

**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	)	

**PETITION FOR RECONSIDERATION OF VIASAT, INC.**

Pursuant to Section 1.429 of the Commission’s rules,<sup>1</sup> Viasat, Inc. seeks reconsideration of portions of the *Report and Order and Further Notice of Proposed Rulemaking* adopted by the Commission on September 26, 2017 in this proceeding (the “*NGSO Order*”).<sup>2</sup>

Viasat is a global communications company that believes everyone and everything in the world can be connected. Viasat currently provides satellite broadband services using a fleet of geostationary orbit (“GSO”) satellites, is expanding its existing capacity with additional GSO satellites featuring even more advanced technical capabilities, and is seeking authority to operate a non-geostationary orbit (“NGSO”) system using spectrum in the Ka and V bands. As such, Viasat has a pronounced interest in ensuring that the Commission’s rules facilitate the introduction of new NGSO systems and services while also ensuring that GSO networks are not adversely impacted by NGSO operations.

Viasat generally supports the Commission’s ongoing efforts to update the Ka-Band Plan and also develop rules and policies to govern the operation of new NGSO systems each containing hundreds or thousands of satellites. That said, Viasat also believes that certain specific aspects of the *NGSO Order* warrant reconsideration. These include: (i) the Commission’s decision to adopt EPFD limits that the Commission itself acknowledges are inadequate to protect existing and future GSO networks from harmful interference; (ii) the

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<sup>1</sup> 47 C.F.R. § 1.429.

<sup>2</sup> *Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, Report and Order and Further Notice of Proposed Rulemaking, 32 FCC Rcd 7809 (2017) (“*NGSO Order*”).

Commission’s perfunctory decision not to consider Viasat’s proposal to modify the Ka-Band Plan to provide for secondary FSS use of the 19.4-19.6 GHz and 29.1-29.25 GHz band segments, which are currently used to a limited extent by Iridium’s NGSO MSS feeder links; and (iii) the Commission’s failure to address whether and how applicants will be permitted to amend their pending NGSO applications to take advantage of rule changes effected by the *NGSO Order*. Viasat urges the Commission to reconsider these decisions, for the reasons set forth below.

**I. THE COMMISSION SHOULD RECONSIDER ITS DECISION TO ADOPT EPFD LIMITS THAT IT ACKNOWLEDGES ARE OUTDATED AND INCOMPLETE**

The *Notice of Proposed Rulemaking* in this proceeding (the “*NPRM*”) proposed to subject NGSO systems operating in the Ka band to the EPFD limits reflected in Article 22 of the ITU’s Radio Regulations.<sup>3</sup> In response, several parties (including Viasat) explained why those limits are *not* sufficient to protect modern GSO systems.<sup>4</sup> Among other things, the record reflects that: (i) the NGSO satellite technologies and network architectures that were prevalent nearly two decades ago, when the ITU’s EPFD limits were first developed, are no longer the norm today; (ii) the ITU EPFD limits adopted in 2000 assumed that the number of NGSO systems at issue would be small (3.5, to be precise)—a far cry from the eleven systems proposed in the Ka band and any other NGSO systems that may be proposed in the future; and (iii) the ITU has not specified any limits on *aggregate* EPFD in the uplink direction (EPFD<sub>UP</sub>), which could place GSO satellite receivers at particular risk from the simultaneous operation of multiple NGSO systems.<sup>5</sup>

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<sup>3</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, at ¶ 19 (2016) (“*NPRM*”).

<sup>4</sup> See, e.g., Comments of Viasat, Inc. at 12-18 (Feb. 27, 2017); Reply Comments of Viasat, Inc. at 6-20 (Apr. 10, 2017) (“Viasat Reply Comments”); Letter from EchoStar Satellite Operating Corporation and Hughes Network Systems, LLC to FCC, IB Docket No. 16-408, at 2-3 (Sept. 1, 2017); Letter from Intelsat License LLC to FCC, IB Docket No. 16-408, at 2-3 (Sept. 15, 2017); Letter from SES Americom, Inc. and O3b Limited to FCC, IB Docket No. 16-408 (June 8, 2017).

