including by immediately implementing any changes to system design, operations, and deployment that may be necessary to ensure such compliance; and (ii) explicitly providing that:

- compliance with any applicable single-entry EPFD limit, in and of itself, may not be sufficient to satisfy an NGSO operator's underlying obligation to protect GSO operations;
- NGSO operators are responsible for immediately implementing further reductions in power density or other system or operational modifications as necessary to protect GSO operations; and
- in the event of harmful interference, each and every NGSO operator contributing to such interference may be held jointly and severally responsible by the Commission and affected GSO operators.

Respectfully submitted,

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June 26, 2017

Exhibit A:
Specified $EPFD_{up}$ Levels / Isolation Angles

Network	File Number	$EPFD_{up}$ dB(W/(m^2*40 kHz))	Isolation Angle
Audacy Corporation	SAT-LOA-20161115-00117	-188	*
The Boeing Company	SAT-LOA-20161115-00109	-162**	6° - 11°
Karousel LLC	SAT-LOA-20161115-00113	-170.5	20°
LeoSat MA, Inc.	SAT-PDR-20161115-00112	-174.2	7°
O3b Limited	SAT-AMD-20161115-00116	-163.7	7.6°
OneWeb***	SAT-LOI-20160428-00041	-170.1	6°
Space Exploration Holdings, LLC	SAT-LOA-20161115-00118	-163.3	22°
Space Norway AS	SAT-PDR-20161115-00111	-173.2	*
Telesat Canada	SAT-PDR-20161115-00108	-162	11.9°
Theia Holding A, Inc.	SAT-LOA-20161115-00121	-187.7	*

* Applicant did not specify an isolation angle.

** Boeing indicates it will reduce earth station power at smaller isolation angles as required to comply with EPFD limits.

*** Provided for illustrative purposes.

EXHIBIT B:
COMMENTS OF VIASAT, INC. IN
IB DOCKET NO. 16-408

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

In the Matter of	)	
	)	
Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters	)	IB Docket No. 16-408

COMMENTS OF VIASAT, INC.

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February 27, 2017

Summary

ViaSat supports the Commission's efforts to: (i) provide greater operational flexibility for FSS satellites in the geostationary-satellite orbit (GSO), and (ii) update, clarify, and streamline the licensing framework for non-geostationary orbit (NGSO) satellite systems. In particular, ViaSat applauds the Commission's efforts to codify certain informal practices and policies reflected in individual licensing decisions that have developed over time. Among other things, these efforts should provide greater clarity to satellite operators and ensure that they work from a common set of assumptions as they seek to efficiently use limited spectrum resources.

The *NPRM* represents the first attempt to comprehensively reform the Ka-Band Plan and NGSO licensing rules in nearly two decades. During that period, NGSO and GSO technologies—and the operating environment more generally—have evolved significantly. In fact, the Commission is faced with the possibility of authorizing eleven NGSO systems in the current Ka-band processing round, and a yet-to-be-determined number in the V-band processing round. Although the *NPRM* acknowledges the need to take this evolution into account in certain contexts, ViaSat recommends that it be taken into account more broadly. Specifically, ViaSat recommends that the Commission reexamine the Ka-Band Plan and its NGSO licensing framework more comprehensively. Among other things, ViaSat recommends that the Commission:

- **More broadly consider ways to promote efficient use of underutilized Ka-band resources.** For example, the 19.4-19.6 GHz and 29.1-29.25 GHz band segments are currently utilized in the United States for satellite services only by two entities. The Commission should carefully consider whether this spectrum could be put to additional, and more efficient, uses by GSO FSS operators.

- **Examine the relevance of decades-old ITU limits to the very different set of circumstances existing today.** Managing NGSO interference into GSO systems should be a critical element of this proceeding. Although "EPFD" limits can be an effective means of facilitating NGSO/GSO sharing, it is not enough to assume that

the existing ITU limits are adequate. Those ITU limits: (i) are based on the assumption that no more than 3.5 NGSO systems will be operating on a co-frequency basis (not the eleven systems with about 4,000 satellites proposed in the pending Ka-band processing round); and (ii) do not take into account the significant technological changes in GSO networks over the past two decades that make them more spectrally efficient.

- **Adopt effective mechanisms for fully protecting GSO systems from NGSO interference.** No mechanism has been proposed to ensure that any aggregate EPFD limits are honored and that critical GSO operations are protected. No rule has been proposed to limit aggregate EPFD in the uplink direction. These matters must be carefully examined and addressed in this proceeding.

- **Examine the extent to which changing NGSO licensing rules for some could constrain the ability of others to provide innovative services.** For example, expanding the use and effectiveness of the "avoidance of in-line interference" mechanism, and requiring operators to meet restrictive earth station performance standards, could also constrain the ability of some NGSO operators to serve the public.

- **Consider how relaxing the NGSO milestone requirement could adversely affect the NGSO sharing environment.** Allowing operators to take nine years to deploy mega-constellations could significantly constrain the capacity and coverage of other, smaller NGSO systems—especially if the "avoidance of in-line interference" mechanism is used as the means of assigning spectrum.

- **Address the inequitable impact on current processing-round applicants of changing baseline licensing rules after the filing window has closed.** Applicants in the current NGSO processing rounds had to design their systems to comply with the global coverage requirement or risk dismissal. Thus, they effectively were precluded from proposing different constellation types. Changing this rule now would benefit only those applicants that chose not to comply at the outset. Disguising waivers of longstanding, baseline, processing-round qualifications through *post-hoc* rule changes would be fundamentally unfair to the other applicants.

ViaSat recommends that the scope of the Commission's inquiry be expanded to account for these issues, many of which are critical for setting the terms on which limited spectrum resources will be used by a variety of NGSO systems with expected lifetimes of fifteen years or more. If these issues are not addressed now, there may be no realistic opportunity to address them in the future. ViaSat believes the Commission can address most, if not all, of these items within the context of its *NPRM*, and also supports the issuance of a further Commission inquiry

as may be necessary to ensure that these critical issues are evaluated fully, and in an informed and reasoned manner.

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Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters	)	IB Docket No. 16-408

COMMENTS OF VIASAT, INC.

ViaSat, Inc. submits these comments in response to the *Notice of Proposed Rulemaking* adopted on December 14, 2016 in the above-captioned proceeding ("*NPRM*"), in which the Commission proposes "revisions to certain of [its] rules and policies governing satellite services, prompted by a planned new generation of large, non-geostationary satellite orbit (NGSO), fixed-satellite service (FSS) systems" and to "update certain rules governing operation of FSS space stations in the geostationary-satellite orbit (GSO) to enable greater operational flexibility."[1]

I. INTRODUCTION

ViaSat is a leading provider of communications solutions to U.S. businesses, consumers, and government users across a wide range of technologies, both satellite and terrestrial. ViaSat currently provides satellite broadband services using an existing fleet of GSO satellites, and is expanding its existing capacity with additional GSO satellites featuring even more advanced technical capabilities.

ViaSat is seeking to augment its GSO offerings with NGSO capabilities using the VIASAT-NGSO satellite network.[2] Among other things, ViaSat's NGSO satellite network would allow it to utilize spectrum resources more intensively and to develop and offer innovative

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1 *NPRM* at ¶ 1.

2 *See* IBFS File No. SAT-LOI-20161115-00120 (filed Nov. 15, 2016).

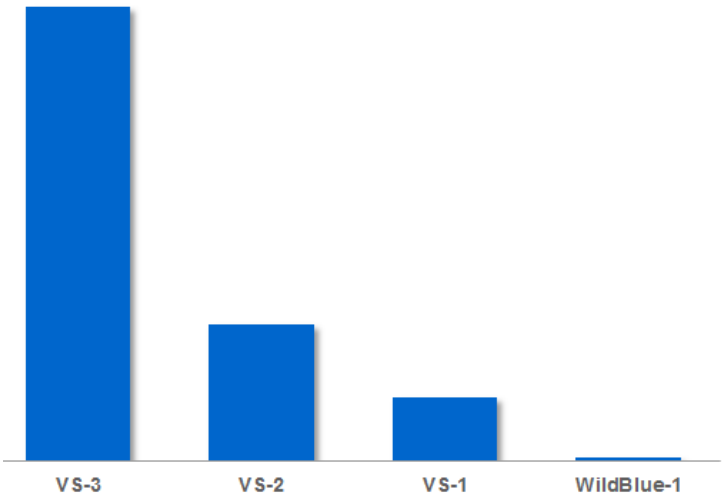
satellite-based communications services that would combine the high throughput available through ViaSat's existing and planned GSO satellites with the enhanced coverage and low latency available through an NGSO platform.

ViaSat supports the Commission's efforts to: (i) provide greater operational flexibility for GSO satellites; and (ii) update, clarify, and streamline its Ka-Band Plan and its licensing framework governing NGSO systems. In particular, ViaSat applauds the Commission's desire to codify informal practices and policies reflected in certain individual licensing decisions that have developed over time. Among other things, these efforts should provide greater clarity to satellite operators and ensure that they work from a common set of assumptions as they seek to efficiently use limited spectrum resources.

The *NPRM* represents the first attempt to comprehensively reform the Ka-Band Plan and NGSO licensing rules in nearly two decades. During that period, NGSO and GSO technologies—and the operating environment more generally—have evolved significantly. Although the *NPRM* acknowledges this evolution in certain contexts, ViaSat recommends that the Commission reexamine the Ka-Band Plan and its NGSO licensing framework more comprehensively in light of this evolution.

Among other things, since the existing regulatory framework was established, multiple generations of GSO satellites have been developed and deployed that provide ever-increasing amounts of capacity, as depicted below in descending order:

Satellite Capacity (Gbit/s)



These system designs respond to the growing demands of satellite broadband users for service quality that compares favorably to terrestrial alternatives. ViaSat's constantly improving technologies now enable it to provide broadband service with an overall user satisfaction rating on par with that of many terrestrial service providers. Therefore, it is not surprising that about one-third of ViaSat's broadband customers have switched to satellite from terrestrial alternatives.

While the first version of satellite broadband services in the Ka band supported speeds that did not exceed 1.5 Mbit/s,[3] today's offerings are far more robust and bandwidth intensive. Specifically, ViaSat currently offers 25/3 Mbit/s speeds in many areas of the country,[4] and will be expanding its 25/3 Mbit/s coverage—and offering even higher speeds throughout its service

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[3] *See WildBlue High-Speed Internet via Satellite Triples Capacity with New Satellite* (Mar. 20, 2007), *available at* http://www.4wildblue.com/News.aspx (announcing March 2007 commencement of commercial service over WildBlue-1, featuring "download speeds of up to 1.5 Mbps, competitive with other high-speed services available in the market today").

[4] *See ViaSat Unveils Fastest Home Satellite Internet Service in the U.S. with the New Exede WiFi Modem and a 25 Mbps Plan* (Nov. 18, 2015), *available at* http://investors.viasat.com/releasedetail.cfm?ReleaseID=943346.

footprint—following the launch of ViaSat-2 in April 2017 and the expected launch of ViaSat-3 in 2019. Indeed: (i) ViaSat-2 will support peak speeds of 100-plus Mbit/s; and (ii) ViaSat-3 will provide over one terabit per second (1,000 Gbit/s) of throughput and burst speeds in the 1 Gbit/s range.[5]

Moreover, ground-breaking satellite broadband technology developed in the past two decades makes it possible for consumers to enjoy high-speed broadband connections on board commercial airlines, and to stream services such as Netflix and Amazon Video while in flight. These broadband connections are being provided to over 1,100 aircraft today, including 555 commercial aircraft and many hundreds of business and government aircraft—most notably, Air Force One. These connections will be provided to over 750 more commercial aircraft in the near future.[6] In total, nearly one million personal electronic devices connect each month though these satellite broadband connections to aircraft.

Additional innovative satellite technologies continue to be developed, including technologies that support advanced mobile capabilities on vehicles, high-capacity terrestrial wireless traffic offloading and backhaul, and other networking capabilities that will be part of a highly connected 5G world.

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5 *See, e.g., ViaSat Announces Third Quarter Fiscal Year 2016 Results* (Feb. 9, 2016), *available at* http://investors.viasat.com/releasedetail.cfm?ReleaseID=954130.

6 *See, e.g., ViaSat Announces Third Quarter Fiscal Year 2017 Results* (Feb. 9, 2017), *available at* http://investors.viasat.com/releasedetail.cfm?ReleaseID=1011337; *ViaSat Announces Second Quarter Fiscal Year 2016 Results* (Nov. 9, 2015), *available at* http://investors.viasat.com/releasedetail.cfm?ReleaseID=941679; *ViaSat Selected for In-flight Wi-Fi Service on American Airlines 737 MAX Fleet* (Jun. 3, 2016) *available at* http://investors.viasat.com/releasedetail.cfm?ReleaseID=974201; *ViaSat to provide Global In-flight Internet and Connectivity Services to Air Force One and other U.S. Government Senior Leader Aircraft* (Jul. 25, 2016), *available at* http://investors.viasat.com/releasedetail.cfm?ReleaseID=980894.

Achieving these new levels of spectral efficiency and developing these innovative services has required billions of dollars of investment in,[7] and fundamental changes to, GSO network designs. Among other things, ViaSat's third-generation broadband spacecraft design is based on a larger scale of frequency reuse than ever before. Those design elements are essential to enable continued reductions in the "cost per bit" of broadband service, to support the growing numbers of satellite broadband subscribers, and to satisfy the insatiable demand for video streaming that consumes ever-increasing amounts of satellite capacity.

The *NPRM* acknowledges this technological evolution in certain contexts, and proposes to evaluate the appropriateness of making certain rule changes in response. ViaSat supports that approach, which is consistent with the Commission's vision when it first allocated 2.5 GHz of the Ka band in each direction for satellite services after: (i) wisely predicting the increased demand for satellite-based services that exists today;[8] and (ii) correctly recognizing that satellite operations might not be able to be "fully and economically accommodated in the only frequency bands [then] available."[9]

ViaSat recommends that the Commission reexamine its Ka-Band Plan and its NGSO licensing framework more comprehensively in light of both the technological evolution

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7 *See* Written Testimony of Michael Rapelyea, Vice President for Government Affairs, ViaSat, Inc. before the Senate Committee on Commerce, Science & Transportation, Hearing on Ensuring Intermodal USF Support for Rural America, at 5-6 (Feb. 4, 2016).

8 *See Proposed Frequency Allocations and Radio Treaty Matters*, 37 Fed. Reg. No. 151, 15714-717, 15733 (Aug. 4, 1972); *corrected at* 37 Fed. Reg. 25175 (Nov 28, 1972); *Frequency Allocations and Radio Treaty Matters*, 38 Fed. Reg. No. 40, 5565, 5595-7 (Mar. 1, 1973).

9 *Establishment of Domestic Communication-Satellite Facilities*, Further Notice of Inquiry and Notice of Proposed Rulemaking, 25 FCC 2d 718, at ¶ 2 (1970) (citing *Establishment of Domestic Communication-Satellite Facilities*, Report and Order, 22 FCC 2d 86, at ¶ 11 (1970)).

discussed above, and the Commission's stated purpose in first allocating the Ka band for satellite services. In particular, ViaSat recommends that this proceeding also examine: (i) other ways to promote efficient use of underutilized Ka-band spectrum resources—including consideration of the 19.4-19.6 GHz and 29.1-29.25 GHz band segments; (ii) the adequacy of existing International Telecommunication Union ("ITU") limits, and whether they need to be updated to account for the evolution of GSO and NGSO technologies over the past two decades; (iii) how to ensure compliance with limits that are essential to protecting GSO networks from NGSO interference; (iv) the ways that changing certain NGSO licensing rules to accommodate certain NGSO system designs could constrain the ability of other NGSO systems to provide innovative services; (v) how relaxing the NGSO milestone requirement could adversely impact the NGSO sharing environment; and (v) how changing baseline NGSO licensing rules after the close of the current NGSO processing rounds could inequitably and adversely affect some applicants in those processing rounds.

The Commission can address most, if not all, of these items in the context of the *NPRM*. To the extent necessary, ViaSat supports a further Commission inquiry to ensure these critical issues are evaluated fully, and in an informed and reasoned manner.

II. PROVIDING GREATER ACCESS TO UNDERUTILIZED KA-BAND SPECTRUM IS ESSENTIAL

ViaSat appreciates the Commission's efforts to modify the Ka-Band Plan to codify existing practices and ensure that the Plan reflects previously authorized satellite spectrum uses.[10] Codification should provide greater transparency and ensure that relevant stakeholders

[10] *See NPRM* at ¶ 8.

work from a common, baseline understanding of potential spectrum uses in a given band segment.[11] It also should help to facilitate more intensive use of Ka-band spectrum resources.

That said, the scope of the efforts to modify the Ka-Band Plan in the *NPRM* appears both under- and over-inclusive. On the one hand, there are compelling reasons to facilitate greater access to portions of the Ka band not specifically addressed in the *NPRM* (including consideration of the 19.4-19.6 GHz and 29.1-29.25 GHz band segments). On the other hand, it would be premature to implement certain of the changes proposed by the *NPRM* before the Commission has fully addressed the terms of certain types of NGSO-GSO and NGSO-NGSO spectrum sharing, as discussed below in greater detail.

A. ViaSat Supports Efforts To Facilitate Increased Use of the 17.8-18.3 GHz, 18.8-19.3 GHz, and 28.6-29.1 GHz Band Segments

ViaSat supports the *NPRM* proposals with respect to the 17.8-18.3 GHz, 18.8-19.3 GHz, and 28.6-29.1 GHz band segments, except for the proposal to limit use of the 17.8-18.3 GHz downlink band segment to individually licensed earth stations.

17.8-18.3 GHz. ViaSat supports the Commission's proposal to restore the previously deleted allocation for FSS downlinks in the 17.8-18.3 GHz band segment, even if FSS use is designated as being on a secondary basis to the fixed service.[12] As the Commission notes, several satellite networks have been authorized to use this band on a non-interference basis after demonstrating that they would adequately protect fixed-service licensees by complying with the ITU's pfd limits, which were developed with input from the terrestrial industry.[13] In restoring the deleted allocation, the Commission should make clear that the allocation permits use of the

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11 *Id.* at ¶ 14.

12 *Id.* at ¶ 9.

13 *Id.*

band segment without limiting it to any particular type of earth station. Because this band segment would be used for downlinks, and receiving earth station operations are passive, the nature of the earth station that is receiving satellite signals transmitted to the Earth's surface has no bearing on spectrum compatibility with terrestrial services in the band. Stated another way, the nature and number of earth stations passively receiving satellite signals does not present any risk to terrestrial services in this context. Thus, there is no reason to constrain FSS use of the band segment by limiting it to individually-licensed earth stations.

Indeed, the Commission reached a similar conclusion in granting a waiver of the United States Table of Frequency Allocations to enable the reception of satellite signals by large numbers of earth stations, on an unprotected, non-conforming basis, in other spectrum that otherwise was not available for such purposes. In doing so the Commission found that allowing such operations on a non-interference basis:

> [W]ould not undermine the rule's purpose because it involves only passive receive-only earth stations that are not capable of causing interference into FS stations operating in this band. Further, because [the operator] has agreed to accept any level of interference from FS stations into its receive-only earth stations' operations in the extended Ku-bands, FS operators will not be required to coordinate their station operations with the . . . receive-only earth stations' operations. Under these circumstances, we determine that additional coordination burden would not be placed upon FS operators and that their ability to expand service in the future would not in any manner be restricted.[14]

There is no reason to reach a different conclusion here and limit secondary use of the 17.8-18.3 GHz band segment to individually licensed earth stations.

18.8-19.3 GHz and 28.6-29.1 GHz. ViaSat supports the Commission's proposal to elevate GSO uses of the 18.8-19.3 GHz and 28.6-29.1 GHz band segments to co-primary status

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[14] *EchoStar Satellite LLC*, 20 FCC Rcd 930, at ¶ 13 (2004).

with NGSO uses.[15] GSO and NGSO systems already routinely coordinate co-primary operations at 18.8-19.3 GHz and 28.6-29.1 GHz internationally. There is no reason why such coordination could not be effectively concluded in the United States as well.

