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June 13, 2017

**VIA ELECTRONIC FILING**

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

**Re: Petition for Declaratory Ruling of WorldVu Satellites Limited,  
IBFS File No. SAT-LOI-20160428-00041**

Dear Ms. Dortch:

On Friday, June 9, 2017, representatives of ViaSat, Inc. met with the International Bureau in connection with the draft order circulated on June 1, 2017 in this proceeding (the “*Draft Order*”).<sup>1</sup> The *Draft Order* would grant the Petition for Declaratory Ruling filed by WorldVu Satellites Limited d/b/a OneWeb on April 28, 2016 (the “Petition”), in which OneWeb seeks to serve the United States market with a non-geostationary-satellite orbit (“NGSO”) fixed-satellite service (“FSS”) network, using, among other frequencies, portions of the Ka band. The International Bureau representatives were Jose Albuquerque, Karl Kensinger, Chip Fleming, Stephen Duall,\* and Clay DeCell.\* The ViaSat representatives were Christopher Murphy, Steven Hemple, Paul Konopka,\* Daryl Hunter,\* and Chris Hofer\* of ViaSat; Mark Sturza\* of 3C Systems Company; and the undersigned counsel to ViaSat.<sup>2</sup>

ViaSat explained that while it recognizes the stated intention to grant the Petition in a manner that “will not prejudice any decision, including a contrary action, in the NGSO FSS rulemaking,”<sup>3</sup> a number of statements in the *Draft Order* reach conclusions about issues that are, in fact, the subject of that pending rulemaking, IB Docket No. 16-408. And while the *Draft Order* would grant the Petition under the condition that “[t]his grant of U.S. market access and any earth station licenses granted in the future are subject to modification to bring them into conformance with any rules or policies adopted by the Commission in the future,”<sup>4</sup> any

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<sup>1</sup> See FCC-CIRC1706-04 (“*Draft Order*”).

<sup>2</sup> Individuals identified with an asterisk participated by telephone.

<sup>3</sup> *Draft Order* ¶ 12.

<sup>4</sup> *Id.* ¶ 27.

conclusions about pending rulemaking issues could be argued to be Commission determinations that are precedential until they are reversed in a subsequent decision by the full Commission.

ViaSat also expressed the view that it is possible to act on the Petition in a manner that does not create such issues. The proposed edits to the *Draft Order* enclosed with this letter as Exhibit A would achieve that goal and are offered with a view toward allowing the Commission to still consider this matter at the June 22 open meeting.

Those proposed edits relate to the yet-unresolved question of whether certain ITU provisions (which the Commission has not adopted in the almost twenty years since they were developed at the ITU) can be assumed to satisfy the Commission's statutory obligations to protect Ka-band GSO satellite systems authorized under United States law from harmful interference generated by U.S.-authorized Ka-band NGSO systems.<sup>5</sup> Historically, the United States has followed a different approach than the ITU to this question of NGSO/GSO protection in the Ka band, as the United States has done in many other respects as well.<sup>6</sup> By way of example, GSO operations are primary to NGSO operations in portions of the Ka band. In other portions, GSOs and NGSOs operate on a secondary basis to other services, but among satellite systems, subsequently authorized NGSO systems (like OneWeb's, assuming adoption of the *Draft Order*) have to protect prior-authorized GSO and NGSO systems.<sup>7</sup> And in yet other

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<sup>5</sup> See Comments of ViaSat, Inc., IB Docket No. 16-408, at 12-18 (Feb. 27, 2017) (expressing concerns over the relevance and sufficiency of the existing ITU single-entry EPFD<sub>up</sub> limit in light of the current operating environment, the lack of any aggregate EPFD<sub>up</sub> limit or even any proposal for such a limit, and the lack of any enforcement mechanism for any aggregate EPFD limits and the ITU's "Resolution 76" aggregate EPFD<sub>down</sub> limits) ("ViaSat NGSO Comments"); Reply Comments of ViaSat, Inc., IB Docket No. 16-408 (Apr. 10, 2017) ("ViaSat NGSO Reply Comments") (attached hereto as Exhibits B and C).

<sup>6</sup> See, e.g., *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Report and Order, 31 FCC Rcd 8014, at ¶ 25 (2016) (authorizing mobile services at 27.5-28.35 GHz even though that band was not identified as one to be studied for mobile services at the ITU) ("*Spectrum Frontiers Order*"); *Licensing of Space Stations in the Domestic Fixed-Satellite Service and Related Revisions of Part 25 of the Rules and Regulations*, Report and Order, FCC 83-184, 54 Rad. Reg. 2d 577, at ¶ 68 (rel. Aug. 16, 1983) (adopting two-degree orbital spacing policies, and more restrictive limitations on GSO operations than those imposed by the ITU Radio Regulations, in order to increase GSO satellite capacity).

<sup>7</sup> See 47 C.F.R. §§ 2.104(d)(3)(iii), 2.105(c)(2)(iii); see also 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 115° W.L.); Call Sign S2917, IBFS File Nos. SAT-LOI-20140204-00013, *et al.* (granted June 18, 2014) (authorizing U.S. market access for a satellite in the Ka band at 89° 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 79° W.L.); Call Sign S2953,

portions, the ITU imposes obligations on NGSO systems to coordinate with prior-filed GSO systems that the United States does not impose, and the ITU's "Article 22" and "Resolution 76" provisions (discussed in the *Draft Order*) simply do not apply in these band segments under the ITU's own rules.<sup>8</sup>

As ViaSat explained in its comments in this proceeding,<sup>9</sup> and also in the context of the pending NGSO FSS rulemaking,<sup>10</sup> the adequacy of those ITU provisions, adopted in a far different operating environment and long ago, cannot be assumed to apply to today's NGSO/GSO operating environment in the Ka band. To the contrary, NGSO operations at the ITU limits present a potential for significant interference into Commission-authorized Ka-band GSO networks that is similar to the interference from 5G systems that the Commission has concluded requires further study.<sup>11</sup>

Moreover, the Commission's responsibility to manage the interference environment for all systems that it either licenses, or permits to serve the United States market, requires that the Commission develop a mechanism to actually enforce and meaningfully apply any such limits that it may adopt. The protection of GSO systems cannot be left to "good faith" negotiations among NGSO operators, as paragraph 26(a) of the *Draft Order* suggests in the case of the Ku band.

Rather than basing its actions on any conclusion about the relevance or adequacy of ITU provisions that the Commission has not yet adopted, ViaSat requests that any action on the Petition instead be based on the actual technical showings OneWeb made in the record of this

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IBFS File No. SAT-LOI-20160208-00015 (granted Oct. 25, 2016) (authorizing U.S. market access in the Ka band at 109° W.L.).

<sup>8</sup> Article 22 specifies single-entry EPFD limits from NGSO systems for certain band segments and in various directions (uplink, downlink, space-to-space). Resolution 76 specifies aggregate EPFD limits (the impact of multiple NGSO FSS systems), but only in the downlink direction, in certain band segments.

<sup>9</sup> See Reply of ViaSat, Inc., IBFS File No. SAT-LOI-20160428-00041 (Sept. 1, 2016). The *Draft Order* does not accurately characterize ViaSat's position in this matter. Notably, the EPFD showings by some of the applicants in the processing round were only filed in recent weeks in response to the Commission's request for additional information, and thus, the aggregate impact of the proposed systems in the processing round could not be adequately assessed previously.

<sup>10</sup> See ViaSat NGSO Comments at 18; ViaSat NGSO Reply Comments at 4-5.

<sup>11</sup> See generally, e.g., ViaSat NGSO Comments and ViaSat NGSO Reply Comments; see also *Spectrum Frontiers Order* ¶ 69 (calling for the establishment of a separate docket for the submission of data and analysis to study aggregate interference into 28 GHz satellite receivers from mobile wireless services).

proceeding. In this case, the Commission could conclude, as the *Draft Order* provides in part, that such technical showings are adequate, based on the existing record, without deciding other issues that are still pending in the NGSO FSS rulemaking. Similarly, the Commission could (and should) permit operations at the power levels proposed in the Petition,<sup>12</sup> rather than authorize operations at substantially higher power levels pursuant to not-yet-adopted rules—power levels that were not actually requested.<sup>13</sup>

For these reasons, ViaSat urges that the limited changes proposed here be made to the *Draft Order*.

Respectfully submitted,

/s/ John P. Janka

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

*Counsel to ViaSat, Inc.*

cc: Nick Degani  
Brendan Carr  
Rachael Bender  
Daudeline Meme  
Erin McGrath  
Jose Albuquerque  
Karl Kensinger  
Chip Fleming  
Stephen Duall  
Clay DeCell

Attachments:

Exhibit A: Proposed Edits to the *Draft Order*  
Exhibit B: Comments of ViaSat, Inc. in IB Docket No. 16-408  
Exhibit C: Reply Comments of ViaSat, Inc. in IB Docket No. 16-408

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<sup>12</sup> *WorldVu Satellites Limited, Petition for a Declaratory Ruling Granting Access to the U.S. Market for the OneWeb System*, IBFS File No. SAT-LOI-20160428-00041, at Annex 2-10 (filed Apr. 28, 2016).

<sup>13</sup> *Draft Order* ¶ 24(h) (which would allow operations at levels 7 dB higher than OneWeb's technical demonstration describes).

**EXHIBIT A:**  
**PROPOSED EDITS TO THE *DRAFT ORDER***

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

In the Matter of )
WorldVu Satellites Limited ) IBFS File No. SAT-LOI-20160428-00041
Petition for a Declaratory Ruling Granting Access ) Call Sign S2963
to the U.S. Market for the OneWeb NGSO FSS )
System )

ORDER AND DECLARATORY RULING\*

Adopted: []

Released: []

By the Commission:

I. INTRODUCTION

1. In this Order and Declaratory Ruling, we grant the request of WorldVu Satellites Limited, d/b/a OneWeb (OneWeb), for certain rule waivers and a declaratory ruling concerning the conditions under which it will be permitted to access the U.S. market using a proposed constellation of 720 satellites authorized by the United Kingdom. The operations proposed will be in the 10.7-12.7 GHz, 14-14.5 GHz, 17.8-18.6 GHz, 18.8-19.3 GHz, 27.5-29.1 GHz, and 29.5-30 GHz frequency bands. In granting this request, we address concerns expressed by commenters seeking various conditions on the grant and partially deny two Petitions to Deny. With this grant—the first of its kind for a new generation of large, non-geostationary-satellite orbit, fixed-satellite service (NGSO FSS) systems—the Commission facilitates OneWeb’s goal “to provide high-speed, affordable broadband connectivity to anyone, anywhere” in the United States and thereby advances the Commission’s mandate “to make available, so far as possible, to all the people of the United States . . . rapid, efficient, Nation-wide, and world-wide” communication services.

\* This document has been circulated for tentative consideration by the Commission at its June open meeting. The issues referenced in this document and the Commission’s ultimate resolutions of those issues remain under consideration and subject to change. This document does not constitute any official action by the Commission. However, the Chairman has determined that, in the interest of promoting the public’s ability to understand the nature and scope of issues under consideration, the public interest would be served by making this document publicly available. The Commission’s ex parte rules apply and presentations are subject to “permit-but-disclose” ex parte rules. See, e.g., 47 CFR §§ 1.1206, 1.1200(a). Participants in this proceeding should familiarize themselves with the Commission’s ex parte rules, including the general prohibition on presentations (written and oral) on matters listed on the Sunshine Agenda, which is typically released a week prior to the Commission’s meeting. See 47 CFR §§ 1.1200(a), 1.1203.

1 WorldVu Satellites Limited, Petition for a Declaratory Ruling Granting Access to the U.S. Market for the OneWeb System, IBFS File No. SAT-LOI-20160428-00041 (filed Apr. 28, 2016) (OneWeb Petition).

2 OneWeb Petition, Narrative at 2; 47 U.S.C. § 151.

## II. BACKGROUND

2. *Petition.* On April 28, 2016, OneWeb filed a petition for declaratory ruling seeking access to the U.S. market for a proposed NGSO FSS satellite system.<sup>3</sup> The proposed OneWeb system consists of a constellation of 720 satellites evenly distributed in 18 near-polar orbital planes, at an approximate altitude of 1200 kilometers. The satellites will operate in the 10.7-12.7 GHz (space-to-Earth), 14-14.5 GHz (Earth-to-space), 17.8-18.6 GHz (space-to-Earth), 18.8-19.3 GHz (space-to-Earth), 27.5-29.1 GHz (Earth-to-space), and 29.5-30 GHz (Earth-to-space) bands, and will be authorized by the United Kingdom. In its Petition, OneWeb sought certain waivers of the Commission's rules.<sup>4</sup>

3. *Processing Round.* On July 15, 2016, the OneWeb Petition was accepted for filing.<sup>5</sup> At the same time, a processing round was initiated for additional NGSO-like applications and petitions in the frequency bands requested by OneWeb.<sup>6</sup> The processing round closed on November 15, 2016. Eleven additional applications and petitions were filed for NGSO-like satellite systems.<sup>7</sup> Each of these applicants and petitioners proposes an NGSO FSS system that, if approved, would have the same status as OneWeb's NGSO FSS system approved here and would have the same rights in case any division of frequencies is required to avoid mutual interference.<sup>8</sup> The Commission's review of these applications and petitions is ongoing.<sup>9</sup>

4. *Comments.* Telesat Canada (Telesat) and the MVDDS<sup>10</sup> 5G Coalition (MVDDS Coalition) filed petitions to deny the OneWeb Petition, based on concerns related to international

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<sup>3</sup> The Commission developed the market access procedure we follow here to facilitate the participation of non-U.S.-licensed satellite systems in the FCC licensing process, even though such systems do not seek a U.S. space station license. As such, favorable action on such a request is in the nature of a policy statement or declaratory ruling with respect to the availability of spectrum and other public interest considerations for future licensing of U.S. earth stations that would operate with the non-U.S.-licensed space station. *See Amendment of the Commission's Regulatory Policies to Allow Non-U.S. Licensed Satellites to Provide Domestic and International Service in the United States*, Report and Order, 12 FCC Rcd 24094, 24106, para. 29, 24173-74, paras. 184-188 (1997) (*1997 Report and Order*). In addition to the present Petition, OneWeb must file and the Commission must approve corresponding earth station applications before OneWeb may provide its proposed services in the United States.

<sup>4</sup> *See infra* paras. 15-20.

<sup>5</sup> *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, 31 FCC Rcd 7666 (IB 2016).

<sup>6</sup> *Id.*; *see also* 47 CFR § 25.157(a) (defining "NGSO-like satellite operation" as operation of any NGSO satellite system, and operation of a geostationary-satellite orbit, mobile-satellite service satellite to communicate with earth stations with non-directional antennas).

<sup>7</sup> *See* IBFS File Nos. SAT-MOD-20160624-00060 and SAT-AMD-20161115-00116 (O3b Limited); SAT-PDR-20161115-00108 (Telesat Canada); SAT-LOA-20161115-00109 (The Boeing Company); SAT-PDR-20161115-00111 (Space Norway AS); SAT-PDR-20161115-00112 (LeoSat MA, Inc.); SAT-LOA-20161115-00113 (Karousel LLC); SAT-PDR-20161115-00114 (Kepler Communications Inc.); SAT-LOA-20161115-00117 (Audacy Corporation); SAT-LOA-20161115-00118 (Space Exploration Holdings, LLC (SpaceX)); SAT-PDR-20161115-00120 (ViaSat, Inc.); SAT-LOA-20161115-00121 (Theia Holdings A, Inc.).

<sup>8</sup> *See infra* para. 18.

<sup>9</sup> *See infra* para. 11.