<sup>5</sup> *Id.*

Viasat also submitted significant technical analysis to quantify the risk of harmful interference to GSO networks—including an analysis showing the likely impact that uplink operations at the ITU’s EPFD<sub>UP</sub> limits would have on GSO satellites.<sup>6</sup> This analysis has become even more relevant with the passage of time; notably, the Commission’s recent practice in licensing NGSO systems has been to authorize operation at the EPFD limits specified in the Commission’s rules,<sup>7</sup> as opposed to requiring operations to be consistent with the maximum EPFD described in relevant applications<sup>8</sup>—which is often much lower.<sup>9</sup> Attached as Exhibit A is a paper that expands upon this analysis. The bottom-line conclusion is that even a single NGSO FSS system operating at the EPFD<sub>UP</sub> levels permitted by new Section 25.146(a)(2) has the potential to cause harmful interference into multiple GSO FSS networks, resulting in significant signal degradation and capacity losses for those GSO networks, while *multiple* NGSO FSS systems operating simultaneously pose an even greater risk to GSO FSS networks.

No party has challenged Viasat’s technical analysis. Moreover, the *NGSO Order* itself “recognize[s] that [the ITU] limits were not developed with the most advanced modern GSO networks in mind . . . .”<sup>10</sup> Yet, the *NGSO Order* makes no effort to update the ITU EPFD limits and proceeds to adopt the outdated and incomplete ITU Article 22 EPFD limits anyway. In other words, the *NGSO Order*: (i) acknowledges that the regulatory framework created by that order will leave GSO networks vulnerable to new NGSO operations, and (ii) does nothing to address

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<sup>6</sup> Viasat Reply Comments at 9-11.

<sup>7</sup> See, e.g., *WorldVu Satellites Limited*, 32 FCC Rcd 5366, ¶ 23.h (2017); *Telesat Canada*, 32 FCC Rcd 9663, ¶ 27.e (2017); *Space Norway AS*, 32 FCC Rcd 9649 ¶ 24.g (2017).

<sup>8</sup> See, e.g., Petition to Deny or Impose Conditions of Viasat, Inc., IBFS File Nos. SAT-LOA-20161115-00117, SAT-LOA-20161115-00109, SAT-LOA-20161115-00113, SAT-LOA-20161115-00112, SAT-MOD-20160624-00060, SAT-AMD-20161115-00116, SAT-LOA-20161115-00118, SAT-PDR-20161115-00111, SAT-PDR-20161115-00108, SAT-LOA-20161115-00121, at 6, Exhibit A (June 26, 2017) (identifying EPFD levels proposed in Ka-band NGSO applications in the processing round and noting the applied-for levels that were below the EPFD limits in Article 22).

<sup>9</sup> Exhibit B summarizes the proposed EPFD<sub>UP</sub> levels in the Ka band NGSO system applications.

<sup>10</sup> *NGSO Order* ¶ 35.

that vulnerability (notably, EPFD limits are the only mechanism in the *NGSO Order* that in any way protect GSO networks from NGSO operations).

This aspect of the *NGSO Order* simply is not sustainable, legally or otherwise. To the contrary, it is the very definition of “arbitrary and capricious” agency action that cannot be sustained under the Administrative Procedures Act (“APA”). Courts have made clear that an agency “must examine the relevant data and articulate a satisfactory explanation for its action including a ‘rational connection between the facts found and the choice made.’”<sup>11</sup> An agency decision that “entirely fail[s] to consider an important aspect of the problem” or “offers an explanation . . . that runs counter to the evidence before the agency” fails this test.<sup>12</sup>

Here, the Commission was presented with record evidence demonstrating that NGSO systems operating in accordance with the ITU’s EPFD<sub>UP</sub> limits could still pose a risk of harmful interference into GSO networks. The Commission acknowledged that risk. Yet, the Commission chose to ignore that risk in summary fashion without any convincing justification.

The “arbitrary and capricious” nature of such action is underscored by the Commission’s perfunctory “explanation.” The Commission asserts that relying on the ITU’s flawed EPFD limits is appropriate because: (i) *Viasat* has not proposed any new EPFD limits to the Commission; and (ii) “it would not be advisable to remain without Ka-band EPFD limits” after NGSO systems are licensed. These explanations do not withstand scrutiny.