B. GSO and NGSO Access to 19.3-19.7 GHz and 29.1-29.5 GHz Should Be Examined

ViaSat supports the Commission's proposal to permit GSO and NGSO operations in the 19.3-19.4 GHz and 19.6-19.7 GHz band segments. These band segments are not being used by NGSO MSS feeder links, even though they are currently designated for this purpose. Terrestrial fixed-service operations would be adequately protected from FSS downlinks through the pfd limits in Sections 25.208(c) and (e).[16]

ViaSat also supports the Commission's proposal to allow NGSO operations in the 29.3-29.5 GHz band segment on an unprotected, non-interference basis with respect to GSO operations. The 29.3-29.5 GHz band segment is already available to GSO FSS.[17] Thus, there should be no change in the priority or protection of GSO uses in this band segment.

However, the Commission's proposals for the 19.3-19.4 GHz, 19.6-19.7 GHz, and 29.3-29.5 GHz band segments do not go far enough—they do not address the remainder of the 19.3-19.7 GHz and 29.1-29.5 GHz band segments. In particular, the 19.4-19.6 GHz and 29.1-29.25 GHz band segments—which are utilized in the United States by Iridium for NGSO MSS feeder links and by one GSO FSS system but otherwise are largely fallow—would be left underutilized, to the detriment of the public.

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15 *NPRM* at ¶ 12. Currently GSO is secondary to NGSO in the 28.6-29.1 GHz band segment and does not have any designation in the 18.8-19.3 GHz band segment.

16 47 C.F.R §§ 25.208(c) and (e).

17 The Ka-Band Plan currently provides for GSO FSS use of the 29.3-29.5 GHz band segment. *See NPRM* at Appx. B.

ViaSat therefore urges the Commission to fully and expeditiously examine the ability of GSO FSS operations to be conducted in the 19.4-19.6 GHz and 29.1-29.25 GHz[18] segments and NGSO FSS operations to be conducted in the 19.4-19.6 GHz and 29.1-29.3 GHz band segments (with NGSO on a non-interference basis with respect to GSO), while protecting NGSO MSS feeder link operations. Doing so could allow this spectrum to be used more efficiently. Indeed, when the Commission designated these band segments for NGSO MSS use, it anticipated that multiple satellite systems would operate there on a shared basis.[19] Yet, today Iridium is only one of two satellite system operators using this spectrum in the United States. Because Iridium's NGSO MSS feeder link stations are limited in number, it should be relatively easy to coordinate shared use of the band with FSS operators. Indeed, the Commission has previously authorized another GSO FSS operator to use this spectrum after concluding that doing so would not create a risk of harmful interference into Iridium's operations.[20]

C. NGSO-GSO Sharing Terms Should Be Fully Examined at 17.8-18.6 GHz, 19.7-20.2 GHz and 29.5-30 GHz

As detailed below, in light of the new operating environment presented by the possible introduction of eleven new NGSO systems in the 17.8-18.6 GHz, 19.7-20.2 GHz and/or 29.5-30

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18 The Ka-Band Plan currently provides for GSO FSS use of the 29.25-29.3 GHz band segment. *See NPRM* at Appx. B.

19 *See 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, at ¶ 66 (1996).

20 *See Inmarsat Mobile Networks, Inc.*, 30 FCC Rcd 2770 (2015) (authorizing Inmarsat's use of 19.4-19.6 GHz and 29.1-29.25 GHz); 30 FCC Rcd 7295 (2015) (granting partial reconsideration to clarify certain conditions applicable to Inmarsat).

GHz band segments,[21] ViaSat recommends that the Commission carefully examine the impact that operating environment may have on the prospects of NGSO-GSO sharing before simply codifying the *ad hoc* practice developed to allow one particular type of NGSO FSS constellation to operate on an unprotected basis with respect to GSO FSS networks in those band segments. Certain of those band segments currently are designated only for GSO FSS,[22] and, as discussed below: (i) it cannot be assumed that the ITU's effective power flux density ("EPFD") limits provide adequate protection from NGSO interference because those limits were developed almost 20 years ago in a very different operating environment; (ii) no mechanism has been proposed to ensure that any aggregate EPFD limits are honored and that critical GSO operations are protected; and (iii) no rule has been proposed to limit aggregate EPFD in the uplink direction. It is critical that the ITU EPFD limits be re-examined to ensure that they are adequate and appropriate in light of both the technological developments that have occurred since they first were adopted in 2000, as well as proposals in the current Ka-band NGSO processing round for eleven separate NGSO systems, operating co-frequency in portions of the Ka band, and consisting of about 4,000 NGSO spacecraft operating in a wide variety of orbits.

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21 *See* The Boeing Company, IBFS File No. SAT-LOA-20161115-00109 (filed Nov. 15, 2016) ("Boeing Ka-Band Application"); Audacy Corporation, IBFS File No. SAT-LOA-20161115-00117 (filed Nov. 15, 2016) ("Audacy Application"); Karousel LLC, IBFS File No. SAT-LOA-20161115-00113 (filed Nov. 15, 2016); LeoSat MA, Inc., IBFS File No. 20161115-00112 (filed Nov. 15, 2016); O3b Limited, IBFS File Nos. SAT-MOD-20160624-00060 (filed June 24, 2016) ("O3b Modification Application"); SAT-AMD-20161115-00116 (filed Nov. 15, 2016) ("O3b Amendment"); Space Norway AS, IBFS File No. SAT-LOI-20161115-00111 (filed Nov. 15, 2016) ("Space Norway Application"); Space Exploration Holdings, LLC, IBFS File No. SAT-LOA-20161115-00118 (filed Nov. 15, 2016) ("SpaceX Application"); Telesat Canada, IBFS File No. SAT-LOI-20161115-00108 (filed Nov. 15, 2016); Theia Holdings A, Inc. IBFS File No. SAT-LOA-20161115-00121 (filed Nov. 15, 2016); WorldVu Satellites Limited (d/b/a/ OneWeb), IBFS File No. SAT-LOI-20160428-00041 (filed Apr. 28, 2016); ViaSat NGSO Application.

22 *NPRM* at ¶ 10.

III. DEVELOPING APPROPRIATE RULES TO PROTECT GSO NETWORKS FROM NGSO INTERFERENCE IS CRITICAL

The *NPRM* suggests that compliance with certain limits reflected in Article 22 of the ITU *Radio Regulations* that were adopted in 2000 "will be sufficient for NGSO FSS systems to protect GSO FSS networks."[23] Those limits attempt to constrain the EPFD, emitted by: (i) NGSO space stations toward GSO space stations; (ii) NGSO space stations toward GSO earth stations; and (iii) NGSO earth stations toward GSO space stations. The Commission proposes to incorporate these ITU technical limits into its Part 25 rules.[24]

Although ViaSat agrees conceptually that appropriate EPFD limits could be an effective means of facilitating the ability of NGSO systems to protect GSO networks from interference, it is not clear that the existing ITU limits are appropriate in the current circumstances that the Commission now faces:

- In light of the significant technological changes in GSO networks over the past two decades that provide increased spectrum efficiency and enable new types of services, it cannot be assumed that the existing ITU limits are adequate.
- The Commission's experience with the current O3b configuration does not necessarily apply to the operating environment presented in the pending processing rounds for eleven different types of NGSO systems in just the Ka band.
- The ITU limits are based on a very small number of NGSO systems (3.5, to be exact) and any EPFD "allowances" may not easily be apportioned across the eleven different NGSO systems proposed in the current Ka-band processing round and the untold number to come in the V-band processing round.
- No mechanism has been proposed to ensure that any aggregate limits are honored and that critical GSO operations are protected.
- No rule has been proposed to limit aggregate interference in the uplink direction—into satellite receivers.

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23 *NPRM* at ¶ 19.

24 *Id.*

Managing NGSO interference into GSO systems should be a critical element of this proceeding, in order to achieve the significant benefits that can be provided by both types of systems. These issues are addressed below.

A. Managing Aggregate Interference from NGSO Systems into GSO Networks Is Essential

As the Commission is well aware from the *Spectrum Frontiers* proceeding, the impact on GSO networks of aggregate interference from multiple, co-frequency transmitters emitting unwanted energy is a matter of significant concern, and one the Commission has committed to continue to study in that context.[25] Unfortunately, there is little discussion of this issue in the *NPRM* or how, specifically, to manage the risk of aggregate interference from all authorized NGSO systems into any particular GSO network.

Comments in the *Spectrum Frontiers* context reflect the seriousness of the issue and are equally applicable in this context:

- SES/O3b: "The Commission must address the risk of harmful aggregate interference to satellites."[26]
- SES/O3b: "Reliable mechanisms must be put in place to ensure any future interference that does arise can be quickly and adequately resolved."[27]
- EchoStar/Hughes: "[A]ggregate interference to space station receive antennas . . . creates potentially debilitating uncertainty for FSS operators and sets in motion a potential problem that cannot later be undone."[28]

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25 *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Report and Order, 31 FCC Rcd 8014, at ¶ 69 (2016).

26 Petition for Reconsideration of SES Americom, Inc. and O3b Limited, GN Docket No. 14-177; IB Docket Nos. 15-256 & 97-95; RM-11664; and WT Docket No. 10-112, at 19 (Dec. 14, 2016).

27 *Id.* at ii.

28 Comments of EchoStar Satellite Operating Corporation and Hughes Network Systems, LLC on Petitions for Reconsideration, GN Docket No. 14-177; IB Docket Nos. 15-256 & 97-95; RM-11664; and WT Docket No. 10-112, at 2-3 (Jan. 31, 2017).

The *NPRM* simply does not propose a complete, or even an adequate, way to manage the risk of aggregate interference into GSO networks from all of the NGSO systems the Commission may authorize in the pending processing rounds.[29] Providing this type of certainty is essential for all satellite operators—both GSO and NGSO—to avoid disruption to essential services and needless interference disputes before the Commission.

B. Aggregate Limits for *Each Direction* Must Be Established and a Suitable Enforcement Mechanism Must Be Developed

The EPFD limits proposed by the *NPRM* would be the sole mechanism adopted to provide interference protection of GSO networks from NGSO operations. As the *NPRM* explains: "We intend that compliance with EPFD limits in the Ka-band would satisfy any obligation on an NGSO FSS system to operate on a non-interference basis with respect to a GSO FSS networks."[30] More specifically, the Commission proposes: (i) a rule governing the total EPFD from a *single NGSO system* in the space-to-space, space-to-Earth, and Earth-to-space directions;[31] and (ii) a rule governing the *aggregate EPFD in the downlink direction* (space-to-Earth) direction *from* all co-frequency space stations of *all NGSO FSS systems.*[32]

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29 ITU RR 22.5K provides that Administrations operating or planning to operate NGSO systems in certain frequencies should apply the provisions of Resolution 76 (rev. WRC-2015) to ensure that the actual aggregate interference into GSO networks caused by NGSO systems operating co-frequency does not exceed the aggregate power levels shown in Resolution 76 for the space-to-Earth, or downlink, direction. These mechanisms do not address precisely how such interference would be managed should it occur, nor do they address the effect of aggregate interference into GSO satellite receivers from the aggregate emissions of all earth station transmitters operating on a co-frequency basis across eleven or more NGSO systems.

30 *NPRM* at ¶ 19 n.52.

31 *NPRM* at Appx. A (proposed Sections 25.208(f), (g), (k)). These proposed rule sections reference the emissions from "all" relevant NGSO space stations. Proposed Section 25.208(e) references the "aggregate PFD produced by the entire authorized constellation." ViaSat suggests replacing "aggregate" with "total" in proposed Section

However, no rule or other mechanism is proposed to manage the risk of aggregate interference into GSO satellite receivers from the potentially hundreds of thousands (or more) of earth stations that the Commission may license to communicate over the numerous NGSO systems that may be authorized through pending processing rounds. Stated another way, there is no proposed rule governing the aggregate EPFD in the Earth-to-space direction from all co-frequency earth stations of all authorized NGSO FSS systems. Nor is a mechanism proposed to ensure that suitable aggregate limits in the space-to-Earth, space-to-space, and Earth-to-space directions are honored and that critical GSO operations thus are protected. These omissions must be addressed.

C. Any Aggregate EPFD "Allowances" Must Be Apportioned Across Eleven or More NGSO Systems in the Ka Band

In the current Ka-band processing round, the Commission is faced with the possibility of either licensing or granting United States market access to eleven NGSO systems, each of which would contribute to the aggregate EPFD received by any given GSO network from co-channel NGSO operations. It remains to be seen how many V-band NGSO systems will be proposed by March 1 that would contribute to aggregate EPFD levels in the V band. The Commission has an obligation to ensure that the aggregate EPFD levels generated by all of the NGSO operations that it authorizes to and from the United States comply with applicable limits in order to protect GSO networks. A suitable methodology must be developed to apportion any aggregate EPFD "allowances" across various authorized NGSO systems.

25.208(e) because the term "aggregate" in the NGSO context is more commonly used as a term of art to refer to the sum of the relevant emissions from all NGSO constellations.

[32] *Id.* (proposed Section 25.208(h)).

D. Prior Experience with One Type of NGSO System Has Limited Value in Managing the Many Different NGSO Systems Proposed to the Commission

As the Commission is aware, it has operational experience applying the ITU's EPFD limits in only one case—the current configuration of the O3b system, which consists of 12 spacecraft operating in an equatorial orbit, and which therefore presents a relatively benign sharing environment with respect to the GSO arc. Specifically, O3b uses certain spectrum (18.8-19.3 GHz and 28.6-29.1 GHz) along the equator, and other spectrum (17.8-18.6 GHz and 27.5-28.6 GHz) elsewhere to avoid in-line events with the GSO arc. In stark contrast: (i) the current Ka-band NGSO processing round consists of proposals for eleven different NGSO systems, potentially operating co-frequency in portions of the Ka band, with about 4,000 NGSO spacecraft in a wide variety of orbits;[33] and (ii) it remains to be seen how many and what type of V-band NGSO systems will have been proposed when the V-band processing round closes.[34]

Nor does the work completed at the ITU thus far adequately address the situation created by the large number of NGSO systems already proposed and likely to be proposed in the near future. As an initial matter, ITU Resolution 76 (Rev. 2015) calls for administrations to "take all possible steps" to ensure that the aggregate interference into GSO networks caused by NGSO systems does not exceed certain specified aggregate power levels, but those limits do not apply to the Earth-to-space (or uplink) direction, and thus do not address the aggregate effect of NGSO uplink interference into GSO satellite receivers. More fundamentally, the ITU limits adopted in

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33 *See* supra pp. 10-11 & n.21.

34 *See* Public Notice, Satellite Policy Branch Information, Boeing Application Accepted for Filing in Part IBFS File No. SAT-LOA-20160622-00058, Cut-Off Established for Additional NGSO-Like Satellite Applications or Petitions for Operations in the 37.5-40.0 GHz, 40.0-42.0 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz Bands, DA 16-1244 (rel. Nov. 1, 2016); *see also* The Boeing Company, IBFS File No. SAT-LOA-20160622-00058 (filed June 22, 2016) ("Boeing V-Band Application").

2000 assume that the number of NGSO systems at issue is small (3.5, to be precise),[35] and do not take into account the possibility of the eleven NGSO systems currently proposed in the Ka-band processing round, or the untold additional systems that will have been proposed by the time the V-band processing round closes in March. In any event, in a case like this where a single administration is effectively authorizing the operation of eleven or more NGSO systems (and their associated earth stations) within its jurisdiction, there undoubtedly is a separate obligation to manage the risk of aggregate interference into GSO networks.

Considering the nature and scope of the NGSO systems in the pending Ka-band processing round alone, it is obvious that those systems present interference risks with respect to GSO operations that were neither previously contemplated nor examined in establishing either the (incomplete) EPFD limits proposed in the *NPRM*, or the ITU's framework for attempting to manage this issue. The *NPRM* acknowledges this concern in discussing the need to suitably protect terrestrial services from NGSO interference,[36] but does not address the same concern in the context of protecting GSO networks from NGSO interference.

In order to ensure that GSO networks are adequately protected from the aggregate EPFD produced by all of the NGSO systems that may be authorized in the current Ka-band and V-band processing rounds, it is essential to evaluate the aggregate impact of all such NGSO systems and develop appropriate rules accordingly.

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35 *See* ITU Res. 76 (Rev. 2015) (noting that "single-entry validation limits have been derived from aggregate epfd masks contained in Tables 1A to 1D, assuming a maximum effective number of non-GSO FSS systems of 3.5").

36 *NPRM* at ¶ 16 ("We recognize, however, that these limits were derived for constellations up to a certain number of satellites and may not be appropriate for some of the large NGSO FSS constellations being currently proposed.").

E. The Continued Adequacy of Existing ITU Limits Cannot Be Assumed

The ITU's EPFD limits were developed almost two decades ago based on satellite technologies and network architectures that were prevalent at the time. There is no basis to simply assume that those same limits would adequately protect newer GSO networks from interference generated by NGSO systems. In general, newer satellites are likely to be more spectrally efficient and employ lower total satellite receiver noise temperatures and higher satellite receive antenna gain than legacy satellites.[37] Such GSO characteristics were not considered in generating the ITU EPFD limits adopted in 2000. Consequently, different EPFD limits might be necessary to ensure the compatibility of NGSO systems with the types of GSO networks that will be deployed on a going-forward basis.

Notably, other portions of the *NPRM* specifically recognize that the passage of time and the evolution of satellite technology could impact whether a technical rule adopted decades ago remains appropriate today. Specifically, in inviting comment on whether the 10-degree "trigger" angle for in-line events should be altered, the Commission explains that this threshold "is based on the characteristics of satellite systems proposed around the turn of the millennium" and suggests that it may be appropriate to narrow that angle as a result.[38] Similarly, it is imperative that this proceeding evaluate the ITU's EPFD limits anew to determine if they remain appropriate in light of current GSO technology. The Commission should not just reflexively incorporate those limits by reference.

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37 *See* ViaSat, Inc. Notice of *Ex Parte* Presentation; GN Docket No. 14-177; IB Docket Nos. 15-256 & 97-95; RM-11664; and WT Docket No. 10-112, Att. 1 at 2 (Apr. 21, 2016).

38 *NPRM* at ¶ 26.

IV. CHANGING CERTAIN NGSO LICENSING RULES COULD CONSTRAIN THE ABILITY TO PROVIDE INNOVATIVE NGSO SERVICES

The *NPRM* proposes a number of changes to long-standing Commission rules for licensing NGSO systems. While it is appropriate to examine those possible changes based on developments and experiences since the underlying rules were first adopted, it also is appropriate to assess whether the proposed rule changes would affect some types of NGSO systems more than others, and whether those changes would constrain, rather than enhance, the ability to provide certain services.

The *NPRM* asks whether the Commission should, in assigning spectrum to various NGSO systems, expand the application of the "avoidance of in-line interference events" mechanism described in Section 25.261 to the spectrum assignment process, instead of using the procedure specified in Section 25.157 for simply dividing the spectrum equally among the qualified applicants in a processing round.[39] While ViaSat believes the "avoidance of in-line events" mechanism can facilitate spectrum sharing in certain cases, it also can significantly constrain the operation of certain NGSO systems.

By way of example, applying the "avoidance of in-line interference" mechanism to assign spectrum to proposed "mega-constellations" can have a dramatic adverse impact on how smaller NGSO constellations would operate. In its comments on Boeing's V-band NGSO application, ViaSat submitted a preliminary analysis estimating the probability of an in-line interference event between the 2,956-satellite Boeing system and the 24-satellite VIASAT-

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[39] *Id.* at ¶ 23.