<sup>10</sup> MVDDS is an abbreviation of the Multichannel Video Distribution and Data Service and is licensed under Part 101 of the Commission's rules. MVDDS is currently defined as a "fixed microwave service licensed in the 12.2-12.7 GHz band that provides various wireless services. Mobile and aeronautical operations are prohibited." 47 CFR § 101.3.

coordination and terrestrial sharing, respectively.<sup>11</sup> Other satellite operators filed comments expressing concerns regarding sharing with other FSS operations.<sup>12</sup> SES and O3b requested that any grant to OneWeb be subject to the same conditions that were placed on the grant of U.S. market access for the O3b NGSO FSS system.<sup>13</sup> ViaSat commented that the OneWeb Petition should be considered in conjunction with other applications and petitions filed in the processing round after their technical details are known, including with respect to aggregate interference, but ViaSat did not take a position regarding the issues in OneWeb's petition.<sup>14</sup> The National Radio Astronomy Observatory (NRAO) expressed concerns about possible interference to radio astronomy facilities<sup>15</sup> and the Governor of the State of Alaska encouraged the Commission to grant OneWeb's Petition.<sup>16</sup> OneWeb opposed the petitions to deny and responded to the comments.<sup>17</sup> In addition, EchoStar and Hughes argue in filings made after the close of the comment period that geostationary-satellite orbit (GSO) FSS satellite operators should be entitled to operate on a co-equal basis with OneWeb in the 18.8-19.3 GHz band.<sup>18</sup>

### III. DISCUSSION

5. After review of the record, we conclude that grant of the OneWeb Petition will serve the public interest, subject to the requirements and conditions specified herein.<sup>19</sup> Our public interest analysis considers the effect of the proposed OneWeb system on competition in the United States, as well as issues of spectrum availability, eligibility requirements and operating requirements, and national security, law enforcement, foreign policy, and trade.<sup>20</sup> Below, we address the various outstanding issues raised by commenters on the Petition. We also address OneWeb's waiver requests. Where appropriate, we defer matters of general applicability to ongoing or potential future rulemakings.

<sup>11</sup> Telesat Petition to Deny (filed Aug. 15, 2016); MVDDS Coalition Petition to Deny (filed Aug. 15, 2016).

<sup>12</sup> SpaceX Comments at 8-15 (filed Aug. 15, 2016); SES S.A. and O3b Limited Comments at 4-7 (filed Aug. 15, 2016) (SES and O3b). Boeing and SpaceX also requested further information from OneWeb regarding its plans to mitigate orbital collisions and debris. Boeing Comments at 4-5; SpaceX Comments at 17-22. Because OneWeb subsequently provided its orbital debris plan, this request is moot. Letter from Jennifer D. Hindin, Counsel to OneWeb, to Marlene H. Dortch, Secretary, FCC (filed Nov. 10, 2016). SES and O3b requested further technical information from OneWeb, SES and O3b Comments at 4-7, which OneWeb provided, also rendering this request moot. OneWeb Opposition and Response (filed Aug. 25, 2016). Ligado supported SES and O3b's request and asked OneWeb to provide further technical information on how OneWeb would mitigate potential interference from its proposed system into GSO gateway operations. Ligado Reply at 2 (filed Sept. 1, 2016). To the extent Ligado seeks more information from OneWeb than it provided in its Petition and response to SES and O3b's Comments, we view no basis for requiring such information in Ligado's filing. OneWeb has provided sufficient [EPFD technical showings regarding ~~these matters~~its ability to protect GSO FSS systems, including gateway operations.](#)

<sup>13</sup> SES and O3b Comments at 7-10.

<sup>14</sup> See ViaSat Comments (filed Aug. 15, 2016); ViaSat Reply at 1 (filed Sept. 1, 2016). Ligado supported deferring consideration of the OneWeb Petition until after the close of the processing round. Ligado Reply at 2-3.

<sup>15</sup> Letters from Harvey S. Liszt, National Radio Astronomy Observatory, to Marlene H. Dortch, Secretary, FCC (filed July 24 and Sept. 6, 2016).

<sup>16</sup> Letter from Bill Walker, Governor, State of Alaska, to the Honorable Tom Wheeler, Chairman, FCC (filed Aug. 3, 2016) ("I am particularly enthused about the fact that OneWeb's network of satellites will be moving in a pole to pole direction, such that Alaska and other Arctic regions will receive tremendous coverage.").

<sup>17</sup> OneWeb Opposition and Response.

<sup>18</sup> Letters from Jennifer A. Manner, Senior Vice President, Regulatory Affairs, EchoStar, to Marlene H. Dortch, Secretary, FCC (filed Sept. 21 and 30, 2016).

<sup>19</sup> *1997 Report and Order*, 12 FCC Rcd at 24106, para. 29.

<sup>20</sup> *Id.* Except as otherwise discussed herein, we conclude that the OneWeb Petition satisfies these basic requirements for U.S. market access.



6. *12.2-12.7 GHz.* The MVDDS Coalition raises several arguments for denying OneWeb’s request for U.S. market access in the 12.2-12.7 GHz band.<sup>21</sup> The MVDDS Coalition argues that granting OneWeb’s request will prejudice the MVDDS Coalition’s Petition for Rulemaking, filed days before the OneWeb Petition, to add a mobile allocation to the 12.2-12.7 GHz band, delete or make secondary the existing co-primary, NGSO FSS allocation, and change other rules to allow Multichannel Video Distribution and Data Service (MVDDS) licensees to provide “5G” two-way mobile and fixed terrestrial services.<sup>22</sup> The MVDDS Coalition states that “viable 5G services in the 12.2-12.7 GHz band require eliminating or designating as secondary the unused NGSO FSS allocation at 12.2-12.7 GHz.”<sup>23</sup> However, the pendency of the MVDDS Coalition’s Petition for Rulemaking is not a sufficient reason to delay or deny OneWeb’s Petition to use the band under the existing FSS allocation and service rules.<sup>24</sup> Rather, we are granting the OneWeb petition subject to the outcome of the pending MVDDS Coalition Petition for Rulemaking. As such, today’s conditional grant of OneWeb’s request does not preclude the Commission from initiating a rulemaking proceeding regarding the 12.2-12.7 GHz band on its own motion or in response to a petition for rulemaking, including the MVDDS Coalition’s pending Petition, in the manner that best serves the public interest. Nonetheless, we note that OneWeb’s request includes several additional frequency bands, such that even if NGSO FSS systems were precluded entirely from the 12.2-12.7 GHz band, OneWeb would still retain a measure of flexibility to provide its proposed services. Accordingly, any investments made toward operations in this band by OneWeb in the United States assume the risk that operations may be subject to additional conditions or requirements as a result of such Commission actions.

7. In addition to the general claim that granting OneWeb’s market access request would prejudice the MVDDS Coalition’s pending Petition for Rulemaking discussed above, the MVDDS Coalition argues that the Commission’s current rules make deployment of coexisting “current generation” MVDDS and NGSO FSS systems “practically infeasible” because of the large distances that would be required to prevent MVDDS operations from interfering with NGSO FSS earth stations.<sup>25</sup> This argument for denying the OneWeb Petition is based on challenges to the adequacy of current rules for MVDDS and NGSO FSS systems sharing the band. As such, the Coalition is either seeking reconsideration—on a grossly untimely basis—of the Commission’s *2002 MVDDS Memorandum Opinion and Order and Second Report and Order* that established the current sharing rules for the 12.2-12.7 GHz band, or presenting arguments that may be appropriate to make in support of its pending Petition for Rulemaking,

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<sup>21</sup> MVDDS Coalition Petition to Deny; MVDDS Coalition Reply (filed Sept. 1, 2016); *see also* Letters from the MVDDS Coalition to Marlene H. Dortch, Secretary, FCC (filed Aug. 12 and 19, Sept. 16, and Oct. 28, 2016).

<sup>22</sup> MVDDS Coalition Petition to Deny at 13-15; *Petition of MVDDS 5G Coalition Petition for Rulemaking*, RM-11768, April 26, 2016; *see also* Petition for Rulemakings Filed, Public Notice, Report No. 3042 (May 9, 2016).

<sup>23</sup> *See, e.g.*, Letters from the MVDDS Coalition to Marlene H. Dortch, Secretary, FCC, at 4 (filed Aug. 12 & 19, 2016); *see also* RM 11768, MVDDS Coalition Comments at 7 (quoting MVDDS 5G Coalition Petition for Rulemaking at 22).

<sup>24</sup> Under the approach that the Commission adopted for NGSO FSS and MVDDS sharing, first in-time NGSO FSS receivers and first in-time MVDDS transmitting systems are afforded more and easier use of the shared 12.2-12.7 GHz portion of spectrum than subsequent deployments. The Commission concluded that such a result is equitable and consistent with the co-primary status of NGSO FSS and MVDDS. *See 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; Amendment of the Commission’s Rules to Authorize Subsidiary Terrestrial Use of the 12.2-12.7 GHz Band by Direct Broadcast Satellite Licensees and Their Affiliates*, Memorandum Opinion and Order and Second Report and Order, 17 FCC Rcd 9614, 9659, para. 111 (2002) (*2002 MVDDS Memorandum Opinion and Order and Second Report and Order*).

<sup>25</sup> MVDDS Coalition Petition to Deny at 5 (citing Tom Peters, *MVDDS 12.2-12.7 GHz NGSO Coexistence Study* at 6 (Aug. 15, 2016) (MVDDS/NGSO Technical Analysis) attached to the Coalition’s Petition as Exhibit 1).

but which are outside the scope of our consideration of OneWeb's market access request in this proceeding.

8. Further, the MVDDS Coalition asserts that coexistence between co-primary terrestrial MVDDS and NGSO systems serving FSS earth stations in motion will “destroy” or “seal the fate” of MVDDS licensed services by rolling out a system that requires so many earth station receivers that it will preclude the installation of a sufficient number of MVDDS transmitting antennas to sustain that service, given the requirement in the current rules that such transmitting antennas cannot be located within 10 km of any qualifying NGSO FSS receiver notwithstanding the co-primary status of MVDDS and NGSO FSS.<sup>26</sup> A grant of U.S. market access includes no authority to deploy earth stations in the United States.<sup>27</sup> Authority for such earth stations must be requested in an appropriate earth station application. Any relevant arguments for such authority can be raised and will be fully and properly considered as part of such an earth station application.<sup>28</sup> As such, grant of the OneWeb Petition for market access does not directly affect MVDDS licensees—who are already operating as co-primary to NGSO FSS operations in this band—or prejudice later requests to operate earth stations in motion that receive from NGSO FSS space stations in the band. Nonetheless, given OneWeb's plan to request waivers in future earth station applications,<sup>29</sup> and the MVDDS licensees' concerns, we believe that clarifying how the current first-in-time sharing rules would apply to any earth stations in motion authorized in the future to receive from NGSO FSS space stations in the band would be useful to avoid confusion and uncertainty.<sup>30</sup> Accordingly, we clarify that such earth stations would be outside of the scope of the existing sharing rules involving terrestrial and satellite users in this band. In particular, the MVDDS minimum distance separation requirement is inapplicable to earth stations that are not at fixed locations. Absent an agreement among the relevant parties, under the existing rules MVDDS licensees are not required to observe any minimum distance separation from any NGSO FSS earth stations in motion that may be authorized in the future in the 12.2-12.7 GHz band.<sup>31</sup>

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<sup>26</sup> See MVDDS Coalition Petition to Deny at 7-8; MVDDS Coalition Reply at 8.

<sup>27</sup> Accordingly, and contrary to the Coalition's assertions, the OneWeb Petition is not procedurally defective for failing to request a waiver of the U.S. Table of Frequency Allocations to provide mobile-satellite service in this band or to operate earth stations in motion. See MVDDS Coalition Petition to Deny at 3, 8-9. In addition, we need not address here OneWeb's request for waiver of section 25.202(a)(1), n.6, which prohibits deployment of ubiquitous, co-primary NGSO FSS earth stations terminals in the 10.7-11.7 GHz band. We dismiss this waiver request below without prejudice.

<sup>28</sup> We note also that section 25.208(o) contains power flux-density limits designed to protect MVDDS. 47 CFR § 25.208(o); see also 47 CFR §§ 101.147(p), 101.1409 (incumbent public safety licensees shall be afforded protection from MVDDS and NGSO FSS licensees).

<sup>29</sup> See Letter from Kalpak Gude, Vice President of Legal-Regulatory, WorldVu Satellites Limited, to Marlene Dortch, Secretary, FCC, at 5 (filed June 24, 2016) (when it applies for earth station licenses OneWeb will address with appropriate waivers the fact that the Commission's rules do not include rules governing the operation of earth stations in motion transmitting to NGSO space stations in frequencies allocated to the FSS); see also Letter from Jose P. Albuquerque, Chief, Satellite Division, FCC International Bureau, to Kalpak S. Gude, Vice President of Legal-Regulatory, WorldVu Satellites Limited, IBFS File No.SAT-LOI-20160428-00041, at 2 (June 10, 2016).

<sup>30</sup> Compare 47 CFR § 2.1 (defining fixed-satellite service as a “radiocommunication service between earth stations at given positions, when one or more satellites are used; the given position may be a specified fixed point or any fixed point within specified areas”) with 47 CFR § 2.1 (defining mobile-satellite service as a radiocommunication service between earth stations intended to be used while in motion or during halts at unspecified points and one or more space stations, or between mobile earth stations by means of one or more space stations).

<sup>31</sup> See 47 CFR § 101.129(b).

9. *ITU Coordination.* In its Petition to Deny, Telesat observes that international coordination will be required between the OneWeb system and its own NGSO FSS system.<sup>32</sup> Telesat argues that, at minimum, any grant to OneWeb should be conditioned upon compliance with this international obligation. OneWeb agrees to such a requirement,<sup>33</sup> and we have included it below as a requirement of the grant, resolving Telesat's concerns and thereby eliminating them as a basis for denying the OneWeb Petition.<sup>34</sup>

10. *Radio Astronomy.* In two letters, NRAO emphasizes the need for OneWeb to coordinate with certain radio telescope facilities prior to commencing operations, pursuant to footnote US131 to the U.S. Table of Frequency Allocations.<sup>35</sup> We remind OneWeb of this obligation, and include a requirement below concerning coordination with radio astronomy facilities.<sup>36</sup>

11. *Consideration with Pending Applications and Petitions.* In its comments, ViaSat argues that the OneWeb Petition must be considered together with all other applications and petitions filed in the OneWeb processing round, and that parties should be afforded an opportunity to comment after the details of these systems are known.<sup>37</sup> As noted above, the OneWeb processing round closed on November 15, 2016. We have performed an initial review of the technical proposals made by the other applicants and petitioners and conclude there is no need to delay grant of the OneWeb Petition until these requests are addressed, in light of the spectrum sharing method among NGSO FSS operators that we require below.<sup>38</sup> This spectrum sharing method—the avoidance of “in-line interference events”—provides for equal spectrum access rights among all grantees in a processing round, regardless of the time of their grant. Rather, when an “in-line event” occurs between any operators authorized in a processing round and no coordination agreement is reached to address the potential interference, the operators are restricted to using an equal but separate portion of their commonly authorized frequencies to avoid causing harmful interference to each other.<sup>39</sup> No spectrum preference is given based on the date of grant. No commenter,

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<sup>32</sup> Telesat Petition to Deny; Telesat Reply (filed Sept. 1, 2016); *see also* International Telecommunication Union (ITU) Radio Regulations, No. 9.12 (requiring coordination of certain NGSO systems), No. 9.53 (requiring both parties in coordination to “make every possible mutual effort to overcome [coordination] difficulties, in a manner acceptable to the parties concerned”), No. 11.42 (requiring the immediate cessation of harmful interference actually caused to a recorded assignment with which coordination is required but has not been effected).

<sup>33</sup> OneWeb Opposition and Response at 20-22.

<sup>34</sup> *See infra* para. 24(a). Compliance with ITU coordination procedures is a requirement of the ITU Radio Regulations, which hold the force of treaty to which the United States is a party. Such compliance is a typical condition of both U.S. space station licenses and grants of U.S. market access. *See* 47 CFR § 25.111(b); *see also, e.g., Inmarsat Mobile Networks, Inc., Application to Operate a Fixed-Satellite Service Gateway Earth Station Facility in Lino Lakes, Minnesota with the Inmarsat-5 F2 Space Station*, Order and Authorization and Declaratory Ruling, 30 FCC Rcd. 2770, 2784, para. 41c (IB 2015).