The first explanation is inconsistent with the Communications Act, which charges the *Commission* with managing the use of the radiofrequency spectrum and adopting appropriate service and technical rules to minimize the potential for harmful interference.<sup>13</sup> The fact that *Viasat* has not proposed new EPFD limits does not absolve the Commission of its obligation to develop such limits (through a public process involving commercial satellite operators). Likewise, the failure of the *ITU* to adopt adequate EPFD<sub>UP</sub> limits is irrelevant—particularly

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<sup>11</sup> *Motor Vehicle Mfrs. Ass’n v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 43 (1983) (citing *Burlington Truck Lines v. United States*, 371 U.S. 156, 168 (1962)).

<sup>12</sup> *Id.*

<sup>13</sup> *See, e.g.*, 47 U.S.C. § 303(f).

given the fact that the ITU has not updated its limits in close to two decades. Indeed, even certain NGSO applicants publicly expressed surprise at the Commission’s abdication of responsibility in this respect:

The ability for NGSOs to interfere with GSOs, they have given us sort of a “hall pass” and said go ahead and work it out later. It is kind of interesting because they are supposed to protect the GSOs.<sup>14</sup>

In short, the Commission cannot sidestep its obligations under the Act by asserting that any other party has failed to act appropriately. It is the Commission that must bear primary responsibility for completing the important work necessary to update relevant EPFD<sub>UP</sub> limits or, at a minimum, facilitate a process that will lead to appropriate limits.<sup>15</sup>

The second explanation is similarly unavailing. The Commission provides no support for its conclusory statement that “it would not be advisable to remain without Ka-band EPFD limits” at this time. The Commission ignores the fact that *nothing* compels it to authorize NGSO systems if the only way to do so is under admittedly inadequate EPFD limits. Fortunately, that is not the only option; any number of alternatives would ensure the protection of GSO networks while allowing NGSO processing rounds to move forward—*e.g.*, authorizing NGSO systems subject to the outcome of a future rulemaking proceeding where suitable EPFD limits could be adopted or limiting NGSO systems to EPFD limits specified in their applications that provide an acceptable margin until suitable aggregate EPFD limits can be adopted. The Commission should consider such proposals on reconsideration, particularly because the applications in the current processing rounds are subject to the outcome of this proceeding.

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<sup>14</sup> Testimony of Greg Wyler, Founder and Executive Chairman, OneWeb, before the U.S. Senate Committee on Commerce, Science, and Transportation, October 26, 2017, *available at* <https://energycommerce.house.gov/news/press-release/subcommtech-members-introduce-first-round-broadband-infrastructure-bills/> (at 2:21).

<sup>15</sup> Notably, as part of the preparation for WRC-15, the U.S. State Department declined to support a U.S. proposal for a future agenda item at WRC-19 to restudy the ITU’s EPFD limits for the Ka band.

## **II. THE COMMISSION SHOULD RECONSIDER ITS DECISION NOT TO CHANGE THE KA-BAND PLAN WITH RESPECT TO THE 19.4-19.6 GHZ AND 29.1-29.25 GHZ BAND SEGMENTS**

The *NPRM* proposed to modify the Ka-Band Plan to facilitate more intensive use of spectrum in the Ka band. In its comments, Viasat generally supported the Commission's proposal while observing that it was under-inclusive. More specifically, Viasat noted that the *NPRM* did not specifically address additional band segments that have been underutilized—including, in particular, the 19.4-19.6 GHz and 29.1-29.25 GHz band segments currently used in limited respects by Iridium's NGSO MSS feeder links. Viasat proposed to further modify the Ka-Band Plan to facilitate use of these band segments by FSS systems in order to facilitate greater spectral efficiency, consistent with the Commission's stated policy objectives.

The *NGSO Order* does not address the substance of Viasat's proposal. Rather, the order simply states, in a single sentence included in a footnote, that the Commission agrees with Iridium's earlier assertion that the proposal "falls outside the present rulemaking."<sup>16</sup> But this conclusory statement is belied by the clear intent and specific language of the *NPRM*, which invites proposals such as that submitted by Viasat. Notably:

- (i) Paragraph 8 of the *NPRM* ("Proposal Overview") notes the Commission's intent to allow secondary FSS use of portions of the Ka band allocated for use by NGSO MSS feeder links in order to increase spectral efficiency. Elsewhere (in paragraph 7), the *NPRM* explicitly notes that the 19.4-19.6 GHz and 29.1-29.25 GHz band segments are allocated for NGSO MSS feeder links.<sup>17</sup>
- (ii) Paragraph 8 of the *NPRM* also notes the Commission's intent to "codify existing practices" so as to "formally enable the spectrum use proposed by NGSO FSS broadband constellations currently pending before the Commission." Among the "spectrum use proposed" by applicants is the use the 19.4-19.6 GHz and 29.1-29.25 GHz band segments for FSS.
- (iii) Paragraph 13 of the *NPRM* specifically proposes to allow FSS use of certain band segments that are allocated for NGSO MSS feeder links but underutilized for that purpose. Again, the *NPRM* elsewhere notes that the 19.4-19.6 GHz and 29.1-29.25 GHz band segments are allocated for NGSO MSS feeder links.