NGSO system (without studying any other NGSO system). That analysis estimated, under conservative assumptions, that such in-line events would occur 46.7 percent of the time.[40]

Exhibits 1 and 2 provide further illustrations of how relying on the "avoidance of in-line interference" mechanism to assign spectrum can impact the coverage and capacity of smaller systems. Specifically, Exhibit 1 demonstrates that the need to protect Boeing's system during in-line events would significantly reduce the probability of a given location being covered by ViaSat's NGSO system at any given point in time, to less than 50 percent in large parts of the United States.[41] In contrast, Boeing's coverage would not be materially impacted by the need to protect the much smaller ViaSat system. Similarly, Exhibit 2 demonstrates that the need to protect Boeing's system would significantly reduce the average number of ViaSat satellites visible from a given location at any point in time, and therefore would significantly reduce the available capacity provided by the ViaSat NGSO system. Again, in stark contrast, Boeing's available capacity would hardly be impacted at all by the need to protect ViaSat's NGSO system. In other words, only one of the two systems shoulders the burden of "frequency sharing" in this scenario. That is not an equitable result.

ViaSat recommends that the Commission investigate these dynamics fully, with respect to all of the systems proposed in the current processing rounds, before applying the "avoidance of in-line interference" mechanism to the assignment of spectrum to NGSO systems. In

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[40] Comments of ViaSat, Inc., IBFS File No. SAT-LOA-20160622-00058, at 3 and Ex. A (Dec. 1, 2016). That preliminary analysis is based on applying Section 25.261 of the Commission's rules, which addresses in-line interference events between NGSO FSS networks, and provides a reasonable proxy for evaluating the potential for co-frequency spectrum conflicts among different NGSO networks.

[41] Data from the U.S. Geological Survey establishes that the contiguous United States extends from approximately 23° N to approximately 52° N. *See NASA Web-Enabled Landsat Data – CONUS Lat/Long (WELDUSLL), available at* https://lta.cr.usgs.gov/weldusll.html (last visited Feb. 23, 2017).

particular, the Commission should ensure that all of the trade-offs involved in relying on "avoidance of in-line interference" versus "band splitting" are fully understood, and ensure that the burdens of spectrum sharing are equitably distributed among all NGSO systems.

That trade-off analysis should also consider the consequences of possibly reducing the "angular separation between co-frequency space station operations" used to define in-line interference events, because defining the "trigger" for when an in-line event occurs can affect the coverage and capacity issues described above. Similarly, it is important to fully examine the assumption that imposing "default limits" on off-axis emissions from NGSO earth stations would produce positive benefits.[42] Doing so potentially could foreclose operators from providing services that require earth stations to operate with higher off-axis EIRP densities—*e.g.*, services that employ small mobile terminals.

V. RELAXING THE NGSO MILESTONE REQUIREMENT COULD ADVERSELY AFFECT THE NGSO SHARING ENVIRONMENT

The Commission's NGSO milestone requirement is a cornerstone of its policies for ensuring the efficient use of spectrum resources. As the *NPRM* explains, the "milestone requirement is intended to ensure timely provision of service, and to prevent 'warehousing' of spectrum and orbital resources."[43] Because operators risk losing their licenses, as well as surety bonds, if milestones are not met, they have incentives to efficiently use spectrum resources in a timely fashion under current rules.

The *NPRM* proposes to loosen the existing NGSO milestone by requiring operators to deploy a fixed percentage (*e.g.*, 75 percent) of satellites after six years (or risk losing their

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42 *NPRM* at ¶ 28.

43 *Id.* at ¶ 31.

authorizations and surety bonds) and to deploy the remaining satellites after nine years (or risk losing their authorizations only *for those remaining satellites*).[44] The *NPRM* proposes this change in light of the Commission's belief that "every space station in an authorized constellation . . . may not be necessary to provide the services proposed in the application."[45]

Before it implements any milestone change, the Commission should consider the implications for *other* NGSO operators, and the sharing environment more generally. Regardless of whether every satellite in an authorized NGSO constellation is necessary to provide proposed services, every such NGSO satellite potentially limits (or may even preclude) the ability of other NGSO operators to provide service to the public.

As discussed above, the "mega-constellations" proposed by Boeing and others could impose significant constraints on the operations of smaller NGSO systems. More specifically, smaller NGSO systems (like ViaSat's) would lose significant coverage and capacity due to the need to protect such mega-constellations during in-line events. Changing the milestone requirements to allow the phased deployment of such mega-constellations—and effectively give their operators an option to deploy a significant percentage of their large constellations (*e.g.*, 25 percent) *after* other NGSO operators have had to make made adjustments to accommodate those large constellations—would materially impact the NGSO sharing environment. Applying the existing "band-splitting" rule in a case like this, rather than requiring that the smaller system resort to "in-line avoidance," would facilitate more equitable spectrum sharing by not requiring that a small NGSO system (designed to provide full coverage) significantly reduce its service simply to accommodate a much larger system with limited geographic coverage. The

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44 *Id.* at ¶ 32.

45 *Id.*

Commission should factor these effects into its analysis. To the extent that the Commission seeks to "afford operators greater flexibility with system design and implementation,"[46] the Commission should consider alternatives that could better realize the Commission's objectives without adversely impacting the sharing environment and the operations of other NGSO systems.

VI. SIGNIFICANT NGSO RULE CHANGES COULD INEQUITABLY AFFECT APPLICANTS IN THE CURRENT NGSO PROCESSING ROUNDS

The *NPRM* proposal to change a number of fundamental aspects of the Commission's baseline licensing rules and application requirements for NGSO systems has significant implications for network design. For example, the *NPRM* proposes to eliminate the existing global coverage requirement "to provide operators greater flexibility to design their systems to meet market demands."[47] As the *NPRM* acknowledges, the existing rule is intended to "maximize the use of global spectrum resources,"[48] and the global coverage requirement precludes the use of certain NGSO system designs.[49]

Although rule changes of this type may provide additional flexibility, as a practical matter, only certain operators—namely, those that have already sought waivers of the existing rule(s) in their pending NGSO system applications[50]—are likely to benefit from the rule change. The proposed rule changes therefore threaten to create inequities among applicants and reward operators that were unwilling to comply with the Commission's rules in the first instance.

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46 *Id.*

47 *Id.* at ¶ 35.

48 *Id.*

49 *Id.*

50 *See, e.g.*, Boeing Ka-Band Application at 21, 37; Boeing V-Band Application at 36-37, 65-66; Audacy Application at 44; O3b Modification Application at 10-11; O3b Amendment at 9-10; Space Norway Application at 11-12; SpaceX Application at 13-14.

For example, if the global coverage requirement had not existed, ViaSat would have been able to design an NGSO system utilizing orbits that would have facilitated its ability to provide even more innovative services to the public. Specifically, ViaSat could have focused more capacity over the United States and could have done so at a greatly reduced cost to the end user. Instead, ViaSat optimized its network design to satisfy the global coverage requirement and the other constraints imposed by longstanding Commission rules. The failure to comply with those rules could have resulted in ViaSat's application being dismissed as incomplete or defective, and ViaSat being kicked out of the processing round.

Allowing some applicants to sidestep the requirements of existing rules through post-cutoff-date rule changes would place other applicants at an unfair disadvantage—both competitively and in the coordination negotiations that will inevitably flow from the pending processing rounds. It is no answer to suggest that a pending applicant can simply amend its application to take advantage of a significantly decreased coverage requirement. Employing a fundamentally different NGSO constellation with a different orbital architecture could require new ITU filings as well, and therefore affect matters that are outside the Commission's jurisdiction. Fundamental fairness mandates equitable treatment of all applicants in the processing round. Disguising waivers of longstanding application requirements and baseline processing round qualifications through *post-hoc* rule changes would be fundamentally unfair.

VII. CONCLUSION

ViaSat supports the Commission's efforts to: (i) provide greater operational flexibility for GSO FSS space stations; and (ii) update, clarify, and streamline the licensing framework governing NGSO systems. At the same time, the *NPRM* represents the first attempt to comprehensively revise the Ka-Band Plan and the NGSO licensing rules in nearly two decades,

during which time both NGSO and GSO technologies—and the operating environment more generally—have evolved significantly. Moreover, the possibility of authorizing eleven NGSO systems in the current Ka-band processing round, and a yet-to-be determined number in the V-band processing round, presents circumstances that have not yet been fully evaluated in developing the *NPRM*.

ViaSat therefore recommends that the Commission reexamine its Ka-Band Plan and its NGSO licensing framework more comprehensively by:

- More broadly considering ways to promote efficient use of underutilized Ka-band resources, including consideration of the 19.4-19.6 GHz and 29.1-29.25 GHz band segments.
- Examining the assumption that decades-old ITU limits are adequate for purposes of managing NGSO interference into GSO systems, given intervening technological developments and the proposals to launch many more, and much larger, NGSO constellations than were examined in developing those ITU limits.
- Developing a mechanism to ensure that aggregate interference limits on NGSO systems are honored and critical GSO operations are protected.
- Evaluating how changing some NGSO licensing rules for some system operators could constrain the ability of other NGSO systems to provide innovative services.
- Considering how significantly relaxing the NGSO milestone requirement could adversely affect the NGSO spectrum sharing environment.
- Addressing the inequitable impact on some proposed NGSO systems of changing baseline NGSO licensing rules after the processing round filing windows have closed.

The scope of the Commission's inquiry in this *NPRM* can and should be expanded to account for these issues, many of which are critical for setting the terms on which the limited spectrum resource will be used by a variety of NGSO systems that will have expected lifetimes of fifteen years or more. If these issues are not addressed now, there may be no realistic opportunity to address them again in the near future.

Respectfully submitted,

/s/

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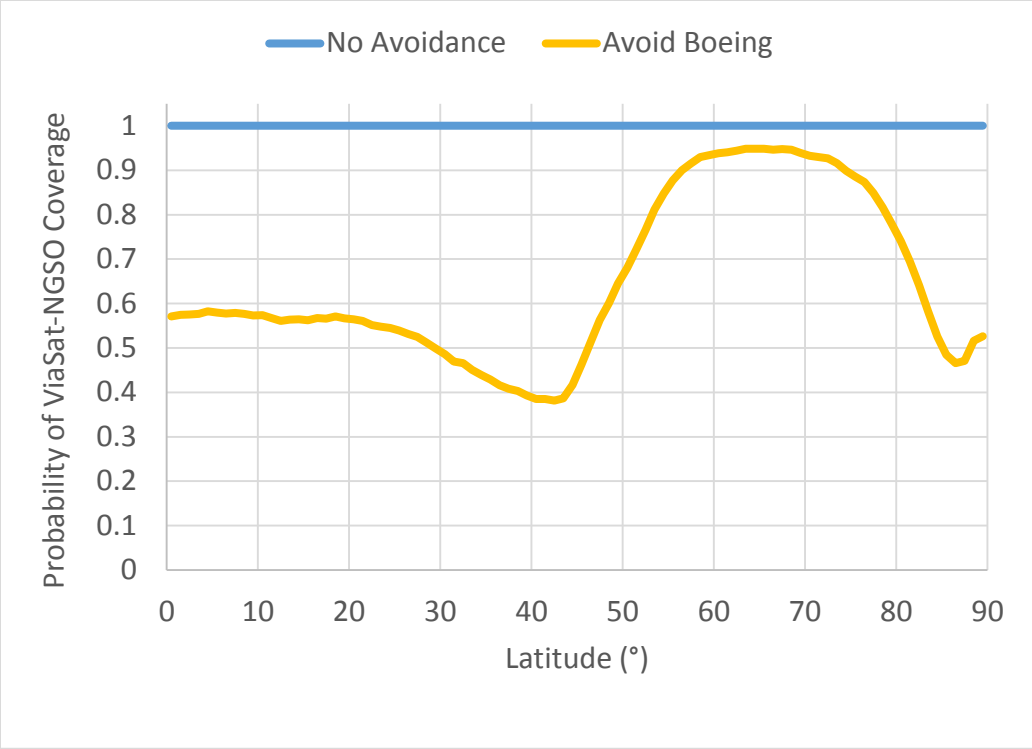
February 27, 2017

Exhibit 1: Impact of Mutual Avoidance on Coverage



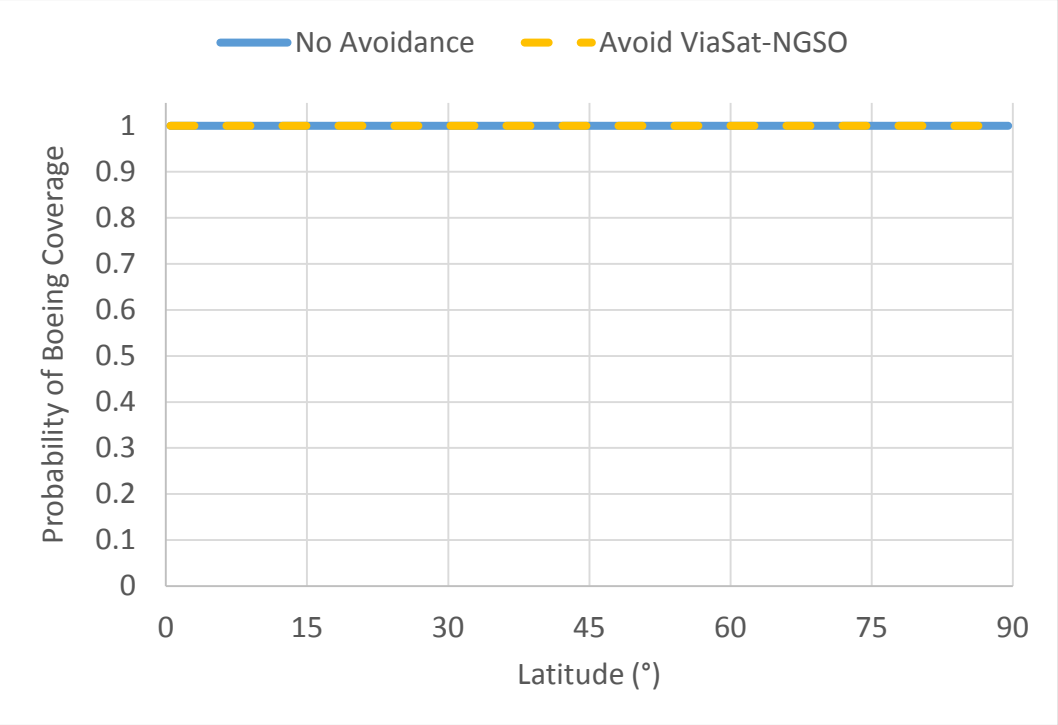
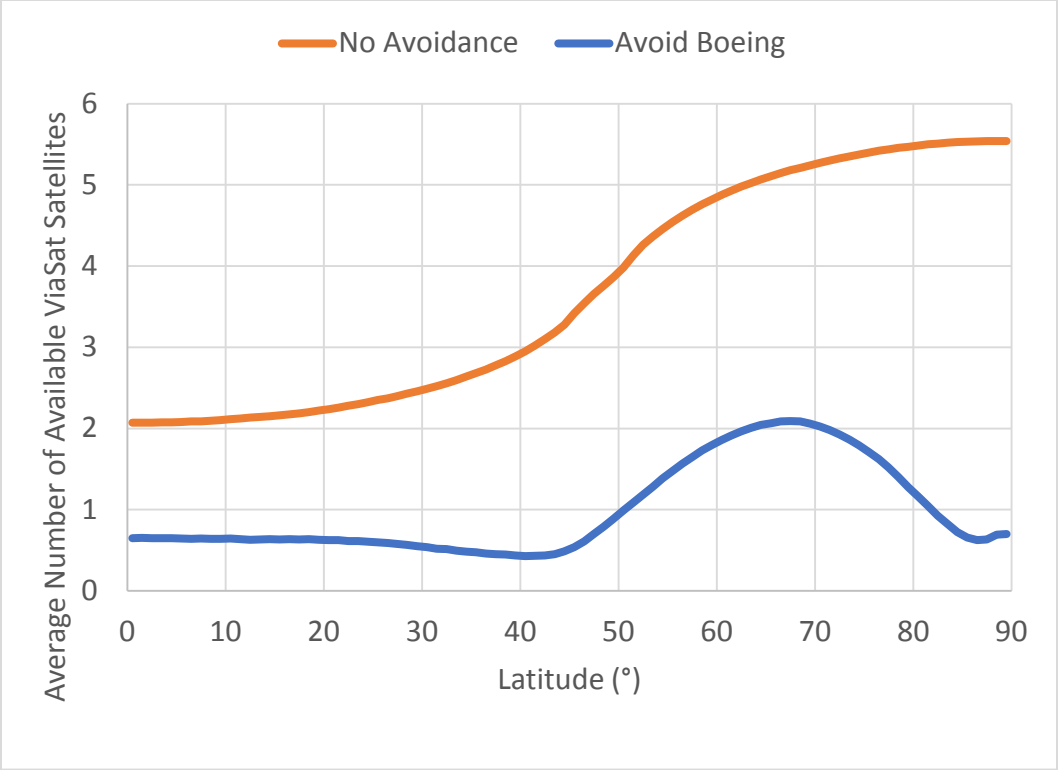
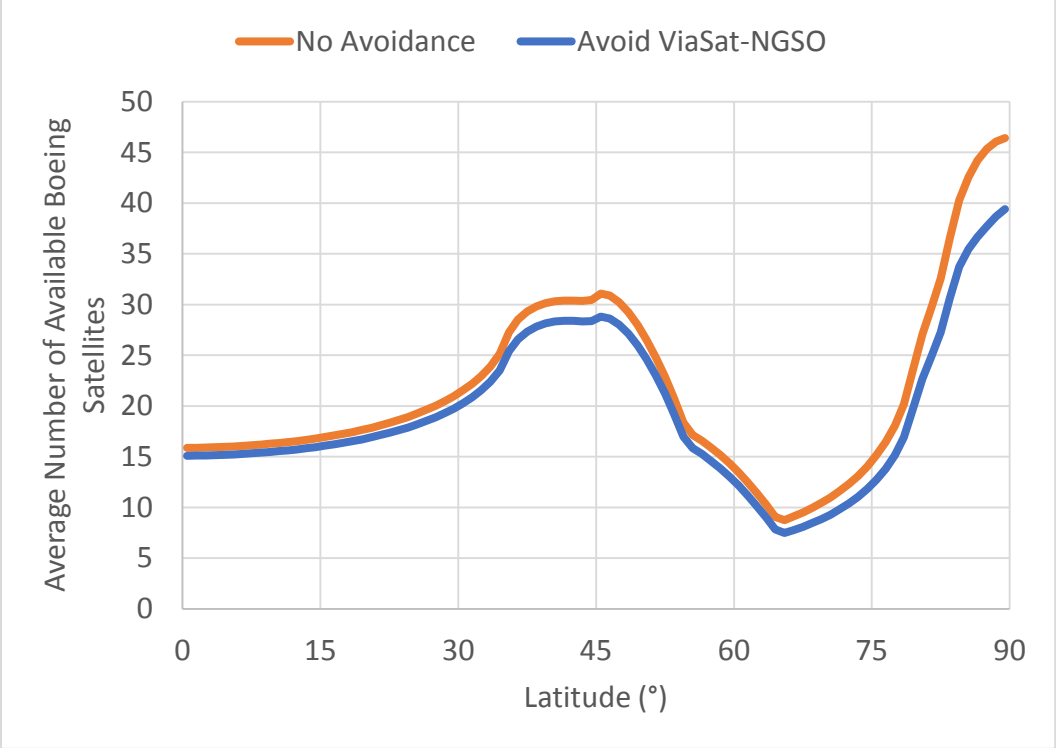


Exhibit 2: Impact of Mutual Avoidance on Capacity





DECLARATION

I hereby declare that I am the technically qualified person responsible for preparation of the engineering information contained in these Comments of ViaSat, Inc. ("Comments"), that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted with these Comments, and that it is complete and accurate to the best of my knowledge, information and belief.

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February 27, 2017

EXHIBIT C:
REPLY COMMENTS OF VIASAT, INC. IN IB DOCKET NO. 16-408

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

In the Matter of	)	
	)	
Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters	)	IB Docket No. 16-408

REPLY COMMENTS OF VIASAT, INC.

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April 10, 2017

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

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	)	
Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters	)	IB Docket No. 16-408

REPLY COMMENTS OF VIASAT, INC.