<sup>35</sup> 47 CFR § 2.106, n.US131.

<sup>36</sup> *See infra* para. 25(b). Such coordination can be based on relevant international recommendations, as NRAO suggests. NRAO July 24, 2016 Letter at 1-2.

<sup>37</sup> ViaSat Comments at 2.

<sup>38</sup> The International Bureau recently placed all but one of these applications and petitions on public notice as acceptable for filing in certain frequency bands. *Applications Accepted for Filing; Cut-off Established for Additional NGSO-like Satellite Applications or Petitions for Operations in the 12.75-13.25 GHz, 13.85-14.0 GHz, 18.6-18.8 GHz, 19.3-20.2 GHz, and 29.1-29.5 GHz Bands*, Public Notice, DA 17-524 (IB rel. May 26, 2017). Because the comment periods have not closed, we are not yet in a position to act on these subsequent requests. In addition, we address ViaSat's concerns of aggregate interference from NGSO FSS systems into GSO FSS networks by the requirement in paragraph 26(a), below.

<sup>39</sup> *See* 47 CFR § 25.261.

including ViaSat, submitted any filings after the close of the processing round opposing the OneWeb Petition on the basis of the other system proposals.

12. *Effect on the Pending NGSO FSS NPRM and Future Proceedings.* In its comments, Space Exploration Technologies Corp. (SpaceX) argues that the OneWeb system design makes inefficient use of spectrum and will hinder shared use by other operators.<sup>40</sup> EchoStar and Hughes argue in filings made after the comment period that in the 18.8-19.3 GHz band, in which NGSO FSS is designated as the primary service, GSO FSS satellite operators should be allowed to operate on a co-equal basis with OneWeb.<sup>41</sup> Both of these issues have been raised in a pending Notice of Proposed Rulemaking concerning NGSO FSS matters.<sup>42</sup> We defer consideration of these broadly applicable matters to that proceeding and, as indicated above, have decided to condition grant of the OneWeb Petition on the outcome of any rulemaking proceedings, which includes that one.<sup>43</sup> As with the MVDDS Coalition's Petition for Rulemaking, we note that grant of the OneWeb Petition will not prejudice any decision, including a contrary action, in the NGSO FSS rulemaking, notwithstanding any statements that may be made in this order regarding issues pending in that proceeding. Rather, decisions of general applicability in the *NGSO FSS NPRM* proceeding will be based on the totality of comments and proposals in that proceeding, including OneWeb's. OneWeb will not receive any special exemptions to the rulemaking based solely on this grant, should OneWeb choose to accept it.<sup>44</sup> Accordingly, we disagree that grant of the OneWeb Petition would be premature until after the conclusion of the *NGSO FSS NPRM*.<sup>45</sup>

13. *Conditions.* Below, we condition this grant of U.S. market access in response to comments and as warranted in the public interest.<sup>46</sup> These conditions relate to ITU coordination, power limits, avoidance of in-line interference, orbital debris mitigation, future rulemakings, bond and milestone requirements, and other existing requirements in our rules and in footnotes to the Table of Frequency Allocations. We also include specific conditions related to our waiver grants. In their comments, SES and O3b ask that we impose on any grant for the OneWeb system the same conditions that were imposed on O3b's NGSO FSS constellation. We do so below, with one exception. O3b's grant of market access and earth station authorizations permit continued communications with the O3b constellation even if O3b makes certain adjustments to its constellation configuration.<sup>47</sup> OneWeb has not requested such a condition, and, in any event, it is unclear whether such a condition is appropriate for OneWeb's constellation configuration. Accordingly, we do not include such a condition below.

14. *Ownership.* In a letter filed April 4, 2017, SpaceX asks that we defer consideration of the OneWeb Petition until OneWeb has provided information concerning an announced merger with Intelsat SA and significant new investment by SoftBank Group Corporation.<sup>48</sup> The announced transaction is still

<sup>40</sup> SpaceX Comments at 2, 4-17.

<sup>41</sup> Letters from Jennifer A. Manner, Senior Vice President, Regulatory Affairs, EchoStar, to Marlene H. Dortch, Secretary, FCC (filed Sept. 21 and 30, 2016).

<sup>42</sup> *Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, Notice of Proposed Rulemaking, 31 FCC Rcd 13651, 13656-58, paras. 12, 17 (2016) (*NGSO FSS NPRM*).

<sup>43</sup> *See infra* para. 27; *see also* Terra Bella Reply (Sept. 1, 2016) (urging reallocation of certain bands to the Earth exploration-satellite service).

<sup>44</sup> OneWeb may petition for reconsideration of this grant to seek deferral of any of its conditions until after the Commission has made a determination on the relevant issues in the pending NGSO FSS rulemaking. *See* 47 CFR § 1.106(c)(2).

<sup>45</sup> Telesat Reply at 3-4.

<sup>46</sup> *See infra* paras. 24-29.

<sup>47</sup> *O3b Limited*, IBFS File Nos. SAT-LOI-20141029-00118 and SAT-AMD-20150115-00004, Condition 11 (grant stamp dated Jan. 22, 2015).

<sup>48</sup> Letter from Tim Hughes, SVP, Global Business & Government Affairs, SpaceX, to Marlene H. Dortch, Secretary,

FCC (filed Apr. 4, 2017).

subject to negotiations with Intelsat's bond holders. Until such time as the negotiations are completed, consideration of the transaction is premature. In any event, Intelsat will need to submit information concerning the proposed merger in connection with an existing Commission proceeding.<sup>49</sup> In the event the transaction is consummated OneWeb will also need to comply with the provisions in section 25.137(g) of our rules, which provide that for an acquisition of control of a non-U.S.-licensed space station that has been granted U.S. market access, the satellite operator must notify the Commission within 30 days after consummation of the transaction.<sup>50</sup> Because the Intelsat filing and OneWeb's future filing will provide a full opportunity for consideration of the proposed transaction, and will allow interested parties to comment on whether the proposed transaction affects any of the considerations the Commission made in granting OneWeb's Petition, consistent with the Commission's rules, we determine that it is not necessary to postpone grant of OneWeb's petition.

15. *Waiver Standard.* OneWeb seeks waivers of several of the Commission's rules.<sup>51</sup> Generally, the Commission may waive any rule for good cause shown.<sup>52</sup> Waiver is appropriate where the particular facts make strict compliance inconsistent with the public interest.<sup>53</sup> In making this determination, we may take into account considerations of hardship, equity, or more effective implementation of overall policy on an individual basis.<sup>54</sup> Waiver is therefore appropriate if special circumstances warrant a deviation from the general rule and such deviation will serve the public interest.<sup>55</sup> We address the specific requests for waivers below.

16. *Waivers for 17.8-18.6 GHz.* OneWeb seeks waivers of the U.S. Table of Frequency Allocations for operations in the 17.8-18.6 GHz band.<sup>56</sup> Within this range, the 17.8-18.3 GHz band is presently not allocated to the FSS. The 18.3-18.6 GHz band is allocated to the FSS, but limited to GSO networks.<sup>57</sup> OneWeb states that it would operate a limited number of gateway earth stations in these bands.<sup>58</sup> In the 17.8-18.3 GHz band, OneWeb provided technical demonstrations to show that it will comply with international power flux-density (PFD) limits designed to protect terrestrial services. In the

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<sup>49</sup> *Intelsat Global Holdings, S.A., Applications to Transfer Control of Intelsat Licenses and Authorizations from BC Partners Holdings Limited to Public Ownership*, IB Docket No. 11-205.

<sup>50</sup> 47 CFR § 25.137(g).

<sup>51</sup> OneWeb requests waivers of sections 2.106, 25.157(e), 25.146(a)(1)(iii), and 25.146(a)(2)(iii) of the Commission's rules and waiver of the Commission's Ka-band Plan. OneWeb also requests a waiver of footnote NG52 to the U.S. Table of Frequency Allocations, 47 CFR § 2.106, which pertains to geostationary satellites. Because OneWeb does not propose operations of geostationary satellites, we dismiss this waiver request as moot. However, OneWeb has stated that "FS operators would not be required to coordinate their station operations with OneWeb's receive only user terminals, because OneWeb has agreed to accept any level of interference from FS stations into its user terminals." OneWeb Petition, Narrative at 25. As noted above, we also dismiss without prejudice OneWeb's request for waiver of section 25.202(a)(1), n.6, restricting use of the 10.7-11.7 GHz band by NGSO FSS systems to operations with gateway earth stations, to refile in connection with such an application.

<sup>52</sup> 47 CFR § 1.3.

<sup>53</sup> *Northeast Cellular Tel. Co. v. FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990).

<sup>54</sup> *WAIT Radio v. FCC*, 418 F.2d 1153, 1159 (D.C. Cir. 1969), *cert. denied*, 409 U.S. 1027 (1972); *Northeast Cellular*, 897 F.2d at 1166.

<sup>55</sup> *Northeast Cellular*, 897 F.2d at 1166.

<sup>56</sup> 47 CFR §§ 2.102(a), 2.106. Non-Federal operations in this band are subject to coordination with Federal systems. 47 CFR § 2.106, n.US334.

<sup>57</sup> 47 CFR § 2.106, n.NG164.

<sup>58</sup> OneWeb Petition, Attach. A at 6, 41. OneWeb anticipates operating in at least four gateway earth station sites in the United States, with a worldwide total of approximately 50 or more gateway earth station sites. *Id.* at 6.

18.3-18.6 GHz band, OneWeb provided technical demonstrations showing that it will comply with international equivalent power flux-density (EPFD) limits designed to protect GSO networks. In addition, it states that gateways operating with the OneWeb system would not claim protection from harmful interference in these bands.<sup>59</sup>

17. In light of OneWeb's ~~technical demonstrations demonstrated ability to protect primary operations from interference~~, and its willingness to operate on a secondary basis, we find good cause to grant a waiver of the Table of Frequency Allocations for operations in this band. Grant of this waiver will not undermine the purpose of the rule, which is to ensure that primary users of the bands are not constrained. As noted in the preceding paragraph, OneWeb provided technical demonstrations ~~of how that show~~ it will ~~comply with longstanding power limits designed to~~ protect both primary terrestrial operations and GSO FSS operations. No commenter in this proceeding has ~~objected to those technical demonstrations suggested that such power limits are insufficient, and the Commission anticipates that compliance with such longstanding international limits will be sufficient also to protect U.S. terrestrial operations due to the significant U.S. involvement in their creation~~. In addition, OneWeb states that deployment in these bands will be limited to gateway earth stations, which are more likely than ubiquitous user terminals to be able to operate compatibly with primary terrestrial services because they are typically fewer in number and make use of larger earth station antennas, which, by limiting off-axis antenna gain, pose a lower risk of receiving harmful interference from terrestrial stations. Indeed, OneWeb's proposed operations with gateway earth stations are more limited than the proposal the Commission has recently made to allow NGSO FSS operation in these bands on a secondary basis with any individually licensed earth station, subject to such power limits.<sup>60</sup> These operations should not pose the undue burden on terrestrial services that the Commission feared in 2000 might arise from general secondary FSS operations, because OneWeb's proposed limited gateway operations can be more easily sited and operated in a manner to avoid receiving harmful interference.<sup>61</sup> We therefore conclude that a waiver is justified. Consistent with OneWeb's statements, we grant this waiver for OneWeb's non-conforming operations in this band on condition that gateways operating with the OneWeb system will not claim protection from harmful interference in these bands, and remind OneWeb that it undertakes these operations at its own risk.

18. *Waiver of Band-Splitting Procedure.* OneWeb seeks to operate in the United States throughout the 10.7-12.7 GHz, 14-14.5 GHz, 17.8-18.6 GHz, 18.8-19.3 GHz, 27.5-29.1 GHz, and 29.5-30 GHz frequency bands. In frequencies that include some of these bands, specifically the 10.7-12.7 GHz, 12.75-13.25 GHz, 13.75-14.5 GHz, 18.8-19.3 GHz and 28.6-29.1 GHz bands, the Commission has adopted rules and policies to allow shared use of frequencies among NGSO FSS systems by avoidance of in-line interference events.<sup>62</sup> In other bands, section 25.157(e) of the Commission's rules provides for

<sup>59</sup> Letter from Kalpak S. Gude, Vice President of Legal-Regulatory, WorldVu Satellites Limited, to Marlene H. Dortch, Secretary, FCC, at 1-2 (filed June 24, 2016).

<sup>60</sup> *NGSO FSS NPRM*, 31 FCC Rcd at 13655-56, paras. 9-10. Accordingly, OneWeb's operations would be consistent with the Commission's proposal, were the Commission to decide to open up this band for NGSO FSS secondary operations.

<sup>61</sup> *Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast Satellite-Service Use*, Report and Order, 15 FCC Rcd 13430, 13459, para. 58 (2000); *see also generally Inmarsat Mobile Networks, Inc., Application to Operate a Fixed-Satellite Service Gateway Earth Station Facility in Lino Lakes, Minnesota with the Inmarsat-5 F2 Space Station*, Order and Authorization and Declaratory Ruling, 30 FCC Rcd 2770, 2778-79, para. 25 (IB/OET 2015) (approving GSO FSS operations in the 17.7-18.3 GHz band because the PFD on the earth's surface would be below levels established by the ITU to protect terrestrial services and would be unlikely to affect other services).

<sup>62</sup> 47 CFR § 25.261; *The Establishment of Policies and Service Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ka-band*, Report and Order, 18 FCC Rcd 14708, 14714, para. 18 (2003); *The Establishment of Policies and Service Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ku-band*, Report and Order, 17 FCC Rcd 7841, 7850, para. 27 (2002).

“available spectrum” to be “divided equally” among the applications granted as the result of a processing round.<sup>63</sup> This rule presumes that NGSO operators cannot use the same frequencies without causing harmful interference to each other, and therefore must be assigned discrete segments of the requested band. OneWeb requests a waiver of section 25.157(e) to permit it to share the 17.8-18.6 GHz, 27.5-28.6 GHz, and 29.5-30 GHz bands with other NGSO FSS operators through avoidance of in-line interference events, rather than by assignment of only a portion of these bands.

19. Based on our technical review of the OneWeb Petition and of other applications and petitions that were submitted in the OneWeb processing round, we conclude that sharing will be possible between the OneWeb system and other proposed NGSO FSS systems in all of the bands requested by OneWeb. The earth stations that will communicate with the OneWeb constellation will have directional antennas.<sup>64</sup> This directionality, which permits avoidance of in-line interference with other NGSO FSS systems in the 10.7-12.7 GHz, 14-14.5 GHz, 18.8-19.3 GHz, and 28.6-29.1 GHz bands, also permits avoidance of in-line interference in the 17.8-18.6 GHz, 27.5-28.6 GHz, and 29.5-30 GHz bands. Thus, because OneWeb’s particular system design enables sharing by avoiding in-line interference events in all requested bands, division of available spectrum would be unnecessarily restrictive. Grant of a waiver in this instance will not undermine the purpose of section 25.157(e), which presumes that NGSO-like operations cannot share frequencies without causing harmful interference, because in this case the bands can be successfully shared.<sup>65</sup> In contrast, enforcing the band-splitting procedure would result in inefficient use of scarce spectrum resources, contrary to the public interest and the expressed desires of competing NGSO FSS participants in the OneWeb processing round.<sup>66</sup> For similar reasons, the Commission has proposed to extend the avoidance of in-line interference mechanism to the additional bands requested by OneWeb.<sup>67</sup> We therefore find good cause to waive section 25.157(e).

20. *Waivers for EPFD Software Code.* Section 25.146 requires NGSO FSS applicants in certain bands to use software to demonstrate that their systems will comply with EPFD limits included in section 25.208.<sup>68</sup> If software approved by the ITU is not available, applicants must provide the source code used. OneWeb utilized a beta version of EPFD software in development with the ITU, a final

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<sup>63</sup> 47 CFR § 25.157(e).

<sup>64</sup> OneWeb Petition, “Ku masks” and “Ka masks” .mdb files (providing information on antenna gain of proposed earth stations).