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<sup>16</sup> *NGSO Order* ¶ 18 n.40.

<sup>17</sup> See *NPRM* ¶ 7.

- (iv) Paragraph 17 of the *NPRM* asks whether there are “additional technical rules or other means by which we can facilitate additional sharing” in the bands to be used by NGSO systems. Viasat’s proposal is responsive to this request in that it would facilitate additional sharing and more intensive use of the 19.4-19.6 GHz and 29.1-29.25 GHz band segments.

In short, Viasat’s proposal is well within the scope of the *NPRM*.

The argument in Iridium’s reply comments—the only basis for the Commission’s contrary determination—is deeply flawed. Iridium ignores the language cited above and instead selectively focuses on the language in the *NPRM* expressing the Commission’s intent to “make available for FSS systems spectrum currently designated for, but never used by, NGSO MSS feeder links.”<sup>18</sup> But nothing in this isolated language precludes the Commission, within the scope of this rulemaking, from making *other* Ka-band spectrum available for FSS use, or considering proposals to do the same. And, contrary to Iridium’s assertion, nothing in the *NPRM* “declined to explore changes to the NGSO MSS feeder link spectrum that Iridium currently uses;”<sup>19</sup> the Commission simply did not include a specific proposal with respect to the 19.4-19.6 GHz and 29.1-29.25 GHz band segments in the *NPRM*.<sup>20</sup> At the same time, the *NPRM* solicited additional proposals—particularly ones for additional sharing of the Ka band—and made clear that the Commission had *not* limited the scope of the proceeding to just the proposals in the *NPRM* itself. For this reason, nothing in Viasat’s proposal “would conflict with the structure the Commission has proposed”—a conclusory claim Iridium made with no support.<sup>21</sup>

And while Iridium suggested that Viasat’s proposal is not a “logical outgrowth” of the *NPRM*, and therefore should not be considered in this proceeding, Iridium ignores that the

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<sup>18</sup> See Reply Comments of Iridium Satellite LLC at 3 (Apr. 10, 2017) (*citing NPRM* ¶ 8) (“Iridium Reply Comments”).

<sup>19</sup> *Id.* at 3.

<sup>20</sup> Iridium mischaracterizes the comments filed by Viasat. *Id.* at 3-4. Viasat has never conceded that its proposal is beyond the scope of the *NPRM*. Rather, Viasat has simply acknowledged that the *NPRM* does not specifically discuss potential FSS use of the 19.4-19.6 GHz and 29.1-29.35 GHz band segments. But that fact alone does not preclude consideration of Viasat’s proposal for the reasons set forth herein.

<sup>21</sup> Iridium Reply Comments at 4.

“logical outgrowth” test is chiefly concerned with ensuring that interested parties have “fair notice” of potential agency actions.<sup>22</sup> The “crux” of the test is simply whether a potential rule change is “reasonably foreseeable.”<sup>23</sup> The record makes clear that the *NPRM* provided Iridium and others with more than “fair notice” that proposals like Viasat’s could be entertained and adopted. And, tellingly, Iridium’s comments demonstrate that it was fully aware that rule changes had the potential to impact “Iridium operations” in the 19.4-19.6 GHz and 29.1-29.25 GHz band segments.<sup>24</sup> Iridium’s comments also expressly acknowledge that “multiple applicants in the Commission’s NGSO FSS processing round have proposed to make use of the [19.4-19.6 GHz and 29.1-29.25 GHz band segments]”—a recognition that Viasat’s proposal would “formally enable the spectrum use proposed by NGSO FSS broadband constellations currently pending before the Commission,” consistent with the intent of the *NPRM*. In short, Iridium’s own comments demonstrate that Viasat’s proposal was “reasonably foreseeable.”<sup>25</sup>