ViaSat, Inc. replies to the comments filed in response to the *Notice of Proposed Rulemaking* adopted on December 14, 2016 ("*NPRM*"). In the *NPRM*, the Commission proposes "revisions to certain of [its] rules and policies governing satellite services, prompted by a planned new generation of large, non-geostationary satellite orbit (NGSO), fixed-satellite service (FSS) systems" and to "update certain rules governing operation of FSS space stations in the geostationary-satellite orbit (GSO) to enable greater operational flexibility."[1]

I. INTRODUCTION AND SUMMARY

The *NPRM* represents the first attempt to comprehensively reform the Commission's NGSO licensing rules in nearly two decades. At that earlier time, the Commission licensed NGSO systems and adopted GSO/NGSO sharing rules for parts of the Ku band based on then-prevalent NGSO and GSO technologies and system designs. In doing so, the Commission built on technical analysis completed by the International Telecommunication Union ("ITU"), which (among other things) assumed that GSO networks would support only the low-throughput communication types prevalent at the time, and that the nature and extent of NGSO systems would be self-limiting due to the need to control self-interference, as well as other technical factors.

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1 *NPRM* ¶ 1.

In the intervening period, NGSO and GSO technologies have evolved significantly, rendering invalid the assumptions underlying the Commission's (and the ITU's) previous analyses. When ViaSat-1 was launched in 2011 (over a decade after the ITU first addressed Ka-band NGSO/GSO sharing criteria), it was the first true broadband satellite, providing a total throughput of approximately 150 Gbit/s; today it is used to offer speeds of 25 Mbit/s and higher. ViaSat's second- and third-generation broadband satellite designs provide even more impressive capabilities. ViaSat-2, planned for launch in the next month, will support peak speeds of 100-plus Mbit/s. ViaSat-3, planned for launch in 2019, will provide over one terabit per second (1,000 Gbit/s) of throughput and burst speeds in the 1 Gbit/s range.[2] These exponential increases in spectral efficiency and throughput rely on fundamental changes in GSO network designs that are essential to enable continued reductions in the "cost per bit" of broadband service, to support the growing numbers of satellite broadband subscribers, and to satisfy the insatiable demand for video streaming that consumes ever-increasing amounts of satellite capacity.

At the same time as these developments in GSO technology are occurring, the Commission is poised to authorize new NGSO systems for the first time in decades. The proposed networks are both more numerous and more technically diverse than those previously proposed to, and authorized by, the Commission in the Ku band or the Ka band. More specifically, the Commission is now faced with the possibility of authorizing *eleven* NGSO systems in the current Ka-band processing round alone, and *nine* NGSO systems in the V-band

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[2] *See, e.g., ViaSat Announces Third Quarter Fiscal Year 2016 Results* (Feb. 9, 2016), *available at* http://investors.viasat.com/releasedetail.cfm?ReleaseID=954130.

processing round.[3] These many systems vary significantly in their size, shape, and technical characteristics, and are briefly summarized in the following table.

Table 1: Number of Satellites per System and per Band[4]

	Ku band	Ka band	V band
Audacy		3	
Boeing		60	2,956
Boeing 2			147
Karousel	12		
Kepler	140		
LeoSat		84	
O3b		60	24
OneWeb	720		2,000
SpaceX	4,425		11,943
Space Norway	2		
Telesat Canada		117	117
Theia	120		
ViaSat		24	
# Systems	**6**	**11**	**9**
# Satellites	**5,419**	**5,627**	**17,334**

This proceeding will establish, in whole or in part, the service rules that will govern how these new NGSO systems will be licensed, how they will operate, and the extent to which they are able to coexist with each other and with GSO networks. Notably, these NGSO systems will have expected lifetimes of fifteen years or more. As such, there may be no realistic opportunity to adjust that framework again in the near future. For this reason, it is critical that the

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[3] The V-band processing round closed on March 1, 2017; most of these V-band proposals were filed after the February 27, 2017 comment date in this proceeding and thus were not discussed in ViaSat's initial comments.

[4] These data are based on the constellation parameters contained in the Schedule S forms submitted by each of the applicants in the current Ku/Ka-band and V-band processing rounds, with the exception of the SpaceX V-band system, where SpaceX submitted additional orbital parameters in a database file. With that one exception, the number of satellites listed for each system is the value reported in Schedule S as the "Total Number of Satellites in the active constellation" for each proposed system.

Commission fully explore all relevant issues *now* so it can develop and adopt rules that properly reflect the needs and capabilities of today's and tomorrow's GSO networks, and ensure compatible operations between and among various GSO and NGSO systems.

Unfortunately, the current state of the record in this proceeding does not allow the Commission to achieve these objectives. And the record certainly does not provide any basis for adopting the means of NGSO-NGSO coexistence in the same spectrum, or the NGSO-GSO protection criteria, proposed in the *NPRM*.

Commenting parties simply assume—without providing any technical analysis whatsoever—that it is appropriate to apply technical standards developed nearly twenty years ago, in another context, to today's GSO satellite networks that have fundamentally different technical characteristics. Among other things, parties assume that the equivalent power flux-density ("EPFD") limits found in Article 22 of the ITU Radio Regulations—first adopted in 2000—are sufficient to protect today's GSO networks from harmful interference.[5] But as ViaSat established in its initial comments, those limits are *not* sufficient, and nothing in the record demonstrates otherwise. Nor have any suitable EPFD limits even been proposed for the V band in this proceeding.[6]

In addition, the record provides no basis for adopting *NPRM* proposals intended to facilitate use of the same frequencies by multiple NGSO systems. Commenting parties fail to consider how certain of those proposals—and, in particular, the proposal to rely on the "avoidance of in-line interference" mechanism in making NGSO system spectrum

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[5] These ITU-R limits form the basis for the EPFD limits the *NPRM* proposes to apply to portions of the Ka band. The *NPRM* does not propose any EPFD limits for the V band.

[6] EPFD limits are being considered as part of the WRC-19 preparation process under Agenda Item 1.6.

assignments—would actually harm the provision of competitive services by other NGSO systems. For example, ViaSat demonstrated in its initial comments that the proposed spectrum assignment mechanism would force smaller networks like VIASAT-NGSO to sacrifice significant levels of coverage and capacity to avoid in-line events with much-larger NGSO systems, all to the detriment of the consumer, while having virtually no impact on the coverage or capacity of the much larger NGSO systems.[7]

While the record provides no data to support these proposals, it does make one point abundantly clear: Certain applicants in the pending Ka- and V-band processing rounds, which have applied for system designs that do not comply with longstanding FCC application requirements and baseline processing round qualifications, now seek to overcome their fundamental deficiencies, and avoid the risk of dismissal, through improper and inequitable post-cutoff notice rule changes. Doing so not only is unsustainable legally, but also would reward those applicants for proposing non-compliant systems, while effectively handicapping those applicants that responsibly designed and proposed FCC-compliant networks in the first instance. And doing so would place the risk and burden associated with the proposed NGSO co-existence rules on applicants that filed compliant applications well before this proceeding ever started.

The Commission should not countenance these efforts. Instead, the Commission should ensure that NGSO systems are licensed in a manner that preserves the integrity of the Commission's rules while facilitating the ability of NGSO systems to fairly operate along with each other, and also reasonably share spectrum with GSO networks.

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[7] Comments of ViaSat, Inc., IB Docket No. 16-408, at 20, Ex. 1 & 2 (filed Feb. 27, 2017) ("ViaSat Comments").

To achieve these objectives, ViaSat urges the Commission to: (i) adopt both single-entry and aggregate EPFD limits specifically designed to protect today's high-throughput GSO network designs from harmful interference resulting from the significant number of NGSO systems proposed in the pending Ka-band and V-band processing rounds; (ii) develop a mechanism to ensure that suitable aggregate EPFD limits in the space-to-Earth, space-to-space, and Earth-to-space directions are honored and that critical GSO operations are therefore protected; (iii) authorize NGSO operations in specific band segments based on "band-splitting," instead of requiring applicants to rely on the "avoidance of in-line interference" mechanism, and allow NGSO systems to coordinate with each other to define mutually acceptable terms on which they may access additional spectrum; and (iv) dismiss all pending Ka- and V-band NGSO applications (without prejudice to refiling) and initiate new processing rounds *after* this proceeding has been fully resolved, and new service rules are established and become effective, to avoid otherwise providing impermissible advantages to those applicants that have proposed systems that do not satisfy longstanding FCC application requirements and baseline processing round qualifications.

II. PROPOSED EPFD LIMITS WOULD *NOT* ADEQUATELY PROTECT EXISTING OR FUTURE GSO NETWORKS

The record reflects widespread recognition of the need to ensure that NGSO system operations do not adversely impact GSO operations. For example, SES and O3b recognize the need to utilize appropriate technical limits to ensure that NGSO FSS systems operating in the Ka band do not cause unacceptable interference to GSO FSS operations.[8] Inmarsat urges the Commission to ensure that NGSO operations in the Ka band "operate in such a way that any

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[8] Comments of SES S.A. and O3b Limited, IB Docket No. 16-408, at 19 (filed Feb. 27, 2017) ("SES/O3b Comments").

unacceptable interference shall be rapidly eliminated."[9] OneWeb recognizes the need for appropriate technical limits to ensure that GSO operations are adequately protected.[10] Boeing similarly recognizes the need for NGSO systems to inhibit transmissions within a "GSO protection zone" around the equator in order to "protect GSO systems."[11]

Although ViaSat welcomes such acknowledgments of the need to protect essential GSO operations, no commenter provides a workable solution for ensuring that GSO networks are actually protected. In particular, no commenter establishes that the EPFD limits proposed by the Commission would be sufficient to protect today's GSO networks from harmful interference generated by the *eleven* NGSO systems proposed in the pending Ka-band processing round. Instead, various commenters simply assume this to be true.[12] But there is no basis for this assumption, particularly because the satellite technologies and network architectures that were prevalent nearly two decades ago, when the EPFD limits were first developed at the ITU, are no

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9 Comments of Inmarsat, IB Docket No. 16-408, at 9 (filed Feb. 27, 2017) ("Inmarsat Comments").

10 Comments of OneWeb, IB Docket No. 16-408, at 22-23 (filed Feb. 27, 2017) ("OneWeb Comments").

11 Comments of The Boeing Company, IB Docket No. 16-408, at 4 (filed Feb. 27, 2017) ("Boeing Comments"). Notwithstanding its recognition of the need to protect GSO operations, Boeing raises vague concerns about the extension of certain NGSO "compliance measures" to the Ka band. *See id.* at 9. Boeing makes no effort to explain *which* compliance measures it views as unnecessary in the Ka-band context, frustrating any effort to meaningfully address its "concerns." In any event, for the reasons set forth elsewhere in these reply comments, it is critical to ensure that GSO operations in the Ka band and elsewhere are fully protected, and ViaSat urges the Commission to act accordingly.

12 *See, e.g.*, Comments of Kepler Communications Inc., IB Docket No. 16-408, at 2 (filed Feb. 27, 2017) ("Kepler Comments"); Comments of LeoSat MA, Inc., IB Docket No. 16-408, at 10 (filed Feb. 27, 2017) ("LeoSat Comments"); Boeing Comments at 4; OneWeb Comments at 22-23; Comments of Space Norway AS, IB Docket No. 16-408, at 8 (filed Feb. 27, 2017) ("Space Norway Comments"); Comments of Space Exploration Technologies Corp., IB Docket No. 16-408, at 5 (filed Feb. 27, 2017) ("SpaceX Comments").

longer the norm today. Moreover, as ViaSat explained in its comments, the Commission's experience with the licensing and operations of the current O3b constellation simply does not translate into a means for managing the many different types of NGSO constellations now before the Commission.[13] And neither the *NPRM* nor any commenter addresses what EPFD limits would be suitable to ensure GSO and NGSO compatibility in the V band.

EFPD limits are proposed to be the sole mechanism for ensuring that GSO networks actually are protected from harmful interference resulting from NGSO operations in the Ka band.[14] Moreover, the Commission has previously licensed GSO networks and hybrid GSO/NGSO networks in the V band,[15] but the Commission has never before licensed a single stand-alone NGSO network in the V band, let alone *nine stand-alone NGSO networks with well over 17,000 NGSO spacecraft.* In these circumstances, it is essential that the Commission develop and adopt EPFD limits for *both* the Ka band *and* the V band that adequately protect current GSO network technology from NGSO interference.[16] It is essential that such development and adoption occur before any NGSO systems in the pending Ka-band and V-band processing rounds are authorized.

If the Commission instead intends to rely on the general terms of No. 22.2 of the ITU Radio Regulations, that decision should be made expressly clear. In that case, it would be

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13 ViaSat Comments at 16-17.

14 *NPRM* ¶ 19 n.52 ("We intend that compliance with EPFD limits in the Ka-band would satisfy any obligation on an NGSO FSS system to operate on a non-interference basis with respect to a GSO FSS networks.").

15 *See, e.g.*, Stamp Grant, Hughes Network Systems, LLC, IBFS File No. SAT-LOA-20111223-00248 (Aug. 3, 2012); *Northrop Grumman Space & Mission Systems Corp.*, 24 FCC Rcd 2330 (2009) ("*Northrop Grumman Order*").

16 Such limits also should apply to the 18.8-19.3 GHz and 26.6-29.1 GHz band segments, in which the Commission proposes to elevate GSO use to co-primary status. *See NPRM* ¶ 12.

essential that the consideration of both (i) the eleven NGSO applications and the over 5,600 satellites proposed in the pending Ka-band processing round, and (ii) the nine NGSO applications and the over 17,000 satellites proposed in the pending V-band processing round, include a full assessment of their aggregate impact on the operation of GSO spacecraft.

A. Commenting Parties Do Not Establish that Proposed Uplink EPFD Limits Would Adequately Protect GSO Networks

The uplink EPFD limits proposed in the *NPRM* would not adequately protect GSO networks from interference generated by the NGSO systems proposed in the pending processing rounds. This interference is likely to be significant, as illustrated by the following tables.

Table 2 presents a link-budget analysis demonstrating how emissions from a single NGSO system would impact ViaSat's first-, second-, and third-generation broadband satellite designs. This analysis assumes that the uplink EPFD emissions from all co-frequency NGSO earth stations of that single NGSO system are at the limit set forth in proposed Section 25.208(k)—*i.e.*, -162 dBW/(m^2 * 40 kHz). As depicted in Table 2, ViaSat's first-generation broadband satellite (*i.e.,* ViaSat-1) would experience 0.6 dB of uplink noise floor degradation from the NGSO earth stations of a single NGSO system operating at this limit. ViaSat's second- and third-generation broadband satellites would experience 3.2 dB and 4.5 dB of uplink noise floor degradation, respectively. In real-world terms, this equates to a significant loss of the GSO satellite's uplink capacity in any given beam. In short, NGSO system operations that create uplink EPFD at the limit proposed in the *NPRM* are predicted to have a significant adverse impact on the operations of today's GSO networks—including, but certainly not limited to, those currently operated and planned by ViaSat.

Table 2: Impact of Uplink EPFD from a Single NGSO FSS System

	ViaSat 1st Gen	ViaSat 2nd Gen	ViaSat 3rd Gen
Frequency (MHz)	29750	29750	29750
Lambda (m)	0.010	0.010	0.010
EPFD (dBW/(m^2 * 40 kHz))	-162.0	-162.0	-162.0
Conversion factor 40 kHz to Hz (dB)	46.0	46.0	46.0
EPFD (dBW/(m^2 * Hz))	-208.0	-208.0	-208.0
Meter squared antenna gain (dB(m^2))	50.9	50.9	50.9
Satellite receive antenna gain (dBi)	53.0	61.0	61.0
Interfering power received from NGSO (dBW/Hz)	-205.94	-197.94	-197.94
Satellite Noise Temperature (K)	1350.0	1050.0	650.0
Satellite G/T (dB/K)	21.7	30.8	32.9
Thermal Noise Density, N_o (dBW/Hz)	-197.3	-198.388	-200.471
Interference Noise Density, I_o (dBW/Hz)	-205.94	-197.94	-197.94
I_o/N_o (dB)	-8.6	0.4	2.5
Uplink Degradation (dB)	0.6	3.2	4.5
$\Delta T/T$ (%)	13.7	110.9	179.1

Notably, Table 2 shows the impact of only a *single* NGSO system and does not account for the aggregate impact of the *eleven* NGSO systems proposed in the ongoing Ka-band processing round, each of which would contribute to the aggregate EPFD received by any given GSO satellite from co-channel NGSO earth station operations.[17] Table 3, below, depicts the aggregate impact of multiple NGSO systems, each operating at the -162 dBW/(m^2 * 40 kHz) uplink EPFD limit proposed in the *NPRM*. With 5,627 satellites planned by the eleven entrants in the current Ka-band NGSO processing round, it is certainly possible that more than one NGSO system could cause interference to a given GSO satellite. Among other things, unwanted energy from multiple systems could combine as the result of off-axis emissions, including through side lobes.

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[17] The proposed single-entry limit is based on Article 22 of the Radio Regulations, which only addresses single-entry limits, and which refers to Resolution 76 for limits on aggregate interference. However, Resolution 76 does not address aggregate uplink interference; it addresses only aggregate downlink interference.

Table 3: Impact of Aggregate Uplink EPFD from Multiple NGSO FSS Systems[18]

	Uplink Degradation (dB)		
# Systems	ViaSat 1st Gen	ViaSat 2nd Gen	ViaSat 3rd Gen
1	0.6	3.2	4.5
2	1.0	5.1	6.6
3	1.5	6.4	8.0
4	1.9	7.4	9.1
5	2.3	8.2	10.0
6	2.6	8.8	10.7

Conspicuously, the *NPRM* does not propose, or even discuss, *any* rule or other mechanism to manage the risk of aggregate interference from the earth stations of multiple NGSO systems.[19] And while a properly derived single-entry limit potentially could be used to mitigate the risk of such aggregate interference, the single-entry limit proposed in the *NPRM* is grossly inadequate for this purpose. That limit does not account for the significant evolution in GSO network design over the past twenty years. Instead, the *NPRM* simply assumes that a twenty-year old ITU-R limit developed in a very different context is appropriate to protect today's high-throughput GSO satellites. It is not. Moreover, any attempt to use a single-entry limit for this purpose necessarily would need to be based on apportioning to each NGSO system just some of the aggregate EPFD permitted to be generated toward any given GSO network by multiple co-channel NGSO system operations.[20]

Notably, the -162 dBW/(m^2 * 40 kHz) uplink EPFD limit proposed in the *NPRM* is based on Table 22-2 of the ITU Radio Regulations, which was initially adopted at WRC-2000, and was

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18 This representative analysis includes fewer than all of the proposed NGSO systems because it seems unlikely that each and every one of those systems would simultaneously contribute co-channel interference into a given GSO beam. The appropriate number of NGSO systems to be considered for purposes of developing a suitable aggregate uplink EPFD limit requires further study.

19 ViaSat Comments at ii, 11-17.

20 *See id.*

last updated by WRC-03. The data template in Recommendation ITU-R S.1328-4 ("Satellite System Characteristics to Be Considered in Frequency Sharing Analyses Within the Fixed-Satellite Service," which was last updated in 2002) was intended to reflect GSO Ka-band satellite performance estimates during the WRC-03 preparatory process. But, as shown above, GSO satellite design and performance have since evolved significantly.

Indeed, each of ViaSat's in-orbit and planned high-throughput satellites was launched or designed *after* ITU-R S.1328-4 was developed. As noted above, ViaSat-1 was launched in 2011, ViaSat's second-generation broadband satellite is expected to be launched next month, and its third-generation broadband satellite is expected to be launched in 2019. Each of those spacecraft performs at levels of spectral efficiency that are well beyond those assumed in developing that 2002 ITU-R recommendation. Thus, regardless of whether "the U.S. GSO FSS community participated actively" in the development of the Article 22 EPFD limits in the 1998-2002 timeframe,[21] it should be clear that ViaSat did not (as it was not even a satellite broadband provider at the time). Moreover, because ViaSat has driven the improvements in GSO network performance over the past six years, its interests were not otherwise represented in the ITU process conducted long ago.