<sup>65</sup> See *Amendment of the Commission's Space Station Licensing Rules and Policies*, First Report and Order, 18 FCC Rcd 10760, 10865-66, para. 275 (2003) (declining to impose the band-splitting approach in section 25.157(e) to NGSO FSS applicants that proposed to share spectrum using the avoidance of in-line interference method).

<sup>66</sup> See Telesat Petition to Deny at 3 (“Band-splitting will provide too little spectrum to each of the applicants, resulting in no systems being launched.”); SpaceX Comments at 15 (“SpaceX agrees with OneWeb that the Commission should not reflexively impose the automatic band segmentation approach upon the current generation of participants in the upcoming NGSO processing round, and should instead proceed with a regime based on avoidance of in-line interference events.”); see also Boeing Comments at 3 (“The Commission’s rule regarding avoidance of in-line interference events in the Ka-band may better facilitate spectrum sharing among NGSO FSS systems” than band segmentation).

<sup>67</sup> *NGSO FSS NPRM*, 31 FCC Rcd at 13660-61, para. 23. Accordingly, OneWeb’s operations here would also be consistent with the Commission’s proposal, should the Commission decide to adopt this proposal in the NGSO FSS NPRM proceeding. However, the grant of the waiver here for OneWeb’s operations does not predetermine the Commission’s ultimate decision regarding the ability of in-line interference avoidance mechanisms to obviate the need for band-splitting, which will be based on the record in that proceeding.

<sup>68</sup> 47 CFR §§ 25.146(a)(1)(iii), (2)(iii), 25.208. This showing is separate from the showing that must be made, 90 days prior to initiation of service, that OneWeb complies with a different set of EPFD limits. See *infra* para. 25(e).



version of which was subsequently approved by the ITU.<sup>69</sup> OneWeb requests waiver of the requirement to provide its source code in light of the proprietary nature of the third-party software, and given that its version had not been approved by the ITU at the time of use. We find good cause for waiver of the source code requirement in section 25.146(a)(1)(iii), (2)(iii), based on OneWeb's use of this software in development with the ITU, but condition the grant on the requirement that OneWeb satisfactorily undergo the ITU review process of its EPFD demonstration prior to initiation of service. Review by the ITU of OneWeb's compliance with ITU EPFD limits, using methods now approved by the ITU, will provide sufficient additional assurances that OneWeb will comply with the identical EPFD limits in section 25.208 beyond the other technical demonstrations OneWeb has already provided.<sup>70</sup> Thus, grant of this waiver will not undermine the purpose of the rule to reasonably ensure compliance with the relevant EPFD limits.<sup>71</sup>

21. *Other.* In the 14-14.2 GHz band, the National Aeronautics and Space Administration operates Tracking and Data Relay Satellite System facilities at three locations: Guam (latitude 13°36'55" N, longitude 144°51'22" E); White Sands, New Mexico (latitude 32°20'59" N, longitude 106°36'31" W and latitude 32°32'40" N, longitude 106°36'48" W); and Blossom Point, Maryland. For transmissions in the 14-14.2 GHz band from NGSO FSS earth stations located within 125 kilometers of these three sites, the earth station operators should take account of the NASA facilities.

#### IV. CONCLUSION AND ORDERING CLAUSES

22. We conclude that grant of the OneWeb Petition, as conditioned herein, will serve the public interest by enabling OneWeb to pursue its goal of providing broadband Internet access to communities across the United States.

23. Accordingly, IT IS ORDERED, that the Petition for Declaratory Ruling filed by WorldVu Satellites Limited, d/b/a OneWeb, IS GRANTED, pursuant to section 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. § 303(r), and section 25.137(c) of the Federal Communication Commission's rules, 47 CFR § 25.137(c), as set forth in paragraphs 24-29 below.

24. Any future grant of earth station licenses for operations with the OneWeb system will be subject to the following conditions:

- a. Communications between U.S.-licensed earth stations and OneWeb space stations must comport with all existing and future space station coordination agreements reached between the United Kingdom and other administrations. In the absence of a coordination agreement, such communications must comport with applicable provisions of the ITU Radio Regulations.
- b. In the 11.7-12.2 GHz (space-to-Earth) frequency band reception is permitted for transmissions up to the power flux-density limits in Article 21 of the ITU Radio Regulations, and up to the equivalent power flux-density requirements of 47 CFR § 25.208(g), (i), and (j).
- c. In the 12.2-12.7 GHz (space-to-Earth) frequency band reception is permitted for transmissions up to the power flux-density limits in 47 CFR § 25.208(o) and Article 21 of the ITU Radio Regulations, and up to the equivalent power flux-density requirements of 47 CFR § 25.208(l); Earth Stations on Vessels (ESV), Vehicle-Mounted Earth Stations (VMES), and Earth Stations

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<sup>69</sup> Letter from Francois Rancy, Director, ITU Radiocommunication Bureau, to Administrations of ITU Member States, "Examinations under Resolution 85 (WRC-03)" (Dec. 6, 2016), <https://www.itu.int/md/R00-CR-CIR-0414/en>. OneWeb modified the beta software to reflect the specifics of its system design.

<sup>70</sup> We note that this is the only information disclosure required by our rules for which OneWeb seeks a waiver; OneWeb has provided all other information required for its Petition by our rules. *See generally* 47 CFR §§ 25.114, 25.137, 25.145, 25.146.

<sup>71</sup> *See infra* para. 25(d).

Aboard Aircraft (ESAA) shall not claim protection from transmissions of non-Federal stations in the fixed service.

d. In the 14.0-14.5 GHz (Earth-to-space) frequency band reception is permitted for levels up to the equivalent power flux-density requirements of 47 CFR § 25.208(k).

e. In the 10.7-11.7 GHz (space-to-Earth) frequency band reception is permitted for transmissions up to the applicable power flux-density limits in 47 CFR § 25.208(b), and up to the equivalent power flux-density requirements of 47 CFR § 25.208(g), (i) and (j).

f. Waiver of the United States Table of Frequency Allocations, 47 CFR § 2.106, IS GRANTED. Communications in the 17.8-18.6 GHz (space-to-Earth) frequency band are on a non-conforming basis. Such communications are on an unprotected basis and operations must immediately terminate upon notification of harmful interference. In addition, such communications must comport with the applicable power flux-density limits in Article 21 of the ITU Radio Regulations and 47 CFR § 25.208(c), and equivalent power flux-density requirements in Article 22 of the ITU Radio Regulations.

g. In the 18.8-19.3 GHz (space-to-Earth) frequency band reception is permitted for transmissions up to the power flux-density limits in 47 CFR § 25.208(e).

h. In the 27.5-28.6 GHz and 29.5-30 GHz (Earth-to-space) frequency bands transmission is permitted at [individual and aggregate equivalent power flux-density](#) levels up [to those specified in Annex 2-10 of the OneWeb Petition](#) to the applicable equivalent power flux-density requirements of Article 22 of the ITU Radio Regulations.

i. Transmissions in the 27.5-28.35 GHz (Earth-to-space) frequency band are secondary with respect to Upper Microwave Flexible Use Service (UMFUS) operations, except for FSS operations associated with earth stations authorized pursuant to 47 CFR § 25.136.

j. Transmissions in the 28.35-28.6 GHz and 29.5-30 GHz (Earth-to-space) frequency bands are on a secondary basis with respect to GSO FSS operations.

k. Operations must comply with the avoidance of in-line interference method specified in 47 CFR § 25.261(b)-(d) with respect to any NGSO system licensed or granted U.S. market access pursuant to the processing round initiated in Public Notice, DA 16-804.

25. Any future grant of earth station licenses for operations with the OneWeb system will be subject to the following conditions, unless such conditions are satisfied prior to such license grant:

a. In the 14.47-14.5 GHz band, operations are subject to footnote US342 to the U.S. Table of Frequency Allocations, 47 CFR § 2.106, and all practicable steps must be taken to protect the radio astronomy service from harmful interference.

b. In the 10.7-11.7 GHz band, operations must be coordinated with the radio astronomy observatories listed in 47 CFR § 2.106, n.US131, to achieve a mutually acceptable agreement regarding the protection of the radio telescope facilities operating in the 10.6-10.7 GHz band.

c. Space-to-Earth operations in the 17.8-18.6 GHz and 18.8-19.3 GHz bands must complete coordination with U.S. Federal systems, in accordance with footnote US334 to the United States Table of Frequency Allocations, 47 CFR § 2.106, prior to being used. The use of space-to-Earth operations in the 17.8-18.6 GHz and 18.8-19.3 GHz bands must be in accordance with the signed coordination agreement between OneWeb and U.S. Federal operators. Two weeks prior to the start of any operations in the 17.8-18.6 GHz and 18.8-19.3 GHz bands, OneWeb must provide to the Federal user, Jimmy Nguyen, Email: [Jimmy.Nguyen@us.af.mil](mailto:Jimmy.Nguyen@us.af.mil), contact information for a 24/7 point of contact for the resolution of any harmful interference.

d. Prior to initiation of service, OneWeb must receive a favorable or “qualified favorable” finding in accordance with Recommendation 85 (WRC-03) with respect to its compliance with

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applicable EPFD limits in Article 22 of the ITU Radio Regulations.

e. At least ninety days prior to the initiation of service to the public, OneWeb must submit in File No. SAT-LOI-20160428-00041:

- i. a comprehensive technical showing for its NGSO FSS system in the 10.7-12.2 GHz frequency band, in accordance with 47 CFR § 25.146(b).
- ii. a technical showing for its NGSO FSS system in the 12.2-12.7 GHz frequency band, in accordance with 47 CFR § 25.146(g).
- iii. a comprehensive technical showing for its NGSO FSS system in the 17.8-18.6 GHz frequency band, to demonstrate that the NGSO FSS system is expected not to operate in excess of the additional operational EPFD<sub>down</sub> limits and the operational EPFD<sub>down</sub> limits specified in the applicable equivalent power flux-density requirements of Article 22 of the ITU Radio Regulations.

f. Prior to initiation of service, OneWeb must obtain from the United Kingdom Space Agency an authorization for deployment and space operations under the United Kingdom Outer Space Act. OneWeb must file evidence in File No. SAT-LOI-20160428-00041 demonstrating grant of any such authorizations within five business days of action by the United Kingdom Space Agency.

26. Any future grant of earth station licenses for operations with the OneWeb system may be withheld, subjected to additional conditions, or modified, if the following conditions are not met:

~~a. OneWeb must cooperate in good faith with other NGSO FSS operators in order to ensure compliance with the applicable limits for aggregate EPFD in the space-to-Earth direction (EPFD<sub>down</sub>) contained in 47 CFR § 25.208(h), (m), as well as in Resolution 76 of the ITU Radio Regulations.~~

b. OneWeb must maintain an electronic web site bulletin board listing the ephemeris data for each satellite in the constellation, using the North American Aerospace Defense Command (NORAD) two-line orbital element format. The orbital elements must be updated at least once every three days.

c. Satellite operations must be subject to direct and effective regulation by the United Kingdom concerning orbital debris mitigation.

d. OneWeb must coordinate physical operations of spacecraft with any operator using similar orbits, for the purpose of eliminating collision risk and minimizing operational impacts. The orbital parameters specified in this grant are subject to change based on such coordination.

27. This grant of U.S. market access and any earth station licenses granted in the future are subject to modification to bring them into conformance with any rules or policies adopted by the Commission in the future.

28. This declaratory ruling does not address the provision of any Direct-to-Home (DTH) service, Direct Broadcast Satellite Service (DBS)<sup>72</sup> or Digital Audio Radio Service (DARS) to, from, or within the United States.

29. IT IS FURTHER ORDERED that this grant is subject to the following requirements:

OneWeb must post a surety bond in satisfaction of 47 CFR §§ 25.165(a)(1) & (b) no later than [30 days] and thereafter maintain on file a surety bond requiring payment in the event of a default in an amount, at minimum, determined according to the formula set forth in 47 CFR § 25.165(a)(1); and

<sup>72</sup> With respect to DBS and DTH, this paragraph excludes from the scope of the grant those services specified in 47 CFR § 25.701(a)(1)-(5).

OneWeb must launch the space stations, place them in the assigned orbits, and operate them in accordance with the station authorization no later than [6 yrs], 47 CFR § 25.164(b).

This grant of U.S. market access will be null and void automatically, without further Commission action if OneWeb fails to comply with any of these requirements. Failure to comply with the milestone requirement of 47 CFR § 25.164(b) will also result in forfeiture of OneWeb's surety bond. By [6 yrs + 15 days], OneWeb must either demonstrate compliance with its milestone requirement or notify the Commission in writing that the requirement was not met. 47 CFR § 25.164(f).

30. IT IS FURTHER ORDERED that based on the spectrum sharing opportunities provided by Paragraph 24(k) above, which presumes grants on a co-frequency basis with other satellite systems, the request for waiver of the band segmentation provision in 47 CFR § 25.157(e) IS GRANTED.

31. IT IS FURTHER ORDERED that OneWeb's request for waiver of the source code requirements in 47 CFR § 25.146(a)(1)(iii), (2)(iii), IS GRANTED.

32. IT IS FURTHER ORDERED that the request for waiver of 47 CFR § 25.202(a)(1), n.6, restricting use of the 10.7-11.7 GHz band by non-geostationary-satellite orbit (NGSO) fixed-satellite service (FSS) systems to operations with gateway earth stations, IS DISMISSED without prejudice to re-filing in connection with such an application.

33. IT IS FURTHER ORDERED that the request for waiver of 47 CFR § 2.106, n.NG52, concerning geostationary-satellite operations in the 10.7-11.7 GHz band, IS DISMISSED as moot.

34. IT IS FURTHER ORDERED that the Petitions to Deny of Telesat Canada and the MVDDS 5G Coalition ARE GRANTED to the extent indicated herein, and are otherwise DENIED.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch  
Secretary

**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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Exhibit 2: Impact of Mutual Avoidance on Capacity

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

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

**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.”<sup>1</sup>

**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.<sup>2</sup> 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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<sup>1</sup> *NPRM* at ¶ 1.

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

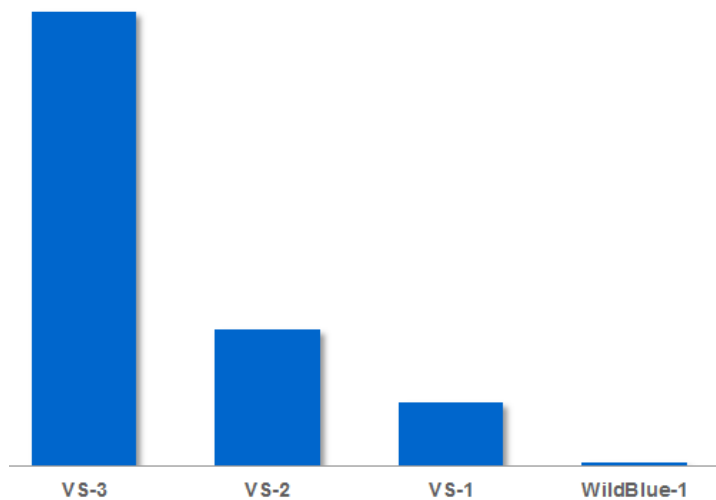
satellite-based communications services that would combine the high throughput available through ViaSat's existing and planned GSO satellites with the enhanced coverage and low latency available through an NGSO platform.

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,<sup>3</sup> 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,<sup>4</sup> and will be expanding its 25/3 Mbit/s coverage—and offering even higher speeds throughout its service

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<sup>3</sup> See *WildBlue High-Speed Internet via Satellite Triples Capacity with New Satellite* (Mar. 20, 2007), available at <http://www.wildblue.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”).

<sup>4</sup> 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.<sup>5</sup>

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.<sup>6</sup> In total, nearly one million personal electronic devices connect each month through 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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<sup>5</sup> See, e.g., *ViaSat Announces Third Quarter Fiscal Year 2016 Results* (Feb. 9, 2016), available at <http://investors.viasat.com/releasedetail.cfm?ReleaseID=954130>.