### **III. THE COMMISSION SHOULD EXPLICITLY CONFIRM THAT APPLICANTS IN PENDING PROCESSING ROUNDS WILL BE PERMITTED TO AMEND THEIR APPLICATIONS TO TAKE ADVANTAGE OF THE NGSO ORDER**

The Commission’s service and technical rules for NGSO systems have significant implications for the system design choices made by NGSO operators. By default, operators must design their systems to ensure compliance with those rules, and must forego non-compliant alternatives that may be preferable for other reasons. For example, Viasat designed its proposed

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<sup>22</sup> *Long Island Care at Home, Ltd. v. Coke*, 551 U.S. 158, 174 (2007).

<sup>23</sup> *Id.*

<sup>24</sup> Comments of Iridium Satellite LLC at 3 (Feb. 27, 2017) (“The proposal in the *NPRM* for the 19 GHz and 29 GHz Sub-bands, if adopted, will put additional strain on Iridium’s feeder link operations.”); *see also id.* (“And there is interest among GSO FSS licensees to seek rule changes that would permit them to operate earth stations in motion in the Iridium Feeder Link Bands.”).

<sup>25</sup> Iridium had a full and fair opportunity to address Viasat’s specific proposal on the merits but chose not to do so. Viasat’s comments were filed in February 2017. Iridium filed its reply comments in April 2017. The NGSO Order was not adopted until September 2017—more than six months after Viasat made its proposal and more than five months after Iridium refused to address Viasat’s proposal on its merits.



NGSO system to satisfy the global coverage requirement that was in effect prior to the adoption of the *NGSO Order*; any other approach would have risked dismissal of Viasat’s application from the processing round as non-compliant.<sup>26</sup> Absent that requirement, Viasat may have focused more capacity over particular regions or countries, like the United States, enhancing Viasat’s ability to provide innovative services to the public at a reduced cost to the end user.

The *NGSO Order* implements various changes designed to provide greater flexibility to NGSO operations, which Viasat welcomes. For example, the order eliminates the global coverage requirement in order to maximize the use of spectrum resources.<sup>27</sup> As a result, operators can now utilize system designs that previously were precluded by the global coverage requirement. However, the *NGSO Order* does not explicitly address how Viasat—and similarly situated operators—will be permitted to take advantage of this new flexibility. Among other things, it is unclear whether and to what extent Viasat could alter its proposed NGSO system in light of the *NGSO Order* without such changes being alleged by third parties to be a “major” amendment or otherwise outside the scope of the current processing round.<sup>28</sup>

In contrast, applicants that sought waivers of the certain pre-*NGSO Order* rules apparently will be able to enjoy the “flexibility” conferred by the *NGSO Order* without having to file any application amendment or post-authorization modification, or risk any related third-party challenges. This would be a perverse result, in that it would reward applicants that were unwilling or unable to comply with the Commission’s rules in the first instance, while disadvantaging applicants that complied with those rules in good faith, as they were required to do. This would create significant inequities before the Commission, in the market, and in the coordination negotiations that will inevitably flow from the pending processing rounds.

It would be far more equitable for the Commission to allow *all* applicants to amend their applications so as to take advantage of the new rules and eliminate waiver requests that are no

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<sup>26</sup> See 47 C.F.R. § 25.112.

<sup>27</sup> *NGSO Order* ¶ 35.

<sup>28</sup> See 47 C.F.R. § 25.116.

longer necessary. This approach would be consistent with Commission precedent.<sup>29</sup> The Commission should take similar action in this case and ensure that all applicants have an opportunity to amend their applications in light of rule changes in the *NGSO Order*.

#### IV. CONCLUSION

Viasat urges the Commission to reconsider the *NGSO Order*'s: (i) decision to adopt EPFD<sub>UP</sub> limits that the Commission acknowledges are inadequate to protect existing and future GSO networks from harmful interference; (ii) perfunctory refusal to consider Viasat's proposal to modify the Ka Band Plan to provide for secondary FSS use of the 19.4-19.6 GHz and 29.1-29.25 GHz band segments, which are currently used to a limited extent by Iridium's NGSO MSS feeder links; and (iii) failure to address whether and how applicants will be permitted to amend their pending NSGO applications to take advantage of rule changes effected by the *NGSO Order*. For the reasons discussed above, reconsideration would eliminate legal vulnerabilities inherent in the *NGSO Order* and more effectively serve the public interest, convenience, and necessity.