In any event, based on the analysis presented above, ViaSat calculates that the single-entry uplink EPFD limit must be no more than -174 dBW/m^2 in a 40 kHz bandwidth to provide adequate protection to GSO networks operating in the Ka band. Even at this level, today's high-throughput GSO satellites would experience higher levels of uplink degradation than low-throughput GSO satellites would have experienced in 2003 if protected with the Article 22 EPFD limits. Nevertheless, the -174 dBW/m^2 limit would significantly reduce the adverse impacts of

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[21] *See NPRM* ¶ 19.

NGSO operations on GSO networks, particularly as compared to the higher limit proposed in the *NPRM*.

B. Commenting Parties Fail To Account for the Significant Enforcement Challenges that Would Impede the Effectiveness of Proposed Uplink and Downlink EPFD Limits

As Inmarsat correctly observes, "currently there is no mechanism to ensure that *aggregate* EPFD limits will be met by all NGSO FSS systems licensed in a particular band."[22] Furthermore, as the Commission itself has recognized, there is no suitable methodology for apportioning aggregate EPFD "allowances" across various authorized NGSO FSS systems to ensure that GSO networks are adequately protected.[23] As ViaSat explained in its initial comments, there is no rule proposed in the *NPRM* governing the aggregate EPFD in the Earth-to-space (uplink) direction from all co-frequency earth stations of all authorized NGSO FSS systems. Nor is a mechanism proposed to ensure that suitable aggregate limits in the space-to-Earth, space-to-space, and Earth-to-space directions are honored and that critical GSO operations thus are protected. These omissions must be addressed,[24] and no commenting party has offered a solution. This issue is important with respect to both: (i) the aggregate *uplink* EPFD limits that still need to be developed; and (ii) the proposed aggregate *downlink* EPFD limits that may be adopted.

Challenges with respect to the enforcement of aggregate EPFD limits put additional pressure on the need to adopt and apply effective single-entry EPFD limits in both the uplink and

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22 Inmarsat Comments at 8.

23 *See generally Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range*, 16 FCC Rcd 4096, at ¶ 107 (2000) (discussing difficulties of ensuring compliance with aggregate EPFD limits) ("*Ku-Band EPFD Order*").

24 ViaSat Comments at 15.

the downlink directions. Notably, the ITU-R single-entry limits were derived from an aggregate EPFD mask that was developed first, under the assumption that 3.5 NGSO systems would be able to share spectrum in a given band segment.[25] More specifically, single-entry limits were designed to ensure that combined interference from those 3.5 NGSO systems would not exceed tolerable levels (as reflected in that aggregate EPFD mask).[26]

The "3.5 network" assumption was grounded in technical analysis conducted in the 1999-2000 timeframe regarding the number of *NGSO* satellites that could operate simultaneously without causing prohibitive levels of self-interference. There simply is no basis for continued use of that assumption today. Indeed, in the current Ka-band processing round, the Commission is faced with the possibility of either licensing or granting United States market access to *eleven* NGSO FSS systems with over 5,600 spacecraft, many of which systems could contribute to the aggregate EPFD received by any given GSO FSS network from co-channel NGSO FSS operations. The same situation exists with respect to the *nine* NGSO systems proposed in the current V-band processing round that would have over 17,000 spacecraft. Notably, applicants have proposed constellations that vary considerably in size, orbital parameters, coverage, and functionality, and that differ from the parameters underlying the technical analysis conducted twenty years ago. This is precisely why ViaSat, in commenting on the two Ka-band and V-band NGSO applications that already have appeared on Public Notice, urged the Commission to

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25 *See* International Telecommunication Union Radiocommunication Sector, *Conference Preparatory Meeting Report on technical, operational, and regulatory/procedural matters to be considered by the 2000 World Radiocommunication Conference*, § 3.1.1.2 (1999).

26 *Id.*

evaluate those proposals within the context of all of the other applications filed by the relevant cut-off dates.[27]

Three times as many NGSO system proposals currently are pending before the Commission than were anticipated when the Article 22 EPFD limits for parts of the Ka band were first developed. If nothing else, the larger number of networks would significantly increase the level of complexity inherent in the NGSO FSS operating environment and thus exacerbate the recognized difficulties associated with enforcing aggregate limits. Consequently, there is an indisputable need to derive new single-entry EPFD limits for all of the Ka band, and to establish single-entry EPFD limits for the V band, in each case that are calibrated to ensure that the aggregate EPFD from all proposed NGSO systems does not exceed tolerable limits[28]—consistent with Commission policy.[29]

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27 *See* Comments of ViaSat, Inc., IBFS File No. SAT-LOI-20160428-00041, at 1-2 & 7 (Aug. 15, 2016) ("OneWeb seeks waivers of certain Commission rules, including rules related to: (i) band splitting among NGSO applicants and (ii) protecting geostationary-orbit ("GSO") satellites from NGSO interference. . . . Thus, OneWeb's waiver requests cannot be considered in isolation. ViaSat therefore requests that the Commission defer consideration of those waiver requests, and the Petition more broadly, until interested parties have the opportunity to evaluate in full the operating environment that would result from all of the NGSO systems proposed by the November 15, 2016 close of the processing round. . . . Similarly, in order to evaluate whether GSO networks are fully protected, the Commission will need to evaluate the aggregate impact into GSO networks of all NGSO systems in the processing round.") (footnotes omitted); Comments of ViaSat, Inc., IBFS File No. SAT-LOA-20160622-00058, at 4 (Dec. 1, 2016) ("A full and complete analysis of the public interest considerations relevant to Boeing's waiver request requires concurrent consideration of those applications, particularly given the complexity of the shared spectrum environment inherent in the operations of multiple NGSO systems in the same spectrum.").

28 *See* Inmarsat Comments at 8.

29 *See Ku-Band EPFD Order* ¶ 106 (suggesting that an appropriate conversation factor must "take[] into account the way in which interference from multiple systems aggregates into a GSO FSS earth station antenna, recognizing that the interference is not strictly additive in a linear or power sense.").

C. Any Changes to the Default GSO/NGSO Spectrum-Sharing Rule Must Fully Protect GSO Networks and Also Ensure Reliable GSO Spectrum Access

The *NPRM* proposes to modify Section 25.156(d)(5) of the Commission's rules to make it easier for NGSO and GSO systems to share spectrum, subject to a broad requirement that NGSO systems protect GSO networks.[30] That rule currently provides that where the Commission has not yet adopted band-specific satellite service rules, the Commission will not consider an application seeking authority to operate an NGSO-like satellite network after it has granted an application for GSO-like operations in the same band segment, unless and until the Commission establishes NGSO-GSO sharing criteria for that frequency band segment—and *vice versa*.[31]

The Commission has not yet adopted band-specific satellite service rules for the 17.8-18.3 GHz, 27.5-28.35 GHz, 37.5-42.0 GHz, 47.2-50.2 GHz, or 50.4-51.4 GHz band segments.[32]

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30 *NPRM* ¶ 21.

31 47 C.F.R. § 25.156(d)(5). In adopting this provision, the Commission was clear that "priority" under this rule is determined by which type of application (GSO-like or NGSO-like) is filed first:

> "[I]f a GSO-like satellite system application is filed first, we will consider other GSO-like satellite system applications in the order they are filed, and we will dismiss subsequently-filed NGSO-like satellite system applications in that band until sharing criteria are established. This is consistent with our current practice. For example, in the Ku-band, we initially considered only GSO satellite applications because the first applications for licenses in that band were for GSO networks. We did not begin considering Ku-band NGSO applications until we had established sharing criteria for compatible services with GSO applicants in that band." *Amendment of the Commission's Space Station Licensing Rules and Policies*, First Report and Order, 18 FCC Rcd 10760, at ¶ 58 (2003).

32 The service rules regarding earth station operations in the 27.5-28.35 GHz and 37.5-40.0 GHz band segments address coexistence with terrestrial uses of this spectrum, not the operation of spacecraft. Section 25.145 addresses NGSO FSS licensing in the 18.3-20.2 GHz and 28.35-30.0 GHz band segments. *See* 47 C.F.R. § 25.145.

However, the Commission has granted applications for GSO-like operations,[33] as well as NGSO-like operations,[34] in all or part of these band segments (other than 50.4-51.4 GHz). The applications for previously authorized GSO and GSO/NGSO hybrid systems demonstrated the ability of both types of satellite systems to coexist in these band segments even in the absence of formal sharing criteria adopted by the Commission. These showings suggest that the proposed change in Section 25.156(d)(5) may be appropriate, provided there are adequate mechanisms in place to ensure that GSO networks are actually protected under real-world conditions.

The Satellite Industry Association notes that "[t]he proven success of co-frequency GSO and NGSO operations in the Ka-band demonstrates" that existing Section 25.156(d)(5) "is not necessary to enable sharing" and "cannot be justified."[35] However, the SIA does not address what terms are needed to ensure that spectrum can be shared without posing a risk to GSO operations. Nor does the *NPRM* clearly address this point. Therefore, while ViaSat agrees that it is possible for GSO and NGSO systems to share spectrum effectively under many circumstances, it remains unclear whether the eleven NGSO systems proposed in the pending Ka-band processing round, and the nine NGSO systems proposed in the pending V-band processing round, would be capable of doing so—particularly since the operating environment presented by the 5,627 Ka-band NGSO satellites and the 17,334 V-band NGSO satellites that have been

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33 *See, e.g., Inmarsat Mobile Networks, Inc.*, Order and Authorization and Declaratory Ruling, 30 FCC Rcd 2770, at ¶ 25 (2015); Stamp Grant, Hughes Network Systems, LLC, IBFS File No. SAT-LOA-20111223-00248 (Aug. 3, 2012); *Northrop Grumman Order*.

34 *See, e.g.*, O3b Limited, IBFS File Nos. SES-LIC-20100723-00952 (granted Sept. 25, 2012); *Northrop Grumman Order.*

35 Comments of the Satellite Industry Association, IB Docket No. 16-408, at 8 (filed Feb. 27, 2017) ("SIA Comments"); *see also* OneWeb Comments at 25 (allowing co-frequency spectrum access for both GSO and NGSO systems would "allow innovative NGSO FSS systems to have access to critical spectrum resources without increasing the likelihood of interference to any incumbent GSO operations.").

proposed would be far different from the situation that exists today, or that ever has been considered previously.

The feasibility of such coexistence ultimately will turn on whether and how NGSO systems actually protect GSO networks—including by complying with appropriate EPFD limits that are still to be developed, and the need to take into account the considerations outlined above in Sections II.A and II.B. The *NPRM* suggests, but does not explicitly state, that compliance with any EPFD limits that the Commission adopts would be the sole mechanism for assessing whether GSO FSS networks are protected from harmful interference resulting from NGSO FSS operations under revised Section 25.156(d)(5).[36] If that is the Commission's intent, any EPFD limits incorporated into the revised rules would need to be designed to provide the requisite protection to GSO networks, and suitable EPFD limits also would need to be adopted for the V band—something that has not even been proposed in this proceeding.

If the Commission instead intends to rely on the general terms of No. 22.2 of the ITU Radio Regulations in modifying existing Section 25.156(d)(5) and applying the revised rule—without reference to any specific EPFD limits—that should be made expressly clear. In that case, it would be essential that the consideration of the nine NGSO applications and 17,334 satellites proposed in the pending V-band processing round include a full assessment of their aggregate impact on the operation of the GSO spacecraft being planned for the V-band.

In any event, Boeing stands alone in opposing the Commission's proposal to substitute a rule similar to No. 22.2 of the ITU Radio Regulations. Boeing instead asks the Commission to conclude that, in those bands where service rules have not yet been adopted, "no presumption

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[36] *NPRM* ¶ 19 n.52 ("We intend that compliance with EPFD limits in the Ka-band would satisfy any obligation on an NGSO FSS system to operate on a non-interference basis with respect to a GSO FSS networks.").

exists regarding whether GSO or NGSO FSS networks will have sharing priority . . . ."[37] But that presumption already *does* exist today and extends directly from the text of No. 22.2 itself: "Non-geostationary-satellite systems shall not cause unacceptable interference to and, unless otherwise specified in these Regulations, shall not claim protection from geostationary satellite networks in the fixed-satellite service and the broadcasting-satellite service operating in accordance with these Regulations. No. 5.43A does not apply in this case."

Boeing mischaracterizes Commission precedent when it claims that there is a "long standing recognition by the Commission of the need for FSS allocations that are primarily for NGSO use."[38] To the contrary, as far back as 1998 a number of satellite commenters explained that it would be "premature to divide the [V band] further for GSO or NGSO operations because not enough is known about the services that may be proposed in these bands."[39] In response, the Commission expressly concluded: "Based on our review of the record, we agree with those commenters arguing that it would be premature to make separate GSO and NGSO designations now."[40]

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37 Boeing Comments at 12.

38 *Id.* (incorrectly referencing *Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz, and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations*, 13 FCC Rcd 24649, at ¶ 22 (1998) ("*V-Band Report and Order*")).

39 *V-Band Report and Order* ¶ 20.

40 *Id*. at ¶ 21.

III. COMMENTING PARTIES FAIL TO ADDRESS HOW ASSIGNING SPECTRUM IN RELIANCE ON THE "AVOIDANCE OF IN-LINE INTERFERENCE" MECHANISM WOULD ADVERSELY IMPACT SERVICE BY COMPETING NGSO SYSTEMS

A number of commenting parties support the Commission's proposal to use the "avoidance of in-line interference" mechanism to assign spectrum to applicants in the pending Ka-band and V-band processing rounds, claiming that this approach would facilitate coexistence by NGSO systems in the same spectrum. For example, SpaceX asserts that the mechanism would permit NGSO FSS systems to operate throughout their authorized bands except during in-line events, and therefore characterizes the mechanism as the "best methodology for intra-service spectrum sharing" and asserts that it is "much preferable to a simple spectrum splitting approach . . . ."[41] Boeing and Lockheed make similar claims, with Boeing advocating the use of this approach in both the Ka and V bands.[42]

Significantly, these parties fail to account for the ways in which reliance on the "avoidance of in-line interference" mechanism in awarding spectrum would actually *harm* the ability of competitive NGSO systems to operate effectively. Notably, in-line events are likely to be far more common than most parties acknowledge—with devastating implications for the coverage and capacity of NGSO FSS systems that are much smaller than, for example: (i) the 11,943-satellite V-band SpaceX system; (ii) the 4,425-satellite Ka-band SpaceX system; (iii) the 2,956-satellite V-band Boeing system; (iv) the 2,000-satellite V-band OneWeb system; and (v) the 720-satellite Ka-band OneWeb system. And efforts to minimize the frequency of in-line

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41 SpaceX Comments at 18.

42 *See, e.g.*, Boeing Comments at 12; Comments of Lockheed Martin Corporation, IB Docket No. 16-408, at 2 (filed Feb. 27, 2017).

events are themselves likely to limit the benefits derived from the NGSO FSS operations of the competitors of SpaceX, Boeing, and OneWeb, as discussed below.

A. Relying on the "Avoidance of In-Line Interference" Mechanism to Assign Spectrum Would Impede Effective Competition

As the *NPRM* acknowledges, using the "avoidance of in-line interference" mechanism would require a transmitting NGSO system operator to cease or limit its transmissions whenever an in-line event occurs.[43] Therefore, the utility of the mechanism depends largely on such in-line interference events being relatively uncommon; where such events are common, they present uncertainty and operational complexity, and also can have a dramatic adverse impact on how certain NGSO constellations would operate.[44] Indeed, as Telesat Canada notes, there already are significant challenges in determining when in-line events occur—with the resulting uncertainty having adverse implications for investment incentives.[45] These challenges would be exacerbated if in-line events were expected to occur frequently.

Given the eleven NGSO FSS systems with 5,627 spacecraft proposed in the Ka-band processing round, and the nine NGSO systems with 17,334 spacecraft proposed in the current V-band processing round, it should be quite apparent that in-line events would *not* be rare. Indeed, a preliminary analysis by ViaSat estimated that in-line events between the 2,956-satellite Boeing V-band system and the 24 satellite VIASAT-NGSO system would occur 46.7 percent of the time.[46] Any requirement for ViaSat's competitive NGSO system to avoid these in-line events

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43 *NPRM* ¶ 22.

44 ViaSat Comments at 19-20; *see also* 47 C.F.R. § 25.261.

45 Comments of Telesat Canada, IB Docket No. 16-408, at 11-14 (filed Feb. 27, 2017) ("Telesat Canada Comments").

46 Comments of ViaSat, Inc., IBFS File No. SAT-LOA-20160622-00058, at 3 and Ex. A (Dec. 1, 2016). That preliminary analysis is based on applying Section 25.261 of the

would result in significant adverse consequences for the service quality and price that ViaSat could offer to consumers.[47] This problem would be exacerbated by any need to avoid the frequent in-line events caused by the operation of each of the 11,943-satellite SpaceX system, the 4,425-satellite SpaceX system, the 2,000-satellite OneWeb system, and the 720-satellite OneWeb system.

Notably, the impact of the "avoidance of in-line interference" mechanism on any given NGSO FSS operator is directly related to the size of that operator's constellation, relative to the size of its competitors. Where one operator utilizes a relatively large constellation with a high degree of satellite diversity, in-line events should not significantly impact the coverage or capacity of the network because alternative transmission paths should be available for its use. As such, it should come as no surprise that operators like SpaceX, Boeing, and OneWeb—each of which plans to launch many thousands of satellites—support spectrum assignments that rely on the "avoidance of in-line interference" mechanism. After all, such an approach to spectrum access would provide them with the ability to access significant swaths of spectrum while compelling their competitors to bear the burden of coexistence.

In contrast, where an operator utilizes a more modestly sized constellation, and has fewer opportunities to employ path diversity to overcome in-line events, relying on the "avoidance of in-line interference" mechanism as the basis for awarding spectrum would likely have a substantial adverse impact on coverage and capacity. Stated differently, relying on that

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Commission's rules (which addresses in-line interference events between NGSO FSS networks), which provides a reasonable proxy for evaluating the potential for co-frequency spectrum conflicts among different V-band NGSO systems.

47 ViaSat Comments at 20-23.

mechanism to award spectrum would disproportionately impact NGSO systems that utilize smaller constellations—such as ViaSat's NGSO system.

These dynamics are illustrated in ViaSat's initial comments, which demonstrate that: (i) the need to avoid Boeing's 2,956-satellite V-band NGSO system during in-line events would significantly reduce the average probability of a given location being covered by ViaSat's NGSO system at any given point in time, to less than 50 percent in large parts of the United States—while Boeing's coverage would not be materially impacted by the need to avoid the much smaller ViaSat system; and (ii) the need to avoid Boeing's system would significantly reduce the average number of ViaSat satellites visible from a given location at any point in time, and therefore significantly reduce the available capacity provided by the ViaSat NGSO system—while, again, Boeing's available capacity would hardly be impacted at all by the need to avoid ViaSat's NGSO system.[48]

These results are not unique to Boeing's V-band system. Indeed, reliance on the "avoidance of in-line interference" mechanism would allow any large-constellation NGSO system to force smaller systems to shoulder almost the entire burden of coexisting in the same spectrum, with highly inequitable results. This is reflected in the attached Exhibits 1A-D, 2A-D, and 3A-B, which depict how this very same problem would be created by the: (i) 11,943-satellite V-band SpaceX system; (ii) the 4,425-satellite Ka-band SpaceX system; (iii) the 2,000-satellite V-band OneWeb system; and (iv) the 720-satellite Ka-band OneWeb system. For completeness, Exhibits 1, 2 and 3 include data for the 2,956-satellite Boeing V-band system; for comparison they also depict the impact of the much smaller 117-satellite Ka-/V-band Telesat system, and the 84-satellite Ka-band LeoSat system.