<sup>6</sup> 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,<sup>7</sup> 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;<sup>8</sup> and (ii) correctly recognizing that satellite operations might not be able to be “fully and economically accommodated in the only frequency bands [then] available.”<sup>9</sup>

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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<sup>7</sup> 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).

<sup>8</sup> 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).

<sup>9</sup> *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.<sup>10</sup> Codification should provide greater transparency and ensure that relevant stakeholders

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<sup>10</sup> See *NPRM* at ¶ 8.

work from a common, baseline understanding of potential spectrum uses in a given band segment.<sup>11</sup> 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.<sup>12</sup> 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.<sup>13</sup> In restoring the deleted allocation, the Commission should make clear that the allocation permits use of the

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<sup>11</sup> *Id.* at ¶ 14.

<sup>12</sup> *Id.* at ¶ 9.

<sup>13</sup> *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.<sup>14</sup>

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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<sup>14</sup> *EchoStar Satellite LLC*, 20 FCC Rcd 930, at ¶ 13 (2004).

with NGSO uses.<sup>15</sup> 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).<sup>16</sup>

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.<sup>17</sup> 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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<sup>15</sup> *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.

<sup>16</sup> 47 C.F.R §§ 25.208(c) and (e).

<sup>17</sup> 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<sup>18</sup> 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.<sup>19</sup> 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.<sup>20</sup>

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

<sup>19</sup> *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).

<sup>20</sup> *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,<sup>21</sup> 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,<sup>22</sup> 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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<sup>21</sup> 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.

<sup>22</sup> *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.”<sup>23</sup> 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.<sup>24</sup>

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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<sup>23</sup> *NPRM* at ¶ 19.

<sup>24</sup> *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.<sup>25</sup> 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.”<sup>26</sup>
- SES/O3b: “Reliable mechanisms must be put in place to ensure any future interference that does arise can be quickly and adequately resolved.”<sup>27</sup>
- 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.”<sup>28</sup>

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

<sup>26</sup> 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).

<sup>27</sup> *Id.* at ii.

<sup>28</sup> 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.<sup>29</sup> 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.”<sup>30</sup> 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;<sup>31</sup> 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*.<sup>32</sup>

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<sup>29</sup> 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.

<sup>30</sup> *NPRM* at ¶ 19 n.52.

<sup>31</sup> *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.

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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.

<sup>32</sup> *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;<sup>33</sup> 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.<sup>34</sup>

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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<sup>33</sup> See *supra* pp. 10-11 & n.21.

<sup>34</sup> 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),<sup>35</sup> 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,<sup>36</sup> 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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<sup>35</sup> 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”).

<sup>36</sup> *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.<sup>37</sup> 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.<sup>38</sup> 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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<sup>37</sup> 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).

<sup>38</sup> *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.<sup>39</sup> 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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<sup>39</sup> *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.<sup>40</sup>

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.<sup>41</sup> 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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<sup>40</sup> 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.

<sup>41</sup> 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.<sup>42</sup> 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.”<sup>43</sup> 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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<sup>42</sup> *NPRM* at ¶ 28.

<sup>43</sup> *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*).<sup>44</sup> 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.”<sup>45</sup>

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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<sup>44</sup> *Id.* at ¶ 32.

<sup>45</sup> *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,”<sup>46</sup> 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.”<sup>47</sup> As the *NPRM* acknowledges, the existing rule is intended to “maximize the use of global spectrum resources,”<sup>48</sup> and the global coverage requirement precludes the use of certain NGSO system designs.<sup>49</sup>

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<sup>50</sup>—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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<sup>46</sup> *Id.*

<sup>47</sup> *Id.* at ¶ 35.

<sup>48</sup> *Id.*

<sup>49</sup> *Id.*

<sup>50</sup> *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.

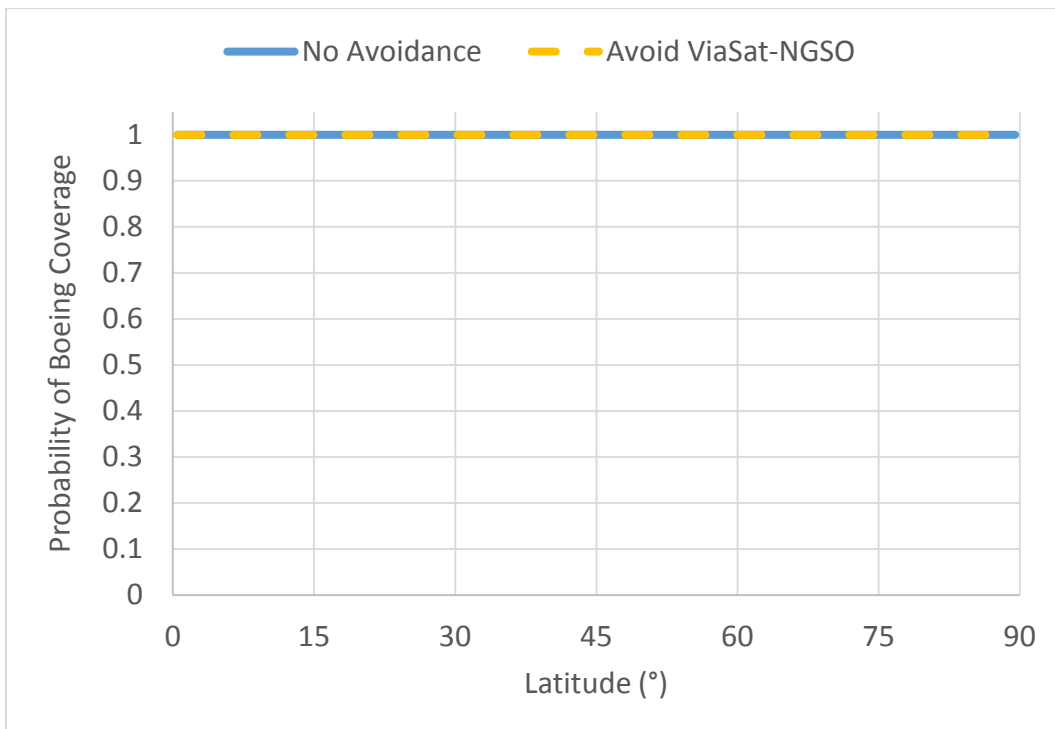
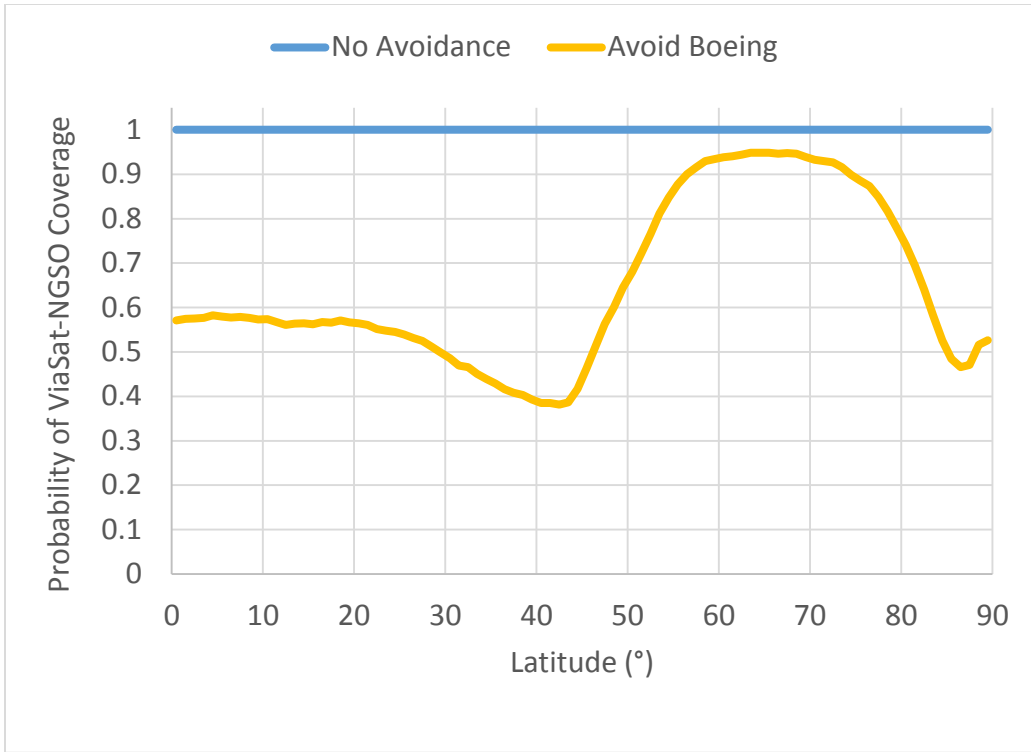
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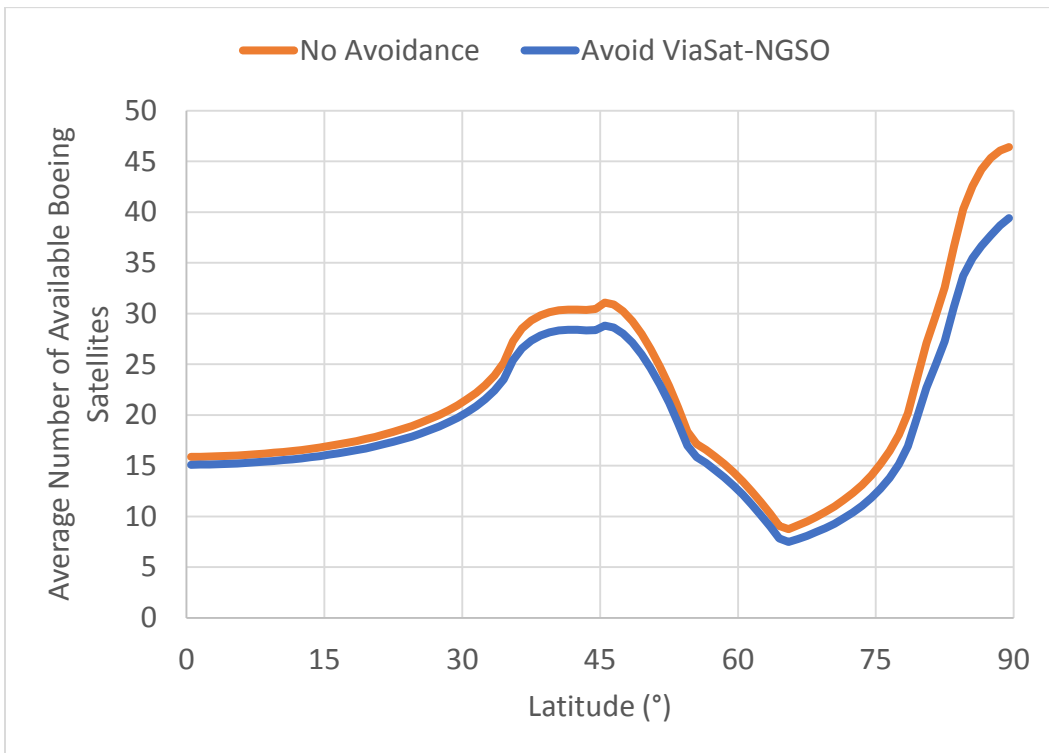
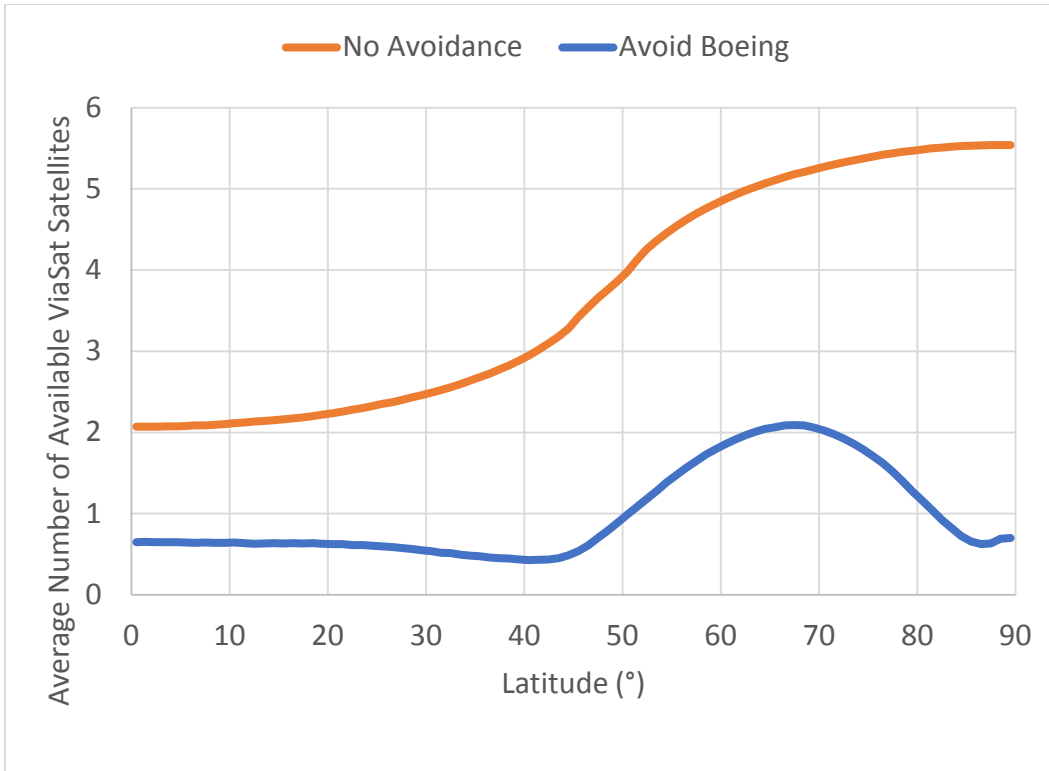
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February 27, 2017

**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.



*Daryl T. Hunter*

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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**

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

**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.”<sup>1</sup>

**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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<sup>1</sup> *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.<sup>2</sup> 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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<sup>2</sup> 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.<sup>3</sup> 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<sup>4</sup>**

	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	
<b># Systems</b>	<b>6</b>	<b>11</b>	<b>9</b>
<b># Satellites</b>	<b>5,419</b>	<b>5,627</b>	<b>17,334</b>

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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<sup>3</sup> 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.

<sup>4</sup> 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.<sup>5</sup> 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.<sup>6</sup>

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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<sup>5</sup> 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.

<sup>6</sup> 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.<sup>7</sup>

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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<sup>7</sup> 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 refile) 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.<sup>8</sup> Inmarsat urges the Commission to ensure that NGSO operations in the Ka band “operate in such a way that any

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<sup>8</sup> 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.”<sup>9</sup> OneWeb recognizes the need for appropriate technical limits to ensure that GSO operations are adequately protected.<sup>10</sup> 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.”<sup>11</sup>

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.<sup>12</sup> 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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<sup>9</sup> Comments of Inmarsat, IB Docket No. 16-408, at 9 (filed Feb. 27, 2017) (“Inmarsat Comments”).

<sup>10</sup> Comments of OneWeb, IB Docket No. 16-408, at 22-23 (filed Feb. 27, 2017) (“OneWeb Comments”).

<sup>11</sup> 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.

<sup>12</sup> *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.<sup>13</sup> And neither the *NPRM* nor any commenter addresses what EPFD limits would be suitable to ensure GSO and NGSO compatibility in the V band.

EPFD 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.<sup>14</sup> Moreover, the Commission has previously licensed GSO networks and hybrid GSO/NGSO networks in the V band,<sup>15</sup> 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.<sup>16</sup> 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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<sup>13</sup> ViaSat Comments at 16-17.

<sup>14</sup> *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.”).

<sup>15</sup> *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*”).