Respectfully submitted,

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<sup>29</sup> For example, in 2003 the Commission amended the substantive regulatory framework for satellite operations in the V band. *See 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*; Second Report and Order, 18 FCC Rcd 25428 (2003). Subsequently, the Commission issued a public notice directing applicants that had filed prior to the cut-off date to amend their applications in light of those rule changes. *See Public Notice, International Bureau Invites Applicants to Amend Pending V-Band Applications*, DA 04-235 (rel. Jan. 29, 2004).

## EXHIBIT A

### **The Commission's Ka-Band EPFD<sub>UP</sub> Limits Do Not Protect Ka-Band GSO FSS Networks**

This paper considers the impact of Ka-band NGSO FSS systems operating at the Commission's EPFD<sub>UP</sub> limit on co-frequency GSO FSS networks. The Commission's rules allow any of the recently licensed Ka-band NGSO FSS systems, and any of the pending systems once they receive licenses, to continually operate at the EPFD<sub>UP</sub> limit. It appears that even if their applications stated they would operate below the limit, their authorizations allow NGSO FSS systems to operate at the Commission's EPFD<sub>UP</sub> limit, without further Commission approval.

Impact is characterized by data rate reduction, the appropriate metric for modern Ka-band GSO networks. Today's two-way satellite connections mainly carry Internet traffic, so maintaining connections is more important than providing a constant bit rate. Adaptive coding and modulation (ACM) is used to combat link degradation resulting from aggregate EPFD<sub>UP</sub> by maintaining the connection, but with reduced throughput. This decrease in throughput results in decreased satellite beam capacity, EPFD<sub>UP</sub> impact is on a beam by beam basis.

The Commission's Report and Order<sup>1</sup> adopts the EPFD limits in Art. 22, Sec. II and Res 76, as follows:

*§25.146 Licensing and operating provisions for NGSO FSS space stations.*

*(a) An NGSO FSS applicant proposing to operate in the 10.7-30 GHz frequency range must certify that it will comply with:*

*...*

*(2) Any applicable equivalent power flux-density levels in Article 22, Section II, and Resolution 76 of the ITU Radio Regulations (both incorporated by reference, see §25.108).*

In accordance with §25.146(a)(2), the single entrant EPFD<sub>UP</sub> limits are as follows.

*22.5D 3) The equivalent power flux-density,  $epfd_{\uparrow}$ , produced at any point in the geostationary-satellite orbit by emissions from all the earth stations in a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Table 22-2, for all conditions and for all methods of modulation, shall not exceed the limits given in Table 22-2 for the specified percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions, into a reference antenna and in the reference bandwidth specified in Table 22-2, for all pointing directions towards the Earth's surface visible from any given location in the geostationary-satellite orbit. (WRC-2000)*

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<sup>1</sup> FCC 17-122.

TABLE 22-2 (WRC-03)

Limits to the  $epfd_{\uparrow}$  radiated by non-geostationary-satellite systems in the fixed-satellite service in certain frequency bands

Frequency band	$epfd_{\uparrow}$ (dB(W/m <sup>2</sup> ))	Percentage of time $epfd_{\uparrow}$ level may not be exceeded	Reference bandwidth (kHz)	Reference antenna beamwidth and reference radiation pattern
27.5-28.6 GHz	-162	100	40	1.55° Recommendation ITU-R S.672-4, $L_s = -10$
29.5-30 GHz	-162	100	40	1.55° Recommendation ITU-R S.672-4, $L_s = -10$

Unlike the  $EPFD_{DN}$  limits, the  $EPFD_{UP}$  limit is a single maximum value that NGSO FSS systems can operate at, but not exceed. Thus, operating a NGSO FSS system at this level of emission at all times and at all locations on the GSO arc would appear consistent with the Commission's rules and the terms of its authorization. As there is no aggregate  $EPFD_{UP}$  limit, all NGSO FSS systems can operate in this manner. Hence, the aggregate  $EPFD_{UP}$  at all times and at all locations on the GSO arc could be N times the single-entry limit, where N is the number of NGSO FSS systems operating in the band. Band splitting will not significantly reduce this impact, as  $EPFD_{UP}$  at the GSO arc results from sidelobe, not mainbeam, emissions. NGSO FSS systems implement GSO arc avoidance to meet  $EPFD_{UP}$  limits.