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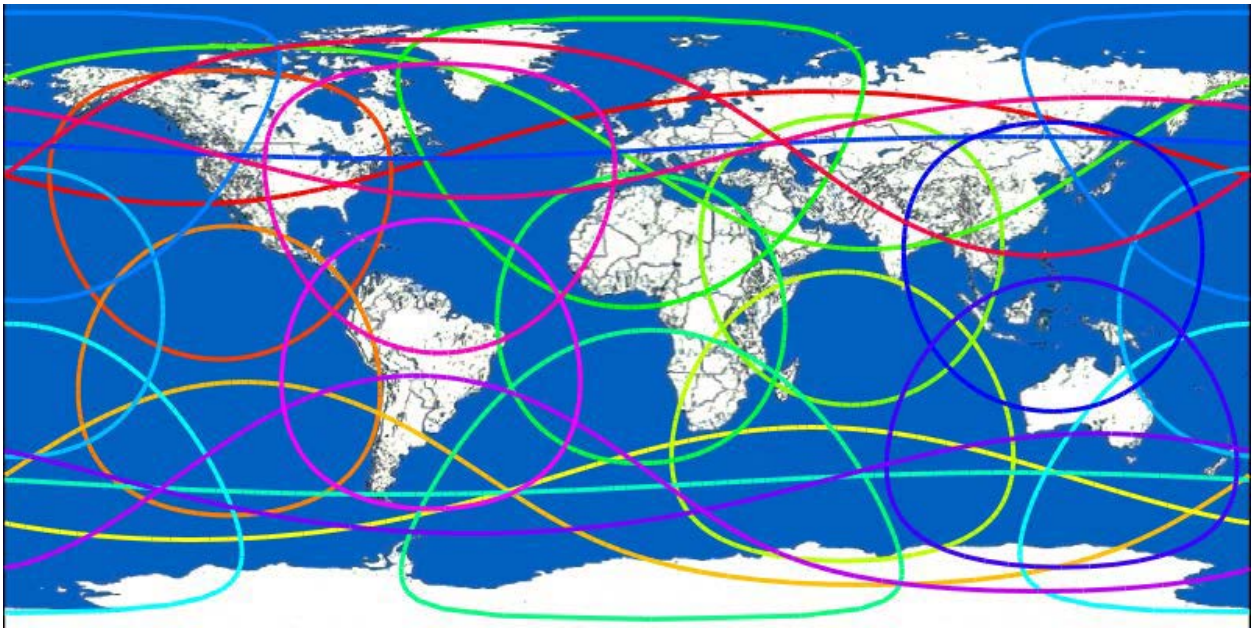
[48] ViaSat Comments at 20 & Ex. 1 and 2.

While the discussion below focuses on the impact on the provision of service to the contiguous United States (CONUS), it bears emphasis that ViaSat's NGSO system expressly is designed to satisfy the Commission's NGSO global coverage requirements,[49] and that its service area also includes Hawaii, Alaska, Puerto Rico, and the U.S. Virgin Islands, as well as the parts of the world depicted below:



Exhibits 1A, 1B, 1C, and 1D show that any need to avoid the much larger SpaceX, Boeing, or OneWeb systems during in-line events would significantly reduce the average probability of any given area being covered by ViaSat's NGSO system, while any need to avoid the Telesat system or the LeoSat system would have nominal impact, at most, on ViaSat. Notably, none of the other proposed NGSO systems would be materially affected by the need to avoid the ViaSat system. More specifically:

- ViaSat would have coverage at all latitudes within its service area *100 percent of the time*, absent the need to turn off to avoid other NGSO systems;

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[49] 47 C.F.R. § 25.145.

- Avoiding the much larger Ka-band SpaceX system would reduce the average probability of ViaSat's covering all of CONUS to *only 30 percent*, with some areas in CONUS covered *a mere 22 percent* of the time;

- Avoiding the much larger V-band SpaceX system would reduce the average probability of ViaSat's covering all of CONUS to *only 19 percent*, with some areas in CONUS covered *a mere 11 percent* of the time;

- Avoiding the much larger V-band Boeing system would reduce the average probability of ViaSat's covering all of CONUS to *only 47 percent*, with some areas in CONUS covered *a mere 37 percent* of the time; and

- Avoiding the much larger V-band OneWeb system would reduce the average probability of ViaSat's covering all of CONUS *to only 49 percent*, with some areas in CONUS covered *a mere 20 percent* of the time.

Exhibits 2A, 2B, 2C, and 2D show that any need to avoid the much larger SpaceX, Boeing, or OneWeb systems during in-line events would significant reduce the capacity available over ViaSat's NGSO system at any given location by reducing the average number of ViaSat satellites available for service, while (again) the Telesat and LeoSat systems would have a nominal impact, at most. Notably (again), none of the other proposed NGSO systems would be materially affected by the need to avoid the ViaSat system. More specifically:

- ViaSat would have, on average, *2.9 satellites* covering every location in CONUS, absent the need to turn off to avoid another NGSO system;

- Avoiding the much larger Ka-band SpaceX system would reduce the average number of ViaSat satellites available to serve a location in CONUS to *only 0.33 satellites*, with some locations in CONUS served by an average of *a mere 0.23 satellites*;

- Avoiding the much larger Ka-band OneWeb system would reduce the average number of ViaSat satellites available to serve a location in CONUS to *only 1.8 satellites*, with some locations in CONUS served by an average of *a mere 1.7 satellites*;

- Avoiding the much larger V-band SpaceX system would reduce the average number of ViaSat satellites available to serve a location in CONUS to *only 0.19 satellites*, with some locations in CONUS served by an average of *a mere 0.11 satellites*;

- Avoiding the much larger V-band Boeing system would reduce the average number of ViaSat satellites available to serve a location in CONUS to *only 0.53 satellites*, with some locations in CONUS served by an average of *a mere 0.43 satellites*; and

- Avoiding the much larger V-band OneWeb system would reduce the average number of ViaSat satellites available to serve a location in CONUS to *only 0.61 satellites*, with some locations in CONUS served by an average of *a mere 0.21 satellites*.

Exhibits 3A and 3B depict the average number of hours that a VIASAT-NGSO user in CONUS would not be able to receive service if ViaSat were required to turn off to avoid another NGSO system during in-line events. By way of reference, 99.9 percent availability would result in no more than 9 hours of outages per year, and 99.7 percent availability would result in no more than 27 hours of outages per year. In contrast, 400 hours of annual outages would yield an unacceptable 95 percent availability level, and 7,100 hours of annual outages would yield an abysmal 19 percent availability level. More specifically:

- ViaSat's NGSO satellite constellation is designed to provide—*100 percent of the time*, 8,760 hours per year—coverage to all of CONUS, absent the need to turn off to avoid another NGSO system;

- Avoiding the much larger Ka-band SpaceX system would reduce ViaSat's NGSO system average availability over CONUS by 6,118 hours per year, dropping availability to *only 30 percent*;

- Avoiding the much larger Ka-band OneWeb system would reduce ViaSat's NGSO system average availability over CONUS by 400 hours per year, dropping availability to *only 95.4 percent*;

- Avoiding the much larger V-band SpaceX system would reduce ViaSat's NGSO system average availability over CONUS by 7,100 hours per year, dropping availability to *only 19 percent*;

- Avoiding the much larger V-band Boeing system would reduce ViaSat's NGSO system average availability over CONUS by 4,600 hours per year, dropping availability to *only 47 percent*; and

- Avoiding the much larger V-band OneWeb system would reduce ViaSat's NGSO system average availability over CONUS by 4,400 hours per year, dropping availability to *only 49 percent*.

Notably, Exhibits 1A-D, 2A-D, and 3A-B consider the impact that each of the various NGSO systems *in isolation* could have on a relatively small constellation like ViaSat's. Just considered alone, any requirement to avoid in-line events with the co-frequency operations of any one of the systems described above could well prevent ViaSat from satisfying its obligations under Section 25.145 to be "capable of providing Fixed-Satellite Service on a continuous basis throughout the fifty states, Puerto Rico and the U.S. Virgin Islands."[50] The aggregate effects of *multiple* NGSO systems operating simultaneously in the same spectrum would be even more significant.

For these reasons, the Commission must consider a band-segmentation approach in the current Ka- and V-band NGSO processing rounds. Otherwise, certain operators would enjoy significant competitive advantages simply because they would deploy large constellations that have preclusive impacts on much smaller NGSO systems. Certainly, nothing should preclude spectrum coordination among operators that enables them to share additional spectrum after reaching mutually agreeable means of avoiding in-line interference events.

B. The In-Line Event "Trigger" Angle Should Not Be Changed

The *NPRM* invites comment as to whether to reduce the "trigger" angle used to define when an in-line event has occurred.[51] In response, a number of parties propose a variety of ways in which that angle might be reduced. For example, LeoSat proposes to reduce the angle to 2-3 degrees.[52] Kepler advocates the use of coordination to determine the angular separation

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50 47 C.F.R. § 25.145.

51 *NPRM* ¶ 26.

52 LeoSat Comments at 12.

threshold to be used by particular sets of operators.[53] SES and O3b propose reducing the angle to an unspecified level.[54] Space Norway recommends that any change to the angle be grounded in studies.[55] Boeing advocates the use of different angles in different circumstances, without explaining what differences would matter for these purposes.[56] Although the specifics vary, each of these parties assumes that reducing the trigger angle would be beneficial, without establishing as much with any objective data.

As ViaSat noted in its initial comments, the manner in which the trigger angle is defined can have a significant impact on the coverage and capacity issues described above.[57] Although reducing the trigger angle could mitigate, but not eliminate, those issues, it also would create different issues. Because the trigger angle reflects the degree of angular separation deemed necessary to avoid harmful interference between NGSO systems, any reduction in the angle requires some substitute mechanism to mitigate the possibility of harmful interference (*e.g.*, more restrictive antenna pointing, off-axis EIRP masks, or other earth station performance requirements), which itself could significantly and adversely impact how operators are able to design their networks and what services those networks are able to support. For example, such mechanisms could effectively preclude the use of NGSO systems for services that employ small mobile terminals. As these applications are likely to be of great benefit to the public, and

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53 Kepler Comments at 4.

54 SES/O3b Comments at 25.

55 Space Norway Comments at 12.

56 Boeing Comments at 12-13.

57 ViaSat Comments at 21.

consistent with SpaceX's advocacy on this point,[58] ViaSat again urges the Commission not to reduce the trigger angle.

Notably, it is not even necessary to consider changing the trigger angle if the band-splitting approach for spectrum assignment is employed. Rather, in such a case, parties could engage in coordination with respect to in-line events and trigger angles, and thus consider on a commercial basis the trade-offs associated with any corresponding and mutually agreeable antenna pointing, off-axis EIRP masks, or other earth station performance requirements that may be appropriate to enable them to share spectrum with each other.

IV. THE COMMISSION SHOULD NOT COUNTENANCE THE EFFORTS OF SOME PARTIES TO USE THIS PROCEEDING TO PROVIDE COVER FOR THEIR PENDING, NON-COMPLIANT NGSO APPLICATIONS

As the Commission is no doubt aware, in their applications for NGSO operating authority in the pending Ka- and V-band processing rounds, several commenters have sought waivers of the Commission's baseline licensing rules and application requirements for NGSO systems. For example, Boeing and SpaceX seek waivers of the Commission's milestone requirement to allow them to deploy only part of their constellations within the current and longstanding six-year NGSO deployment deadline.[59] O3b, SpaceX, and Boeing seek waivers of the current and long-

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58 SpaceX supports retaining the existing 10-degree "trigger" angle to avoid the imposition of additional performance requirements on NGSO FSS earth stations. SpaceX Comments at 20.

59 *See* The Boeing Company, IBFS File No. SAT-LOA-20160622-00058, Narrative at 72 (filed June 22, 2016) ("Boeing V-band Application"); The Boeing Company, IBFS File No. SAT-LOA-20161115-00109, Narrative at 28-29 (filed Nov. 15, 2016) ("Boeing Ka-band Application"); Space Exploration Holdings, LLC, IBFS File No. SAT-LOA-20170301-00027, Waiver Requests at 15-16 (filed Mar. 1, 2017) ("SpaceX V-Band Application"); Space Exploration Holdings, LLC, IBFS File No. SAT-LOA-20161115-00118, Waiver Requests at 8-10 (filed Nov. 15, 2016) ("SpaceX Ka-Band Application").

standing NGSO global coverage requirement.[60] And Boeing, Kepler, LeoSat, SpaceX, Telesat Canada, O3b and OneWeb seek waivers of the current and longstanding band segmentation provisions set forth in Section 25.157 of the Commission's rules.[61]

In other words, SpaceX, Boeing, and O3b have applied for system designs that do not comply with longstanding FCC application requirements and baseline processing round qualifications, and now seek to overcome their fundamental deficiencies, and avoid the risk of dismissal, through improper and inequitable post-cutoff notice rule changes. This would be an irrational and legally unsustainable result. It would reward those applicants for proposing non-compliant systems, while effectively handicapping those applicants that responsibly designed and proposed networks that comply with the Commission's existing rules in the first instance—rules that were not even *proposed* when the processing rounds were opened. And doing so would place the risk and burden associated with the proposed NGSO co-existence rules on applicants that filed compliant applications well before this proceeding ever started.

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60 *See* O3b Limited Ka-Band Application, IBFS File Nos. SAT-AMD-20161115-00116, Narrative at 9-10 (filed Nov. 15, 2016); O3b Limited, IBFS File No. SAT-AMD-20170301-00026, Narrative at 8 (filed Mar. 1, 2017) ("O3b V-Band Application"); SpaceX Ka-Band Application, Waiver Requests at 13-14; SpaceX V-Band Application, Waiver Requests at 9-10; Boeing V-Band Application, Narrative at 65; Boeing Ka-Band Application, Narrative at 28-29; Space Norway AS, IBFS File No. SAT-LOI-20161115-00111, Petition at 11-12 (filed Nov. 15, 2016).

61 Boeing V-Band Application, Narrative at 69; The Boeing Company, IBFS File No. SAT-LOA-20161115-00109 (filed Nov. 15, 2016); Kepler Communications Inc., IBFS File No. SAT-LOI-20161115-00114, Legal Narrative at 12-13 (filed Nov. 15, 2016); LeoSat MA, Inc., IBFS File No. SAT-LOI-20161115-00112, Petition at 14-15 (filed Nov. 15, 2016); SpaceX Ka-Band Application, Waiver Requests at 5-7; SpaceX V-Band Application, Waiver Requests at 12-14; Telesat Canada, IBFS File No. SAT-LOI-20161115-00108, Petition at 32-33 (filed Nov. 15, 2016); Telesat Canada, IBFS File No. SAT-LOI-20170301-00023, Petition at 27-28 (filed Mar. 1, 2017); O3b V-Band Application, Narrative at 10; WorldVu Satellites Limited (d/b/a OneWeb), IBFS File No. SAT-LOI-20160428-00041, Legal Narrative at 17-21 (filed Apr. 28, 2016); WorldVu Satellites Limited (d/b/a OneWeb), IBFS File No. SAT-LOI-20170301-00031, Legal Narrative at 28-30 (filed Mar. 1, 2017).

Notably, at this late date applicants that have not filed waiver requests could be unable to take advantage of any flexibility afforded by changes to the global coverage rule; doing so likely would require a major amendment to a pending application, which generally is not permitted outside of a designated filing window.[62] Moreover, modifying a pending application so that one could take advantage of new rules by employing a fundamentally different NGSO constellation with a different orbital architecture could require new ITU filings as well, and therefore affect matters that are outside the Commission's jurisdiction.

Fundamental fairness mandates equitable treatment of all applicants in the pending processing rounds. By allowing only some applicants to sidestep the requirements of rules that existed at the start of the relevant processing round, the Commission would grant unfair advantages to those applicants—both competitively and in subsequent coordination negotiations. If the Commission nevertheless decides to implement fundamental changes to its NGSO licensing framework, as proposed in the *NPRM*, the most sensible approach would be to dismiss all pending NGSO applications (without prejudice to refiling), initiate new Ka- and V-band

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62 47 C.F.R. § 25.116(c). The V-band and Ka-band cut-off notice indicate that the Commission will provide applicants who filed by the relevant cut-off dates "an opportunity to amend their requests, if necessary, to conform to any requirements or policies that may be subsequently adopted concerning NGSO-like satellite operation in these bands." *See Satellite Policy Branch Information, OneWeb Petition Accepted for Filing, IBFS File No. SAT-LOI-20160428-00041, Cut-Off Established for Additional NGSO-Like Satellite Applications or Petitions for Operations in the 10.7-12.7 GHz, 14.0-14.5 GHz, 17.8-18.6 GHz, 18.8-19.3 GHz, 27.5-28.35 GHz, 28.35-29.1 GHz, and 29.5-30.0 GHz Bands*, Public Notice, DA 16-804, at 2 (July 15, 2016); Satellite Policy Branch Information, Boeing Application Accepted for Filing in Part, IBFS File No. SAT-LOA-20160622-00058, Cut-Off Established for Additional NGSO-Like Satellite Applications or Petitions for Operations in the 37.5-40.0 GHz, 40.0-42.0 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz Bands, Public Notice, DA 16-1244, at 3 (Nov. 1, 2016). Those statements do not expressly allow *discretionary* changes made possible by subsequent rule and policy changes.

processing rounds *after* this proceeding has been fully resolved (and new rules are enacted), and allow all operators to avail themselves of the new rules.

V. CONCLUSION

For the reasons set forth above and in ViaSat's initial comments, the Commission should license NGSO systems in a manner that preserves the integrity of the Commission's rules, facilitates the ability of NGSO systems to share limited spectrum resources with GSO networks, and ensures that smaller NGSO systems are not forced to coexist in the same spectrum as much larger NGSO systems, and bear capacity, coverage, and service level reductions that the much larger systems would not bear. To achieve these objectives, ViaSat recommends that the Commission:

(i) Adopt both single-entry and aggregate EPFD limits specifically designed to protect today's high-throughput GSO networks from harmful interference resulting from the significant number of NGSO systems proposed in the pending Ka-band and V-band processing rounds;

(ii) Develop a mechanism to ensure that suitable aggregate EPFD limits in the space-to-Earth, space-to-space, and Earth-to-space directions are honored and that critical GSO operations thus are protected;

(iii) Utilize "band-splitting" to assign access to specific band segments to each NGSO system, instead of requiring applicants to rely on the "avoidance of in-line interference" mechanism, and allow coordination among NGSO operators to provide them the ability to access additional spectrum based on mutually agreeable sharing techniques; and

(iv) Dismiss all pending Ka- and V-band NGSO applications (without prejudice to refiling) and initiate new processing rounds *after* this proceeding has been fully resolved and after any fundamental changes in the rules for licensing NGSO systems are implemented, to avoid otherwise providing impermissible advantages to those applicants that have proposed systems that do not satisfy longstanding FCC application requirements and baseline processing round qualifications.