<sup>16</sup> 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.*,  $-162 \text{ dBW}/(\text{m}^2 * 40 \text{ kHz})$ . 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 1 <sup>st</sup> Gen	ViaSat 2 <sup>nd</sup> Gen	ViaSat 3 <sup>rd</sup> Gen
Frequency (MHz)	29750	29750	29750
Lambda (m)	0.010	0.010	0.010
EPFD (dBW/(m <sup>2</sup> * 40 kHz))	-162.0	-162.0	-162.0
Conversion factor 40 kHz to Hz (dB)	46.0	46.0	46.0
EPFD (dBW/(m <sup>2</sup> * Hz))	-208.0	-208.0	-208.0
Meter squared antenna gain (dB(m <sup>2</sup> ))	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 <sub>o</sub> (dBW/Hz)	-197.3	-198.388	-200.471
Interference Noise Density, I <sub>o</sub> (dBW/Hz)	-205.94	-197.94	-197.94
I <sub>o</sub> /N <sub>o</sub> (dB)	-8.6	0.4	2.5
Uplink Degradation (dB)	0.6	3.2	4.5
ΔT/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.<sup>17</sup> Table 3, below, depicts the aggregate impact of multiple NGSO systems, each operating at the -162 dBW/(m<sup>2</sup> \* 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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<sup>17</sup> 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<sup>18</sup>**

# Systems	Uplink Degradation (dB)		
	ViaSat 1 <sup>st</sup> Gen	ViaSat 2 <sup>nd</sup> Gen	ViaSat 3 <sup>rd</sup> 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.<sup>19</sup> 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.<sup>20</sup>

Notably, the  $-162 \text{ dBW}/(\text{m}^2 * 40 \text{ kHz})$  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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<sup>18</sup> 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.

<sup>19</sup> ViaSat Comments at ii, 11-17.

<sup>20</sup> *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,<sup>21</sup> 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  $-174 \text{ dBW/m}^2$  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  $-174 \text{ dBW/m}^2$  limit would significantly reduce the adverse impacts of

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<sup>21</sup> 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.”<sup>22</sup> 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.<sup>23</sup> 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,<sup>24</sup> 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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<sup>22</sup> Inmarsat Comments at 8.

<sup>23</sup> *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*”).

<sup>24</sup> 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.<sup>25</sup> 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).<sup>26</sup>

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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<sup>25</sup> 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).

<sup>26</sup> *Id.*

evaluate those proposals within the context of all of the other applications filed by the relevant cut-off dates.<sup>27</sup>

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<sup>28</sup>—consistent with Commission policy.<sup>29</sup>

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<sup>27</sup> 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.”).

<sup>28</sup> See Inmarsat Comments at 8.

<sup>29</sup> 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.<sup>30</sup> 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*.<sup>31</sup>

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.<sup>32</sup>

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<sup>30</sup> *NPRM* ¶ 21.

<sup>31</sup> 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).

<sup>32</sup> 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,<sup>33</sup> as well as NGSO-like operations,<sup>34</sup> 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.”<sup>35</sup> 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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<sup>33</sup> 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*.

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

<sup>35</sup> 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).<sup>36</sup> 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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<sup>36</sup> *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 . . . .”<sup>37</sup> 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.”<sup>38</sup> 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.”<sup>39</sup> 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.”<sup>40</sup>

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<sup>37</sup> Boeing Comments at 12.

<sup>38</sup> *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*”)).

<sup>39</sup> *V-Band Report and Order* ¶ 20.

<sup>40</sup> *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 . . . .”<sup>41</sup> Boeing and Lockheed make similar claims, with Boeing advocating the use of this approach in both the Ka and V bands.<sup>42</sup>

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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<sup>41</sup> SpaceX Comments at 18.

<sup>42</sup> 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.<sup>43</sup> 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.<sup>44</sup> 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.<sup>45</sup> 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.<sup>46</sup> Any requirement for ViaSat’s competitive NGSO system to avoid these in-line events

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<sup>43</sup> *NPRM* ¶ 22.

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

<sup>45</sup> Comments of Telesat Canada, IB Docket No. 16-408, at 11-14 (filed Feb. 27, 2017) (“Telesat Canada Comments”).

<sup>46</sup> 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.<sup>47</sup> 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.

<sup>47</sup> ViaSat Comments at 20-23.

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

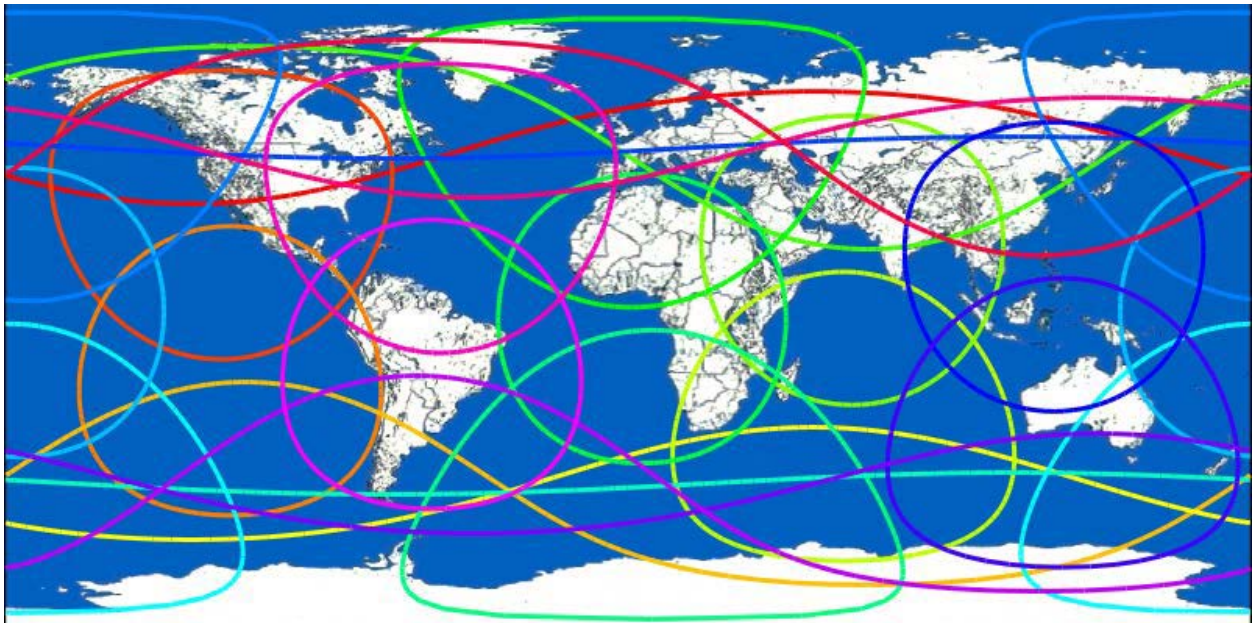
These dynamics are illustrated in ViaSat’s initial comments, which demonstrate that: (i) the need to avoid Boeing’s 2,956-satellite V-band NGSO system during in-line events would significantly reduce the average probability of a given location being covered by ViaSat’s NGSO system at any given point 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.<sup>48</sup>

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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<sup>48</sup> 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,<sup>49</sup> 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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<sup>49</sup> 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 significantly 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.”<sup>50</sup> 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.<sup>51</sup> 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.<sup>52</sup> Kepler advocates the use of coordination to determine the angular separation

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<sup>50</sup> 47 C.F.R. § 25.145.

<sup>51</sup> *NPRM* ¶ 26.

<sup>52</sup> LeoSat Comments at 12.

threshold to be used by particular sets of operators.<sup>53</sup> SES and O3b propose reducing the angle to an unspecified level.<sup>54</sup> Space Norway recommends that any change to the angle be grounded in studies.<sup>55</sup> Boeing advocates the use of different angles in different circumstances, without explaining what differences would matter for these purposes.<sup>56</sup> 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.<sup>57</sup> 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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<sup>53</sup> Kepler Comments at 4.

<sup>54</sup> SES/O3b Comments at 25.

<sup>55</sup> Space Norway Comments at 12.

<sup>56</sup> Boeing Comments at 12-13.

<sup>57</sup> ViaSat Comments at 21.



consistent with SpaceX's advocacy on this point,<sup>58</sup> 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.<sup>59</sup> O3b, SpaceX, and Boeing seek waivers of the current and long-

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<sup>58</sup> 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.

<sup>59</sup> 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.<sup>60</sup> 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.<sup>61</sup>

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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<sup>60</sup> 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).

<sup>61</sup> 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.<sup>62</sup> 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 refile), initiate new Ka- and V-band

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<sup>62</sup> 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 refile) 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,

/s/

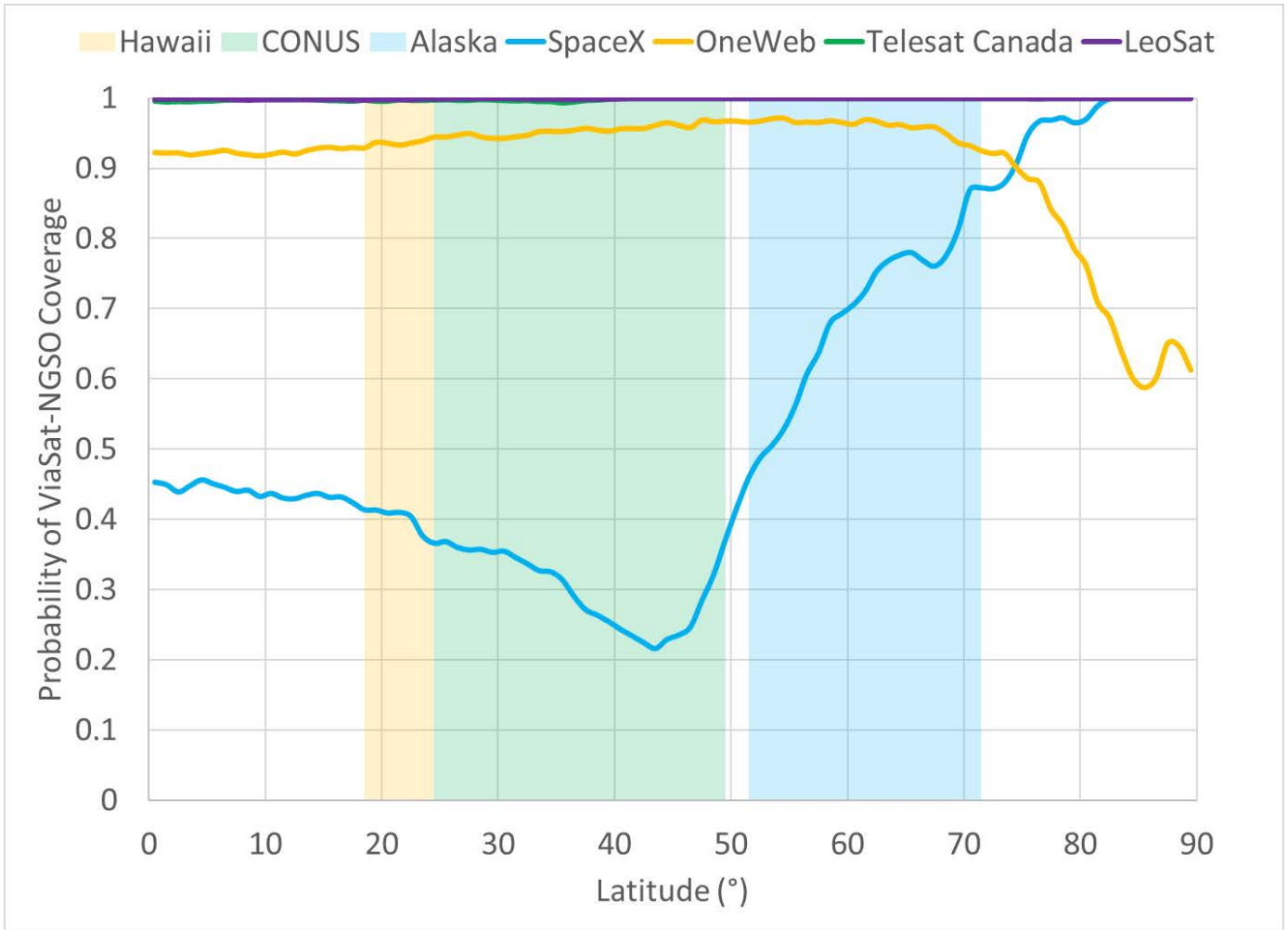
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April 10, 2017