Respectfully submitted,

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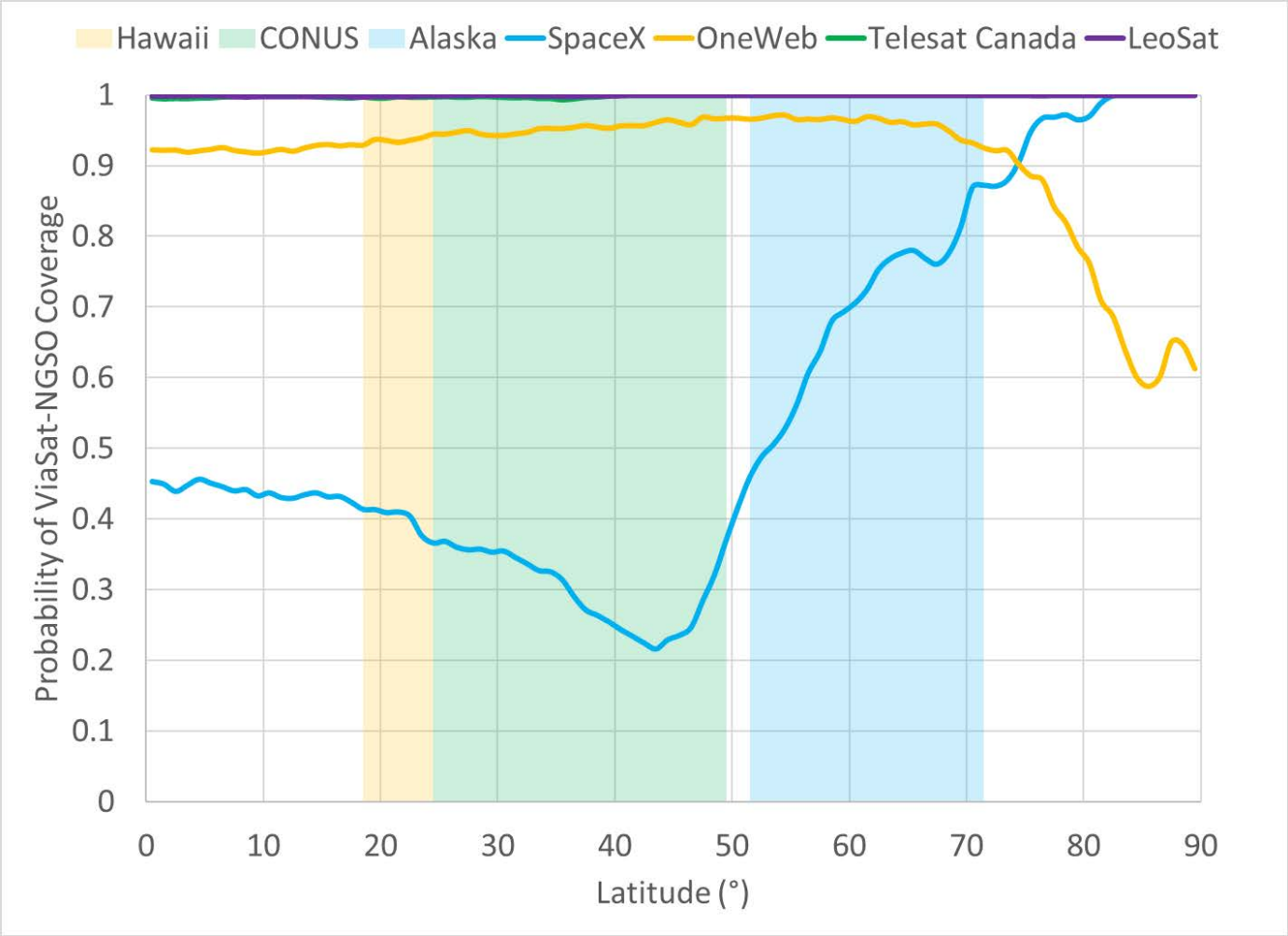
April 10, 2017

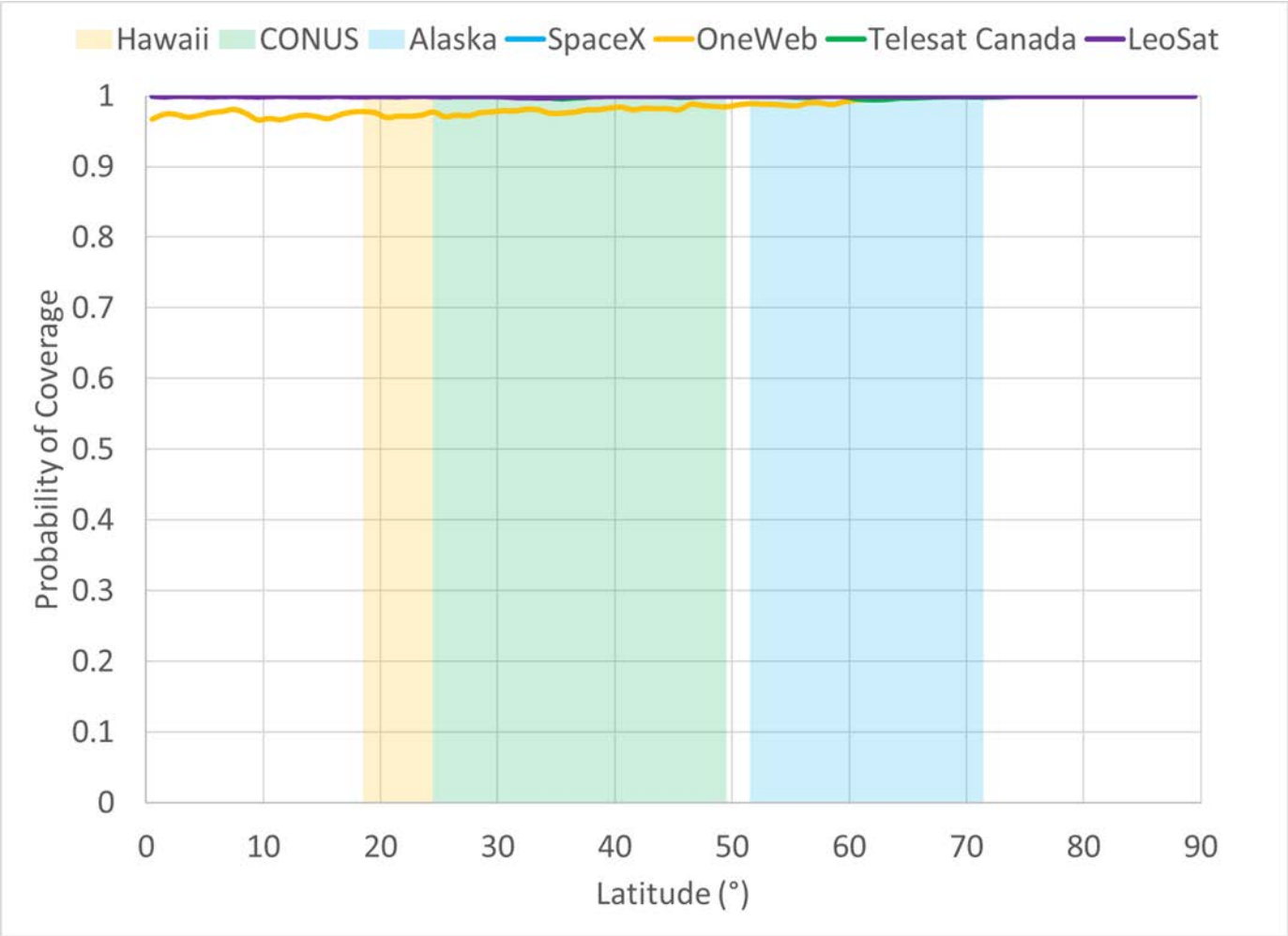
EXHIBITS

Exhibit 1A
Ka Band: Average Coverage Probability Loss for ViaSat-NGSO from Its Avoiding In-Line Events with Other NGSOs (By Latitude)



Note: Loss caused by Telesat Canada and by LeoSat is barely visible on the scale.

Exhibit 1B
Ka Band: Average Coverage Probability Effect on Other NGSOs from Their Avoiding In-Line Events with ViaSat (By Latitude)



Note: Effect on SpaceX, Telesat Canada, and LeoSat is barely visible on the scale.

Exhibit 1C
V Band: Average Coverage Probability Loss for ViaSat-NGSO from Its Avoiding In-Line Events with Other NGSOs (By Latitude)

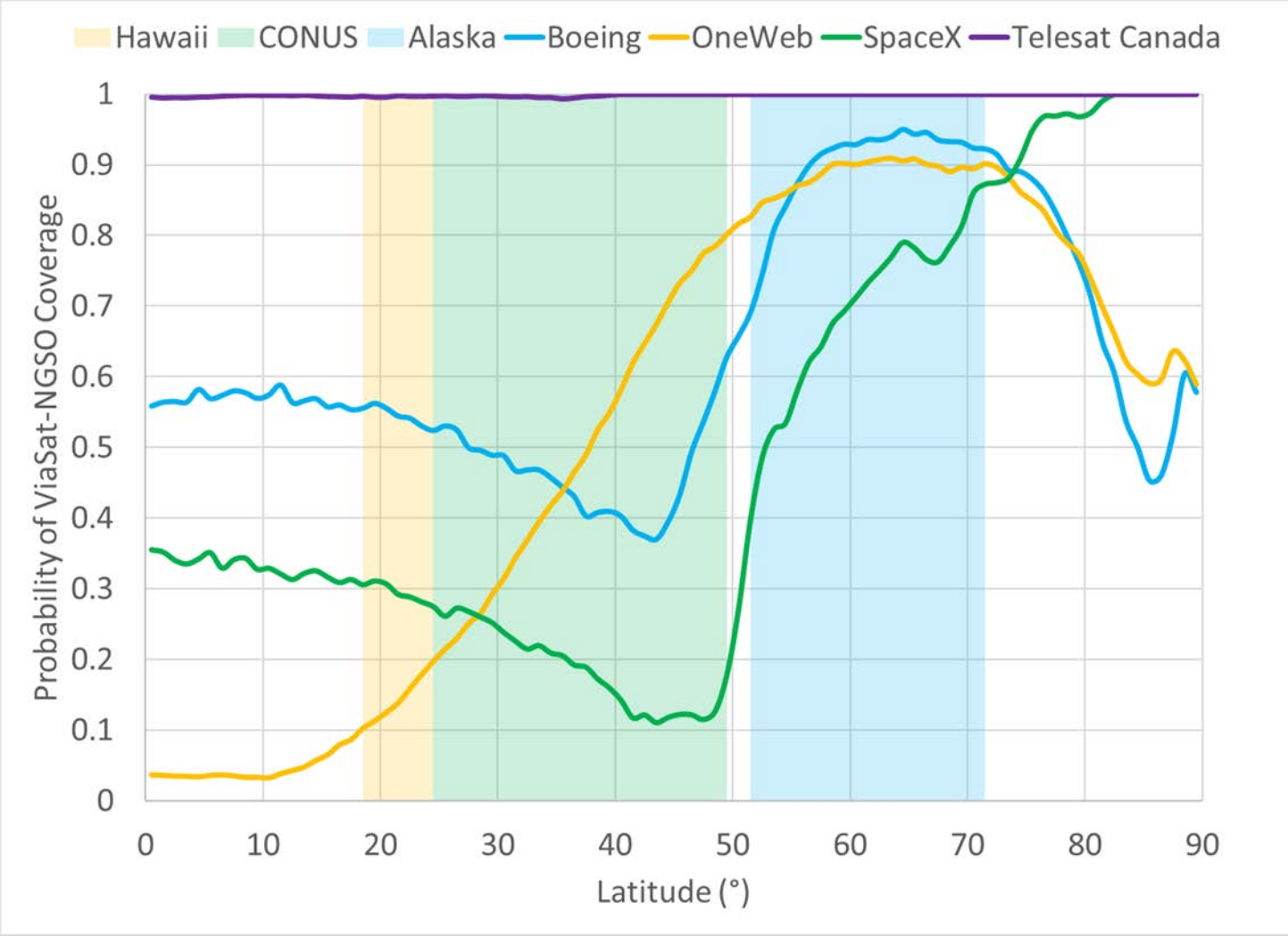
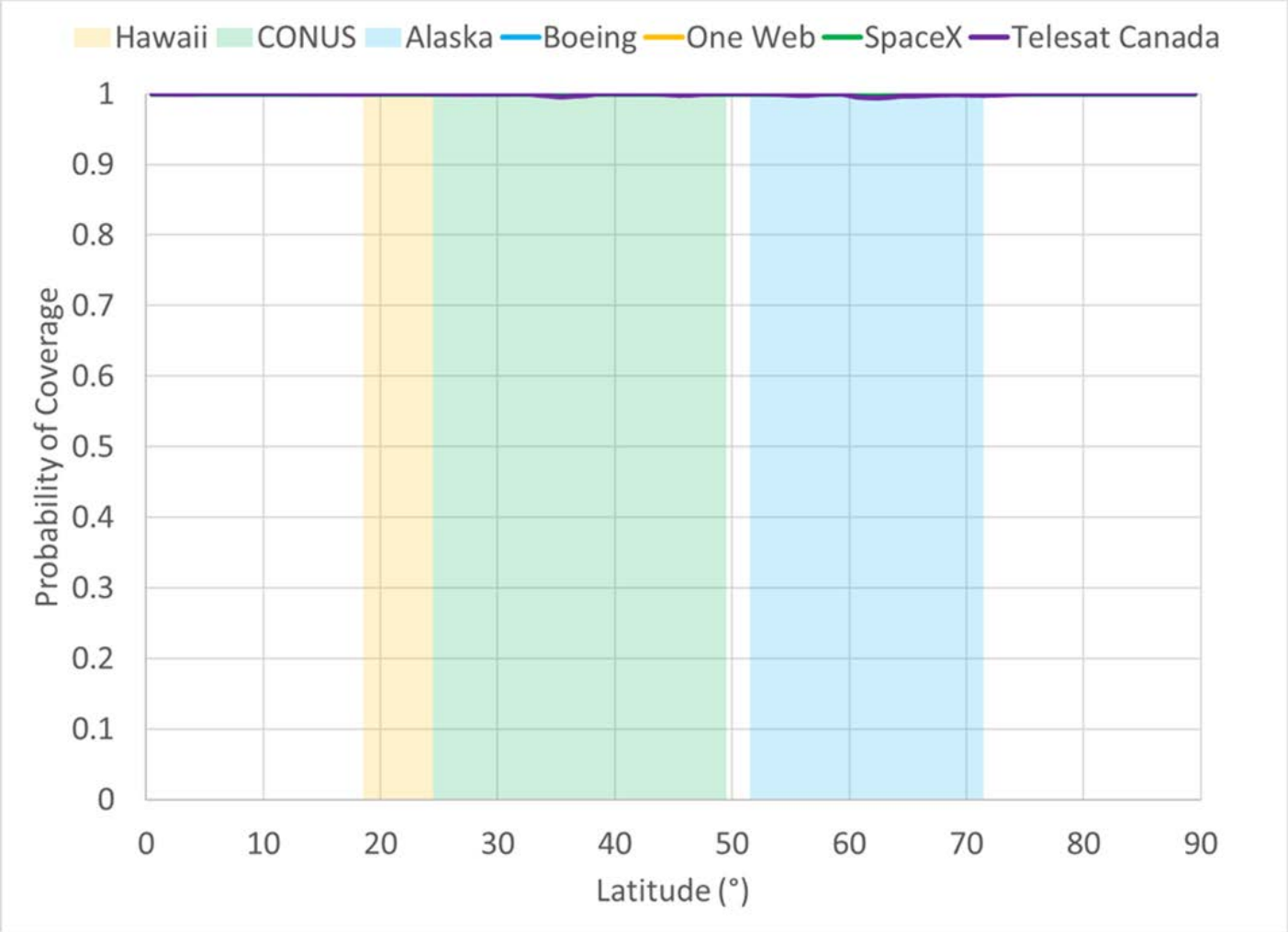


Exhibit 1D
V Band: Average Coverage Probability Effect on Other NGSOs from Their Avoiding In-Line Events with ViaSat (By Latitude)



Note: Effect on Boeing, OneWeb, SpaceX and Telesat Canada is barely visible on the scale.

Exhibit 2A
Ka Band: Average Capacity Loss for ViaSat-NGSO from Its Avoiding In-Line Events with Other NGSOs (By Latitude)

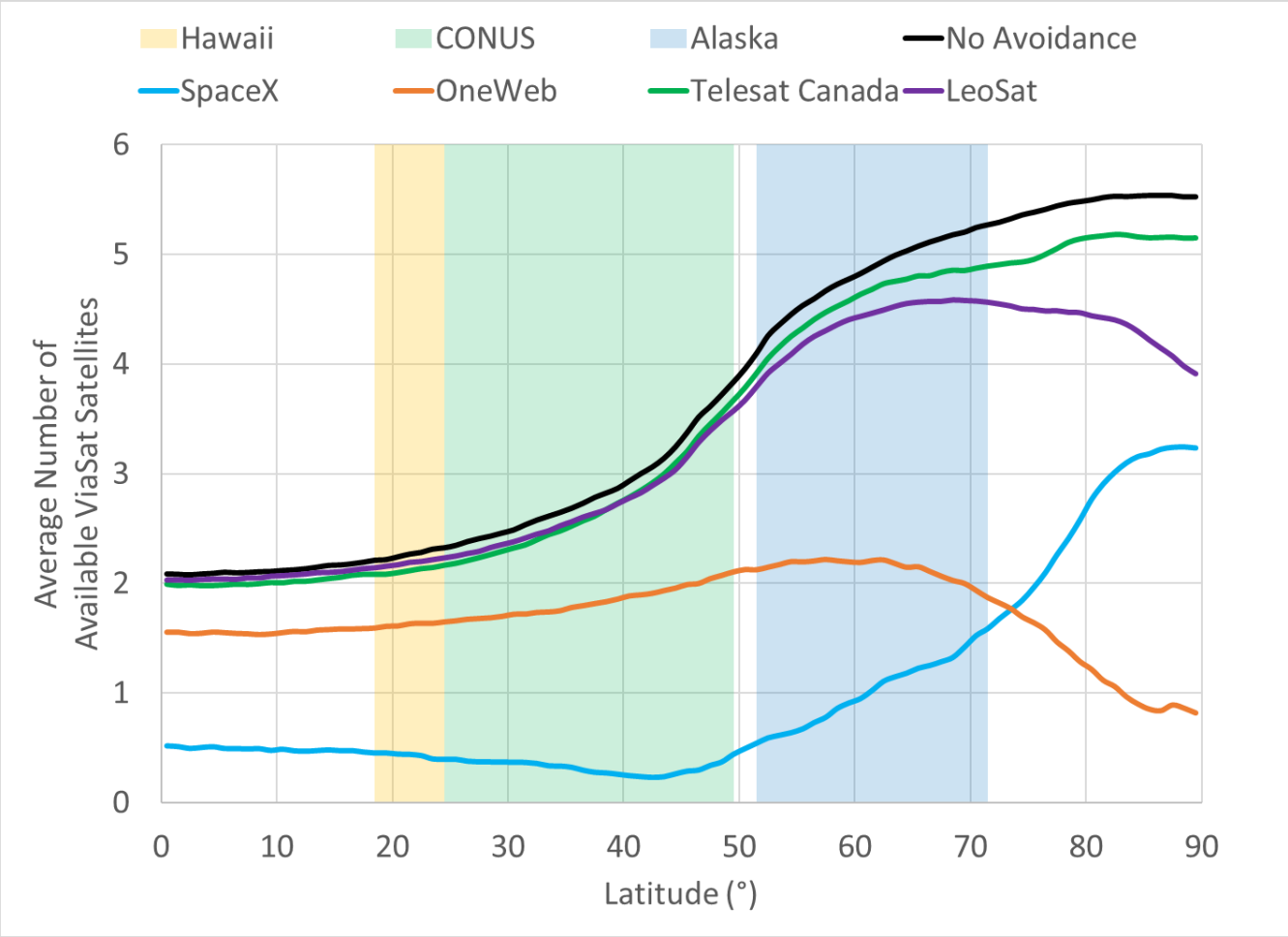


Exhibit 2B
Ka Band: Average Capacity Effect on Other NGSOs
from Their Avoiding In-Line Events with ViaSat
(By Latitude)