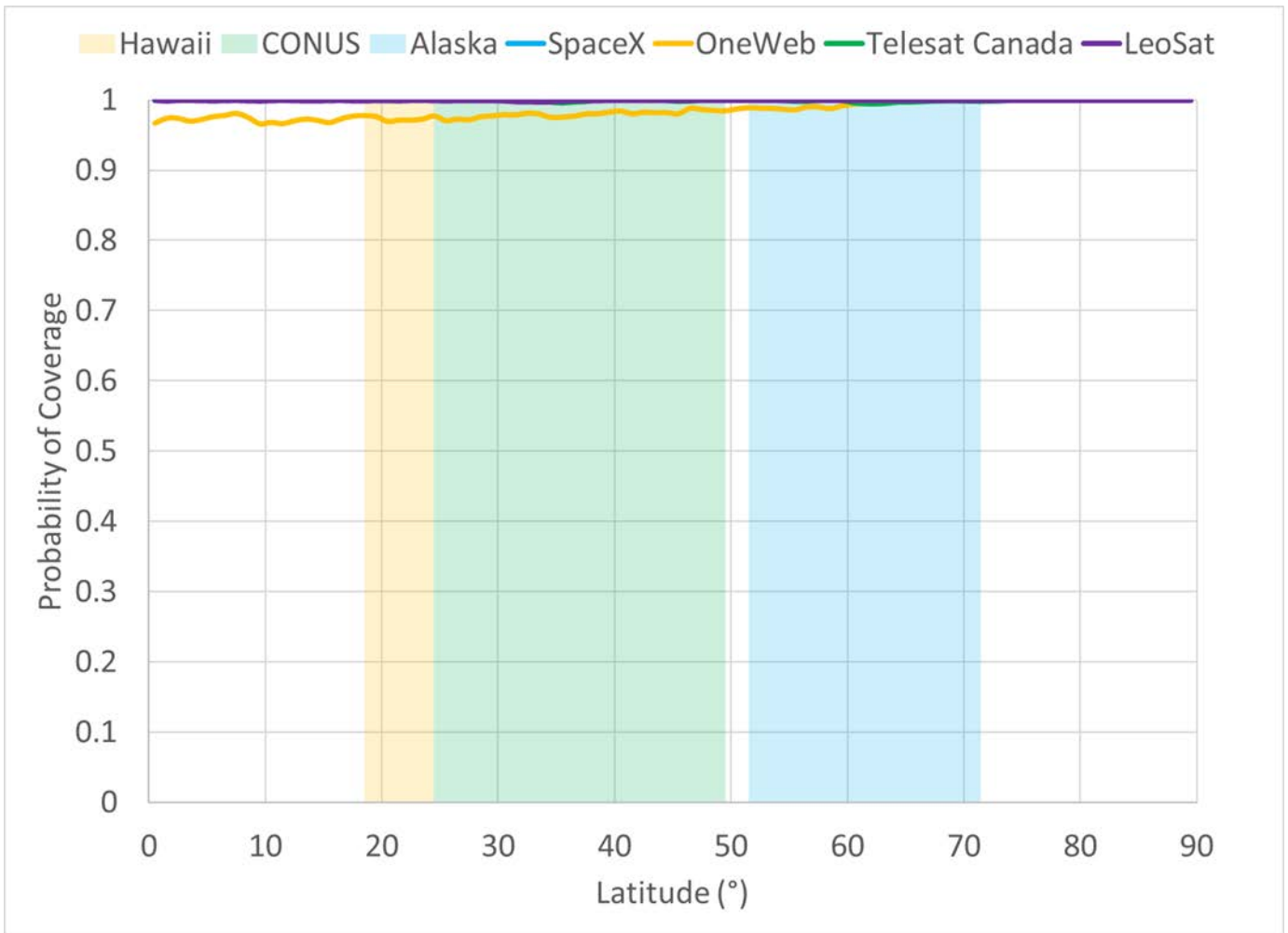
## **EXHIBITS**

**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.

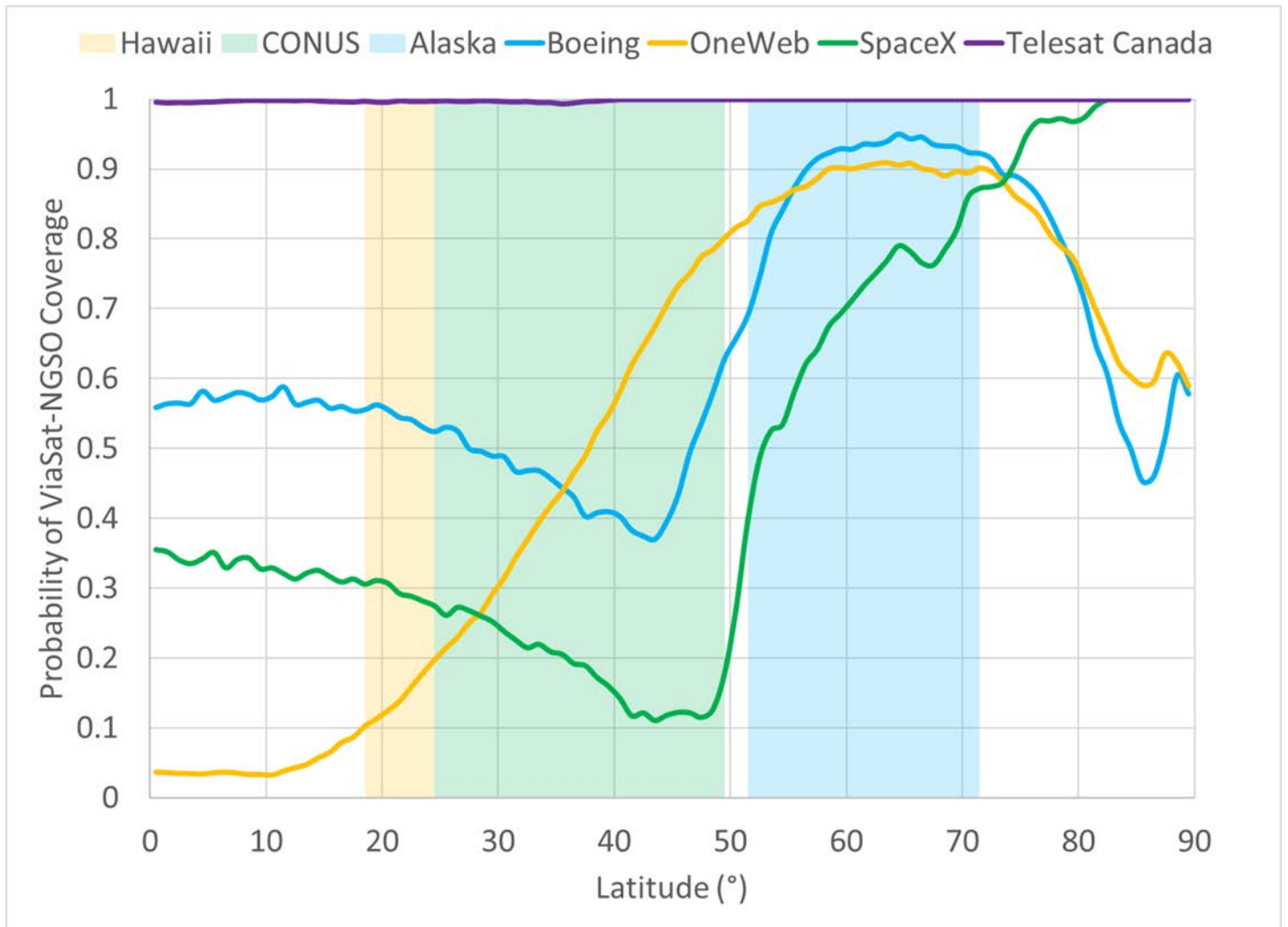
**Exhibit 1B**  
**Ka Band: Average Coverage Probability Effect on Other NGSOs**  
**from Their Avoiding In-Line Events with ViaSat**  
**(By Latitude)**



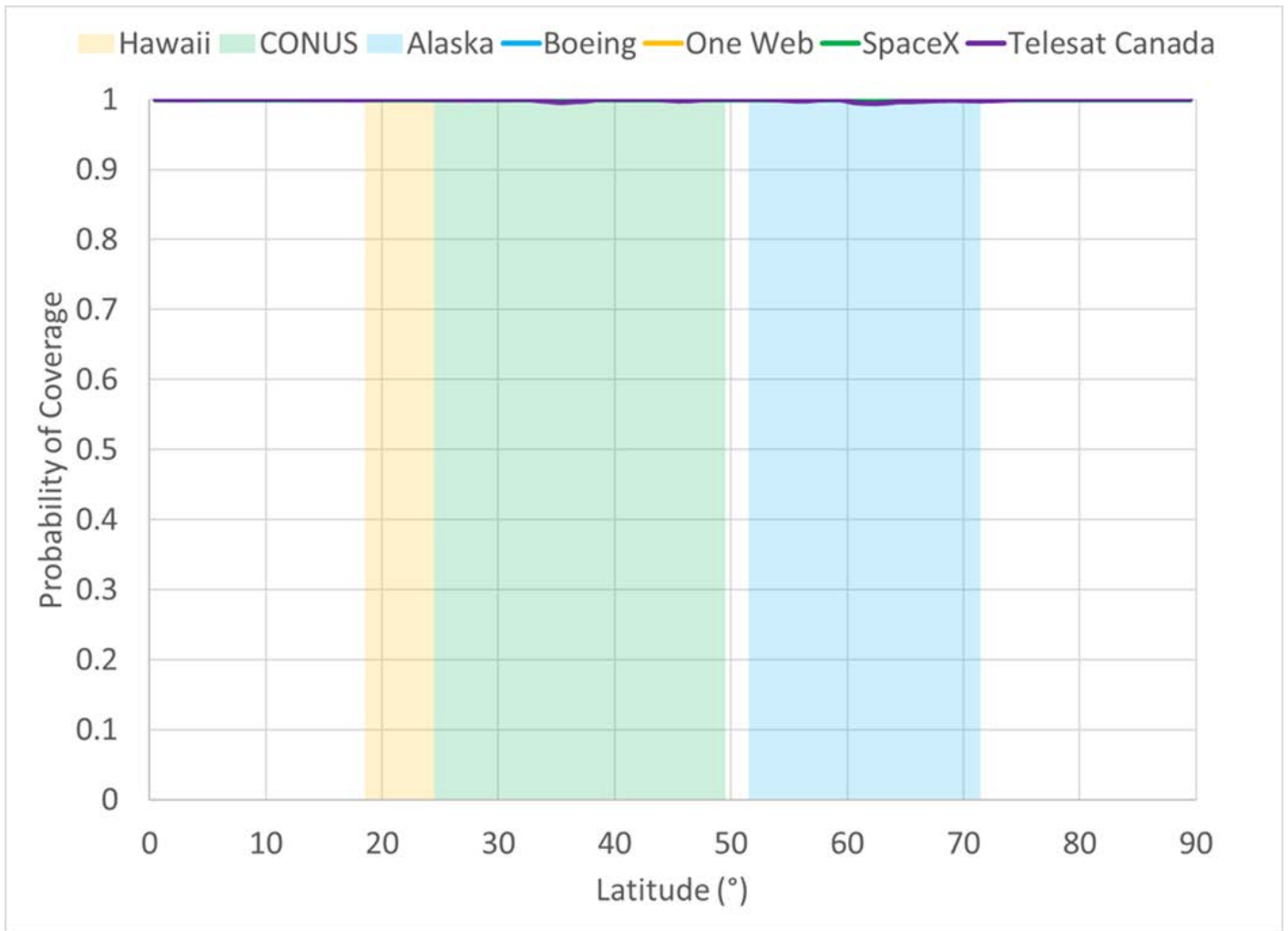
Note: Effect on SpaceX, Telesat Canada, and LeoSat is barely visible on the scale.



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

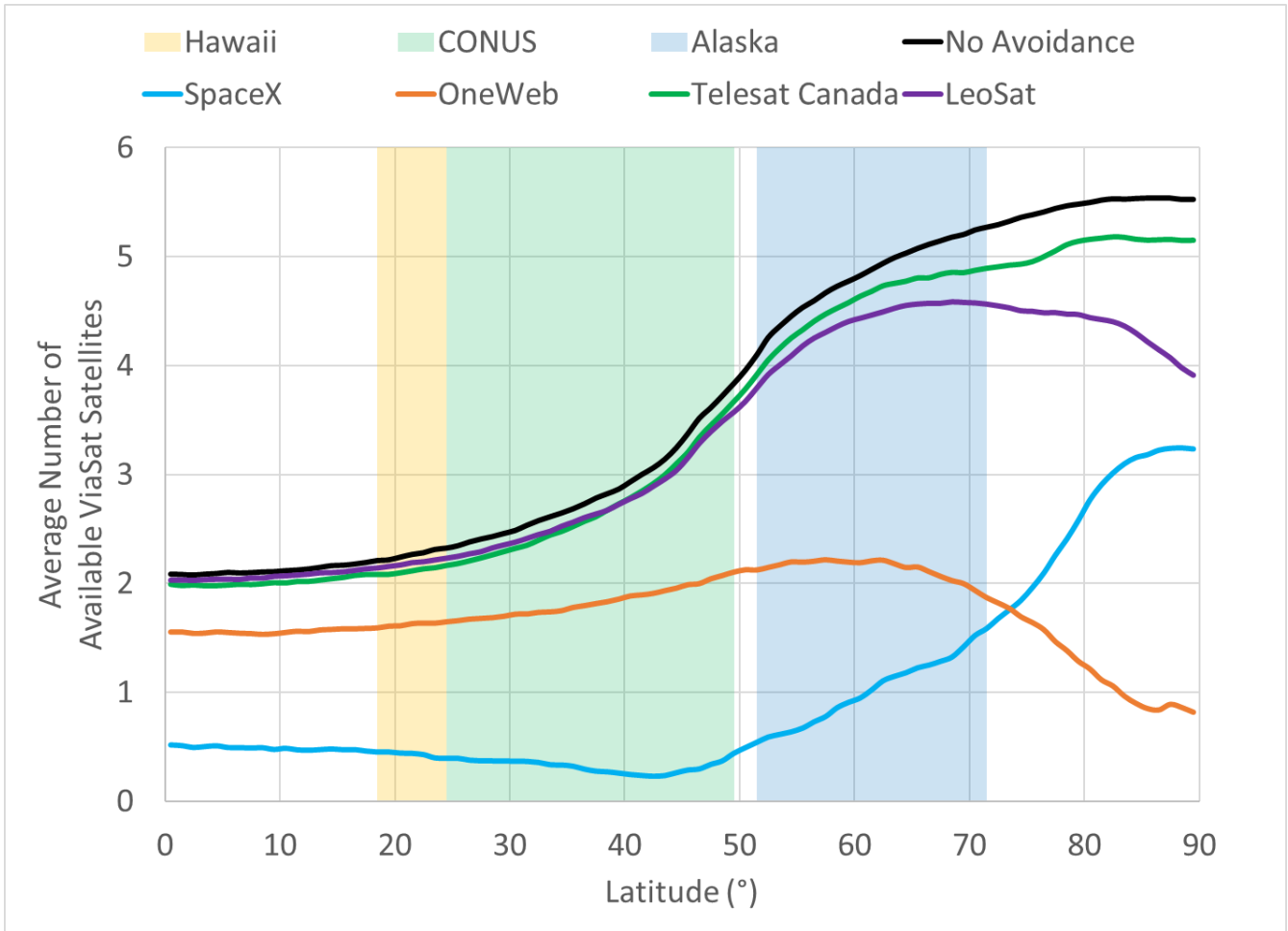


**Exhibit 1D**  
**V Band: Average Coverage Probability Effect on Other NGSOs**  
**from Their Avoiding In-Line Events with ViaSat**  
**(By Latitude)**

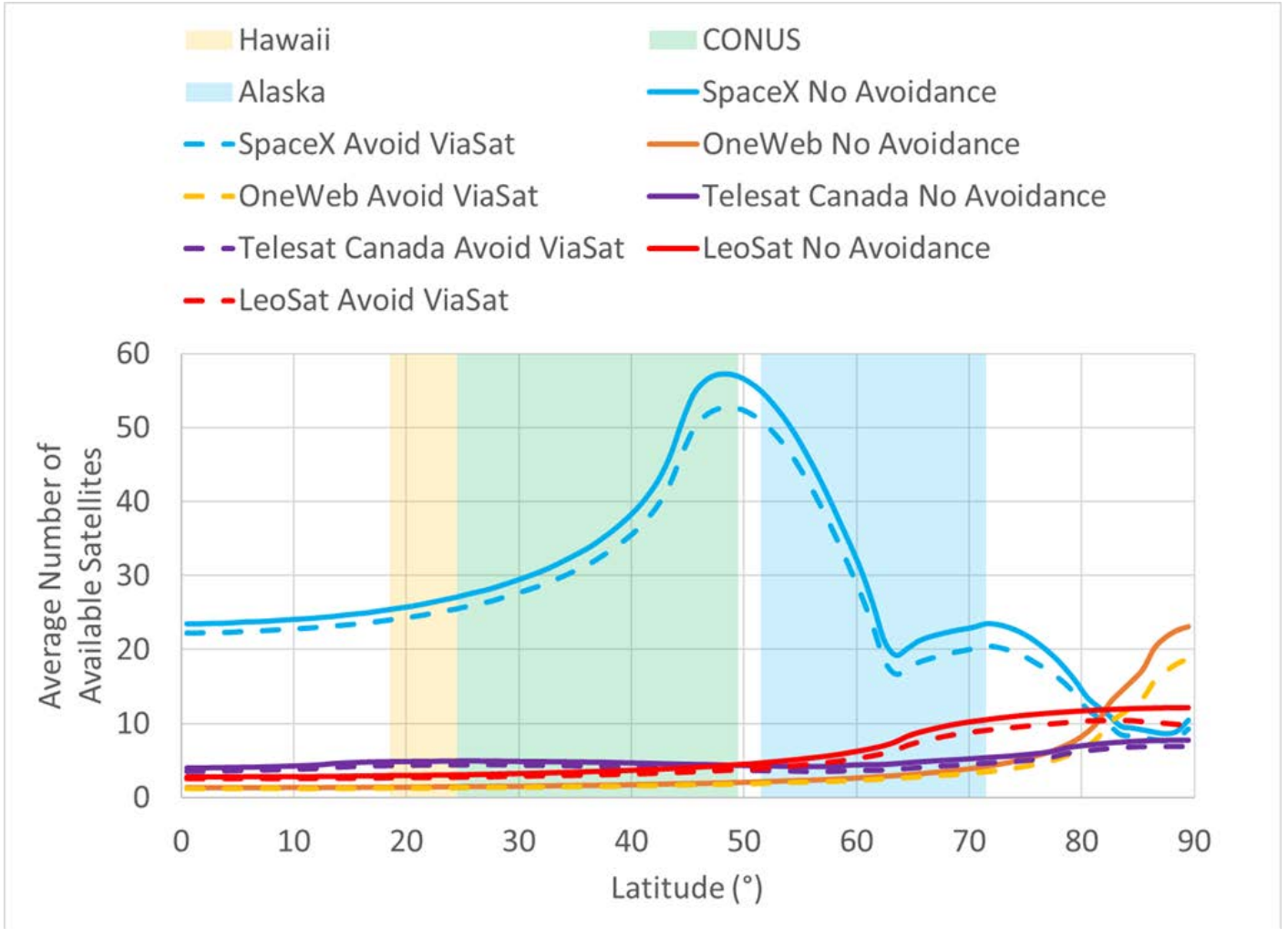


Note: Effect on Boeing, OneWeb, SpaceX and Telesat Canada is barely visible on the scale.