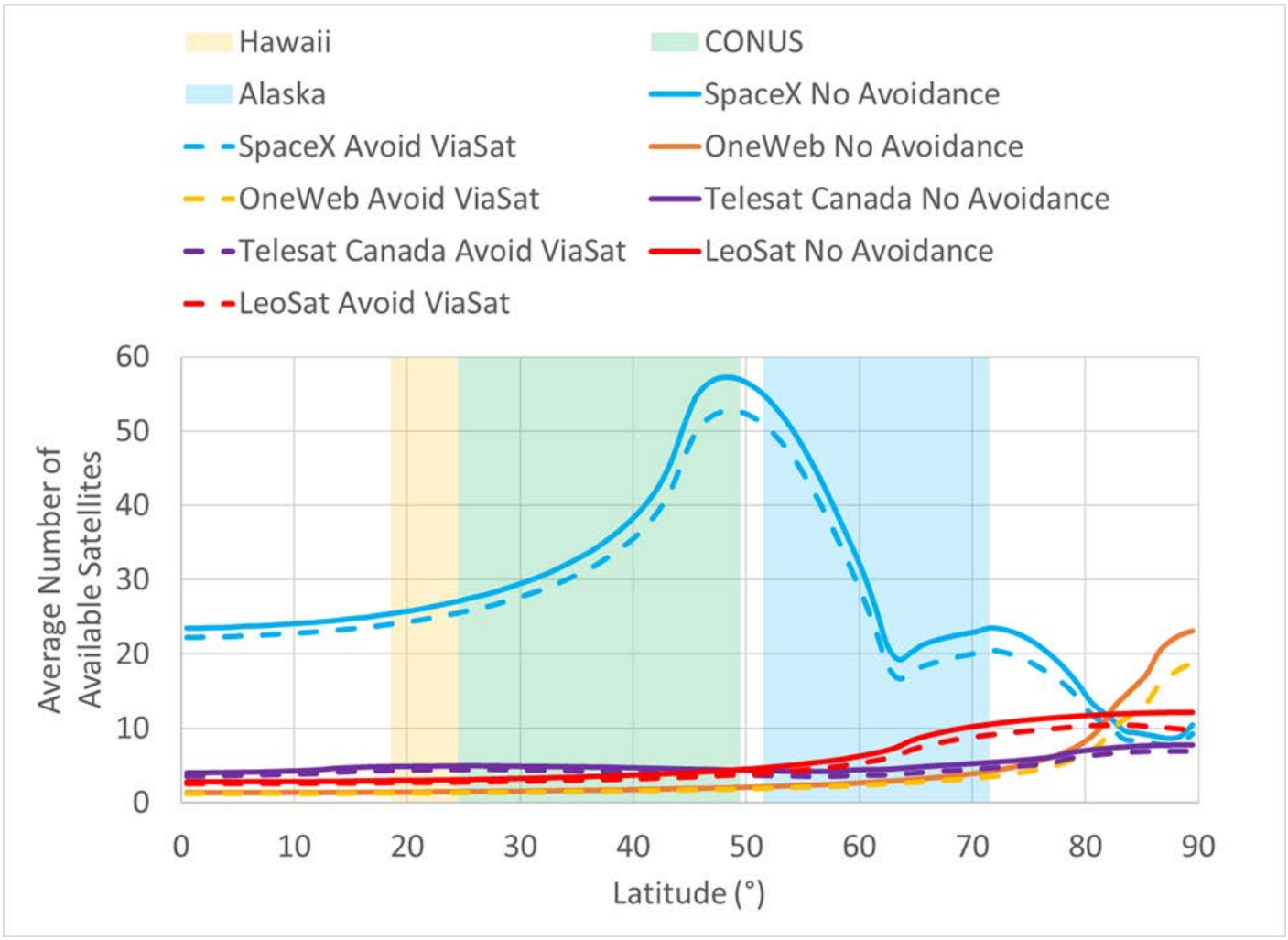


Exhibit 2C
V Band: Average Capacity Loss For ViaSat-NGSO from Its Avoiding In-Line Events with Other NGSOs (By Latitude)

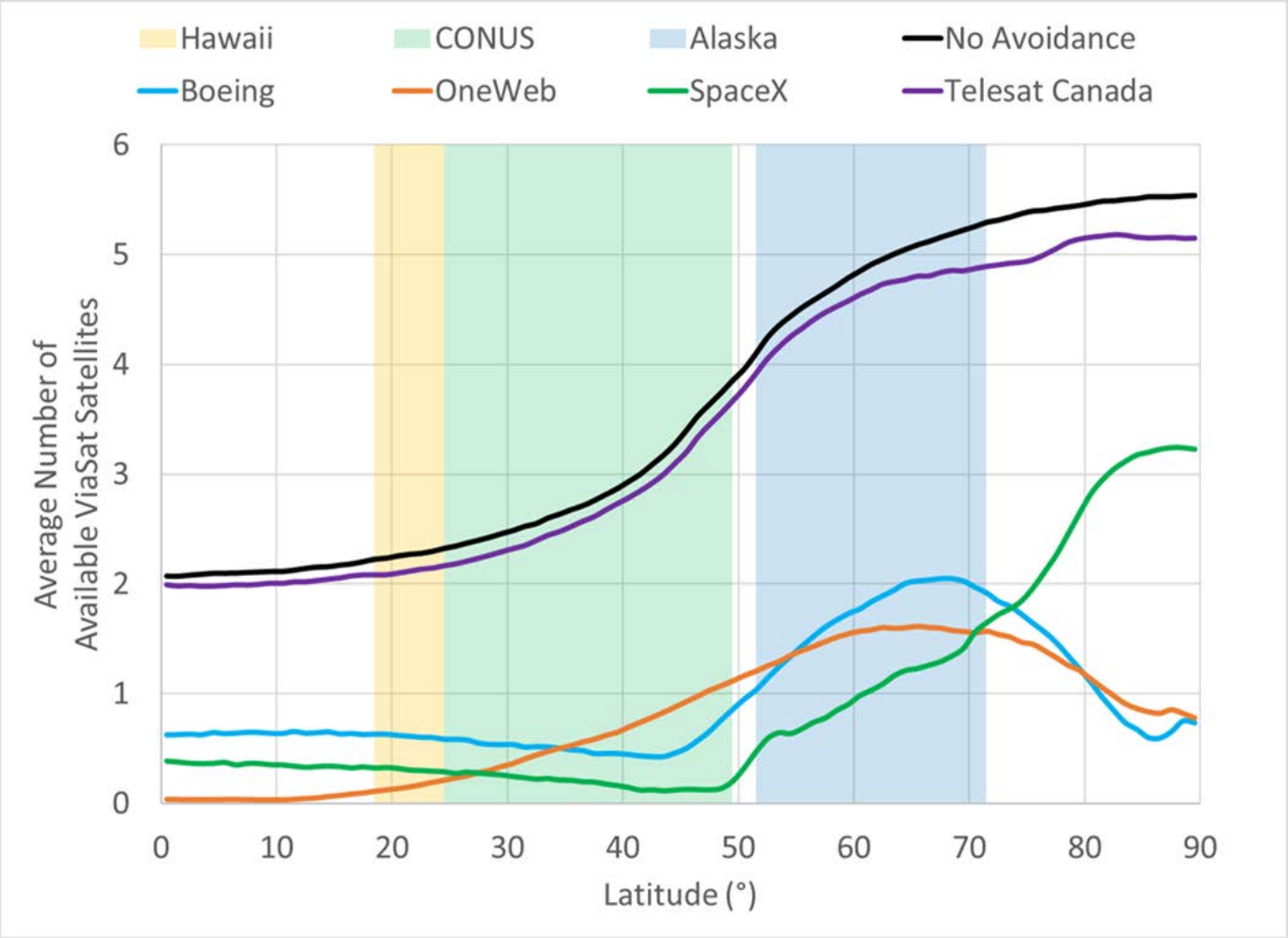


Exhibit 2D
V Band: Average Capacity Effect On Other NGSOs from Their Avoiding In-Line Events with ViaSat (By Latitude)

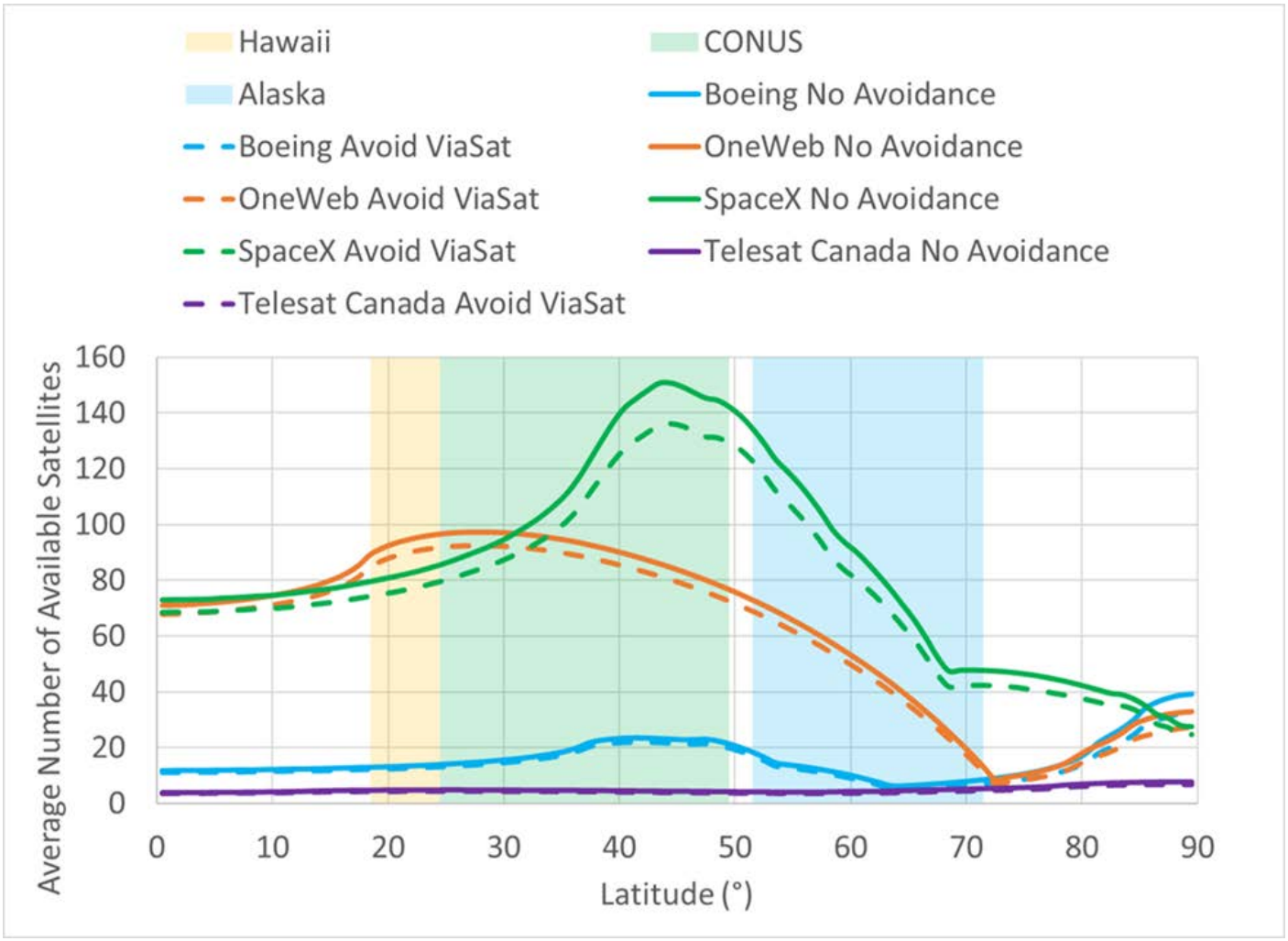


Exhibit 3A
Ka Band: Average Outage Hours Per Year For ViaSat-NGSO from Its Avoiding In-Line Events with Other NGSOs (From 0º to 90º Latitude)

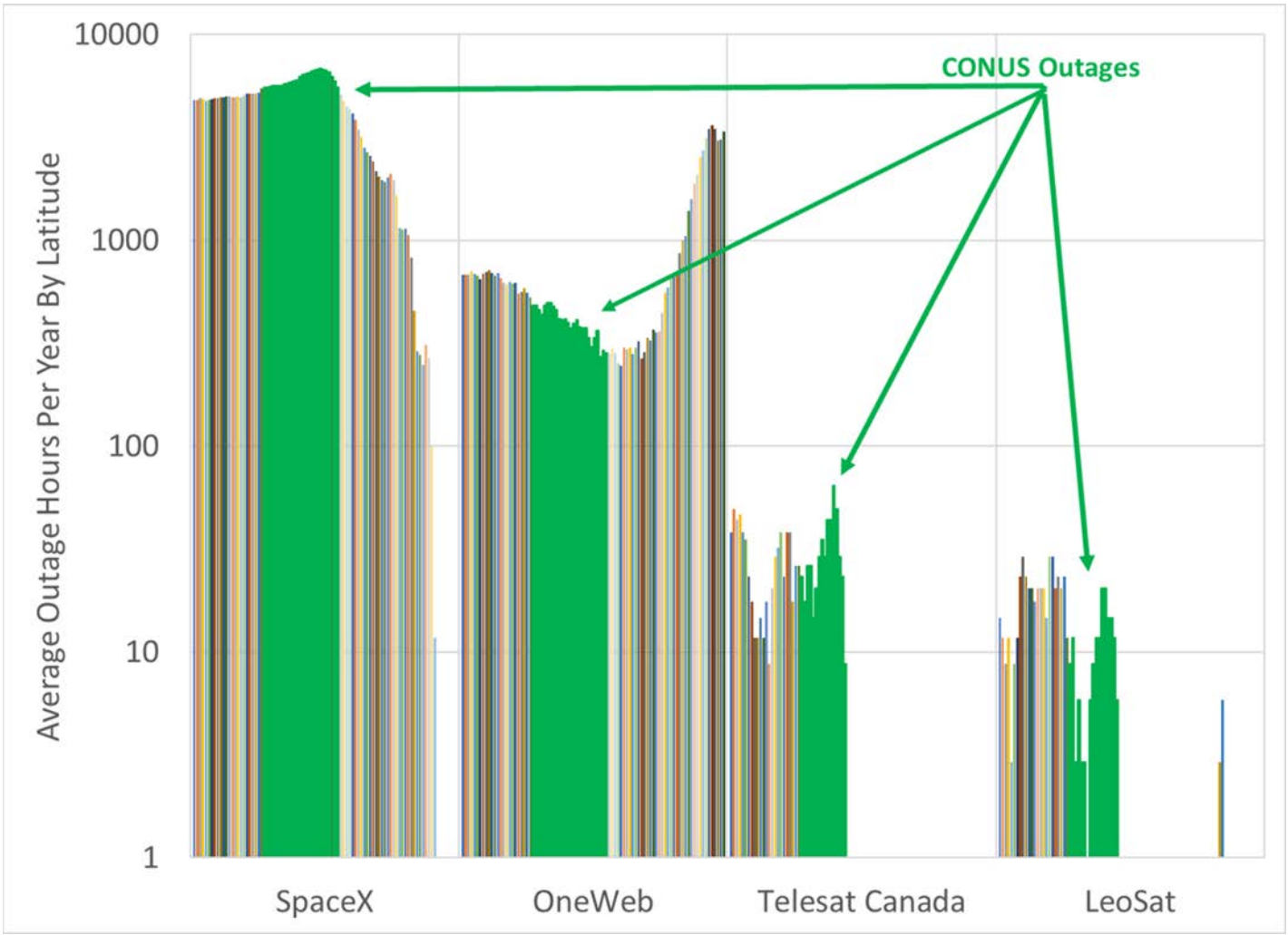
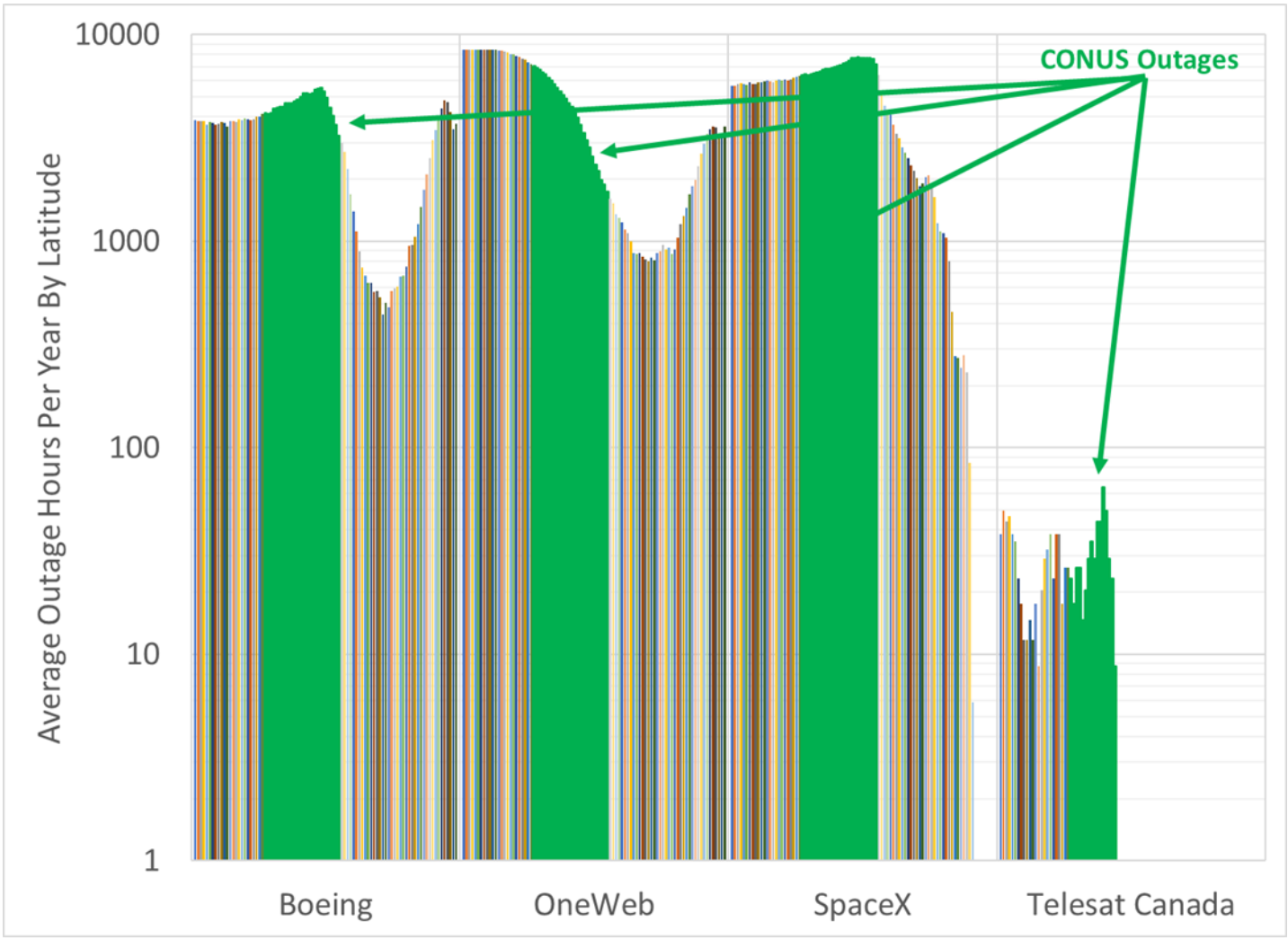


Exhibit 3B
V Band: Average Outage Hours Per Year for ViaSat-NGSO from Its Avoiding In-Line Events with Other NGSOs (From 0º to 90º Latitude)



DECLARATION

I hereby declare that I am the technically qualified person responsible for preparation of the engineering information contained in these Reply Comments of ViaSat, Inc. ("Reply Comments"), that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted with these Reply Comments, and that it is complete and accurate to the best of my knowledge, information and belief.

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April 10, 2017

DECLARATION OF DARYL T. HUNTER

I, Daryl T. Hunter, hereby make the following declarations under penalty of perjury.

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

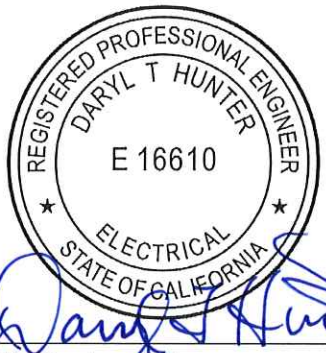
2. I have reviewed the foregoing Petition to Deny or Impose Conditions of ViaSat, Inc. and certify that, to the best of my knowledge and belief, the factual assertions in the Petition are truthful and accurate.

/s/ Daryl T. Hunter
Daryl T. Hunter

Executed: June 26, 2017

DECLARATION

I hereby declare that I am the technically qualified person responsible for preparation of the engineering information contained in the foregoing Petition to Deny or Impose Conditions 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 petition, and that it is complete and accurate to the best of my knowledge, information and belief.



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June 26, 2017

CERTIFICATE OF SERVICE

I, Kayla Ernst, hereby certify that on this 26th day of June, 2017, I served a true copy of the foregoing Petition to Deny or Impose Conditions of ViaSat, Inc. via first-class mail upon the following:

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/s/ Kayla Ernst
Kayla Ernst