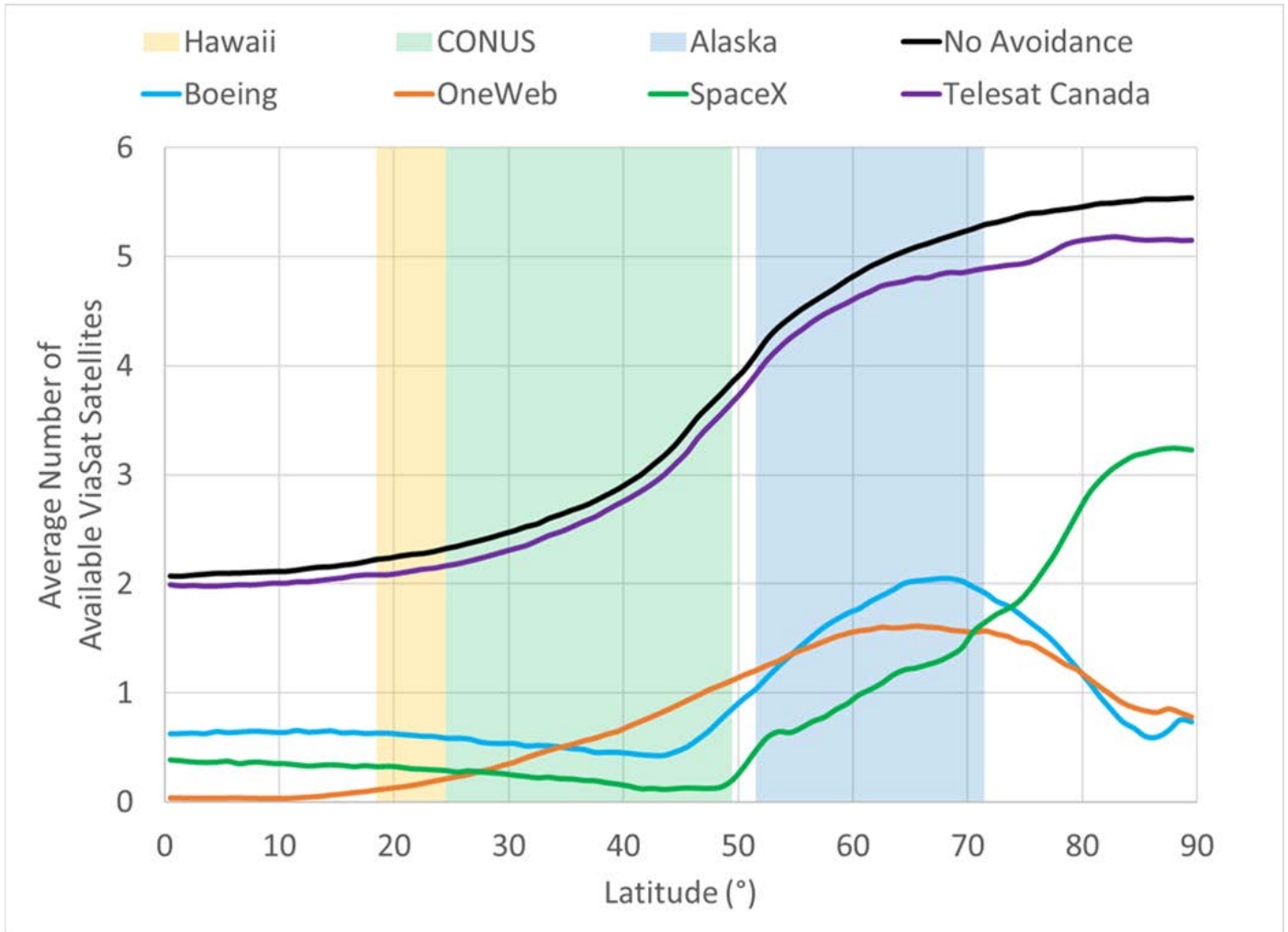
**Exhibit 2A**  
**Ka Band: Average Capacity Loss for ViaSat-NGSO**  
**from Its Avoiding In-Line Events with Other NGSOs**  
**(By Latitude)**



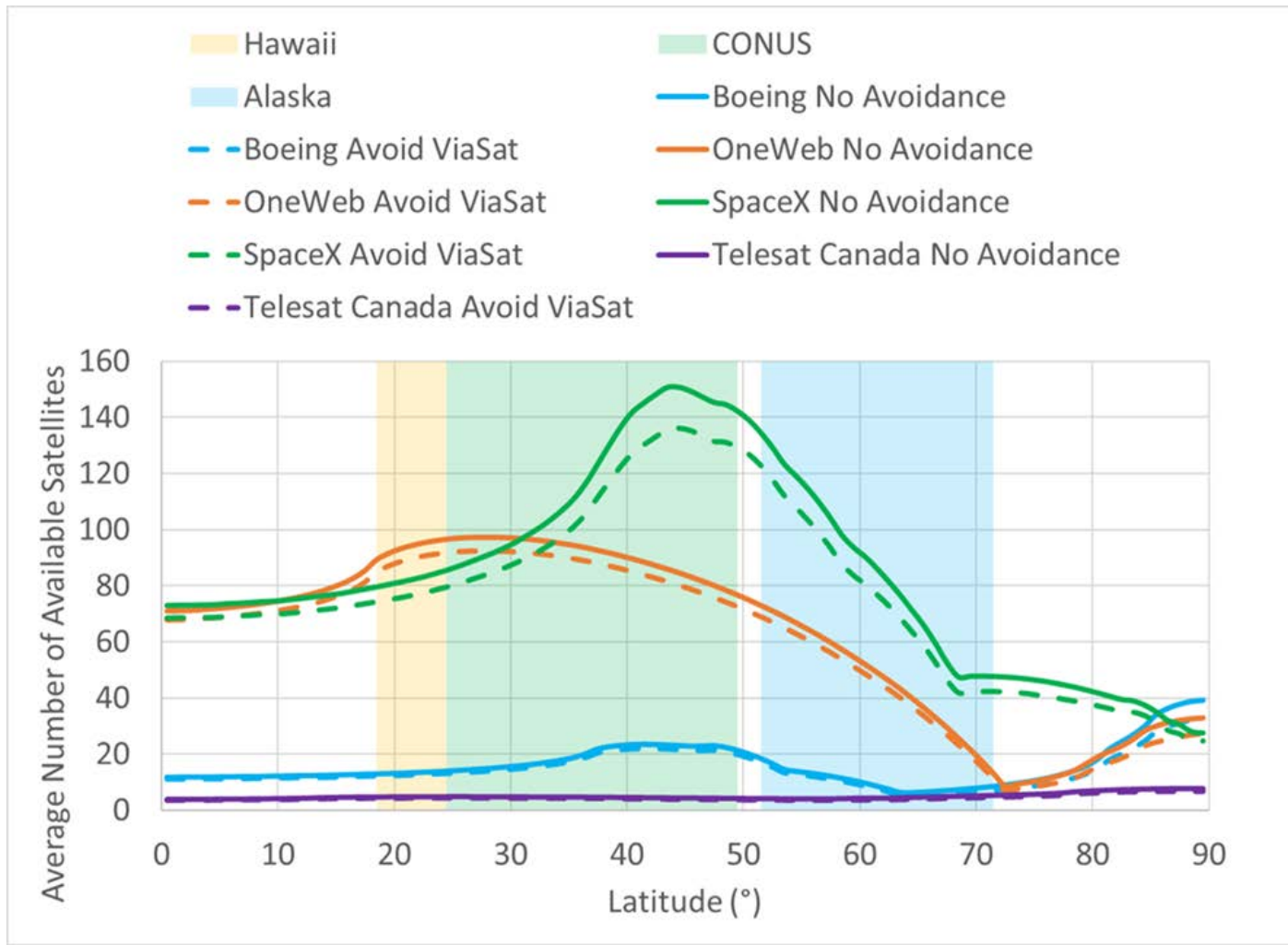
**Exhibit 2B**  
**Ka Band: Average Capacity Effect on Other NGSOs**  
**from Their Avoiding In-Line Events with ViaSat**  
**(By Latitude)**



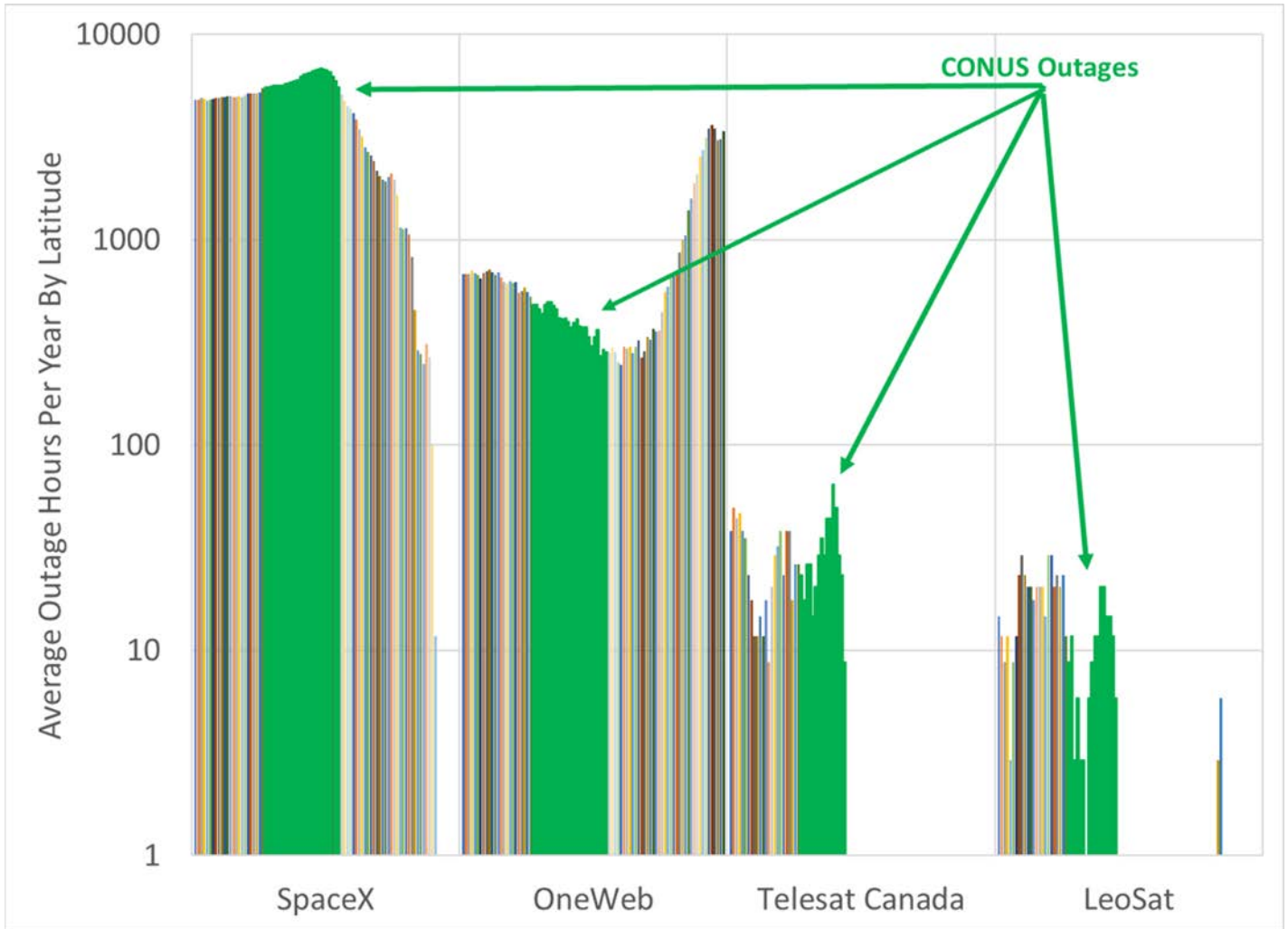
**Exhibit 2C**  
**V Band: Average Capacity Loss For ViaSat-NGSO**  
**from Its Avoiding In-Line Events with Other NGSOs**  
**(By Latitude)**



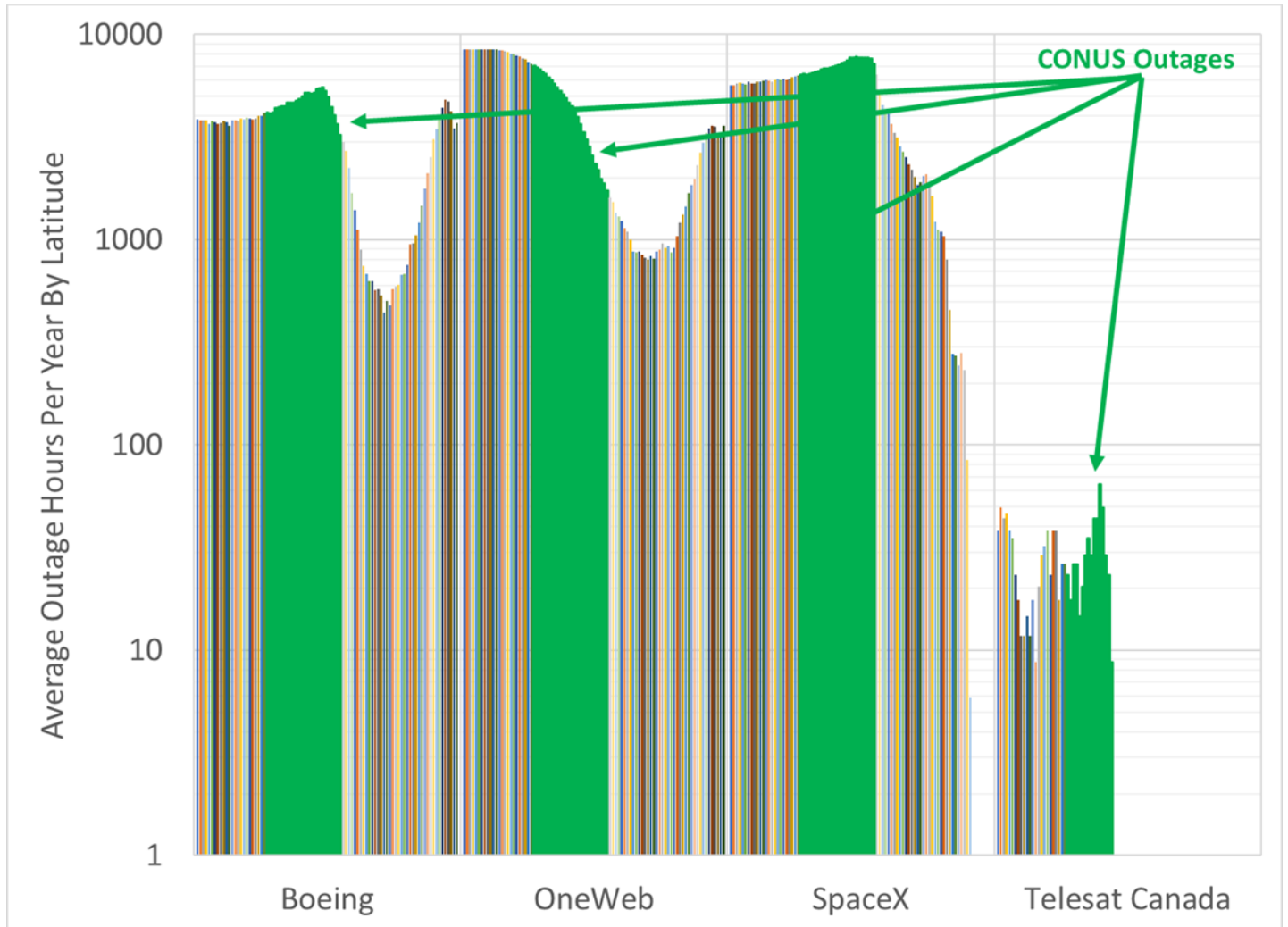
**Exhibit 2D**  
**V Band: Average Capacity Effect On Other NGSOs**  
**from Their Avoiding In-Line Events with ViaSat**  
**(By Latitude)**



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



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



A handwritten signature in blue ink that reads "Daryl T. Hunter". The signature is written over a horizontal line.

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April 10, 2017