Several GSO FSS networks currently authorized, or pending authorization, by the Commission, could be significantly harmed by even a single NGSO FSS system operating in compliance with §25.146(a)(2). Applications for these high G/T<sup>2</sup> satellites were submitted to the Commission within the last 30 months. Competitive pressures will almost certainly result in future applications for two-way broadband Ka-band systems having similar, or even higher, G/T beams.

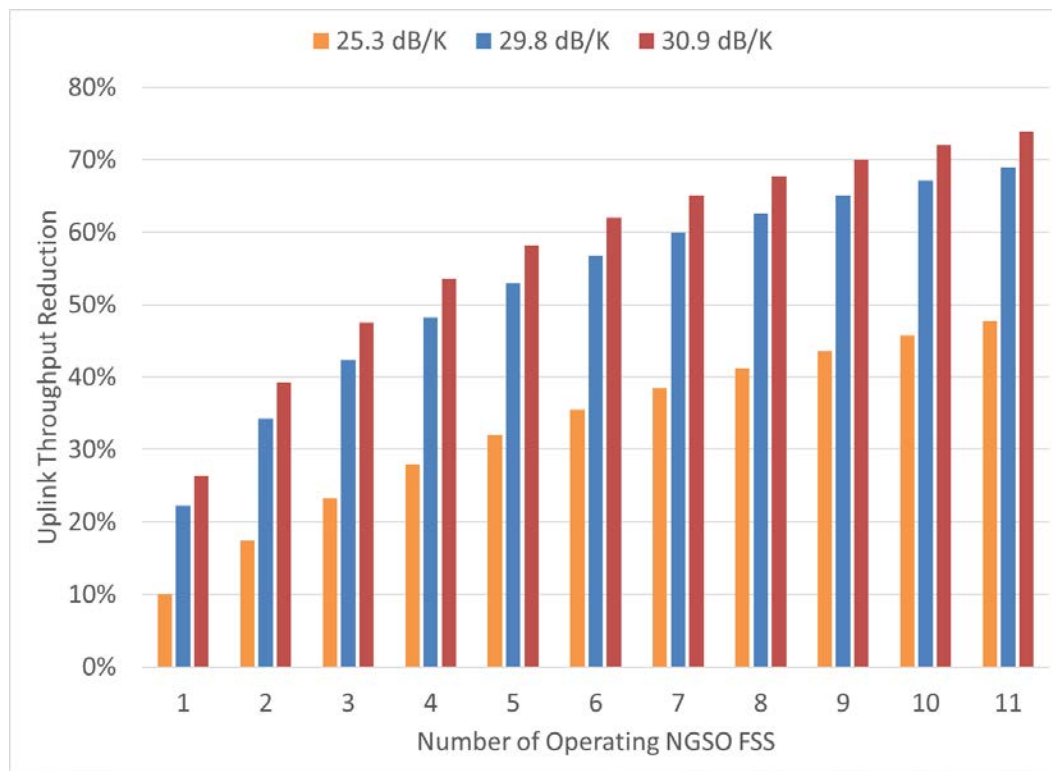
Table 1 shows the uplink degradation and associated uplink data rate reduction that these high G/T satellite beams could experience from a single NGSO FSS entrant operating at the  $EPFD_{UP}$  limit<sup>3</sup>. Figure 1 shows the uplink data rate reduction that these beams could experience as a function of the number of NGSO FSS systems operating in the band.

<sup>2</sup> Satellites with high G/T receive beams are more spectrally efficient, and thus are impacted more severely by interference from NGSO FSS systems' uplink emissions (aggregate  $EIRP_{UP}$ ).

<sup>3</sup> The Appendix provides technical analysis relating uplink degradation and uplink data rate reduction to  $EPFD_{UP}$ .

**Table 1 – Impact of Single Entry EPFD<sub>UP</sub> at §25.146(a)(2) Limit on Select Ka-Band GSO FSS Satellites Authorized, or Pending Authorization, by the Commission**

Application Date	Status	Ka-band G/T	Degradation <sup>4</sup>	Data Rate Reduction <sup>5</sup>
06/18/2015	Granted	30.9 dB/K	3.5 dB	26%
06/24/2016	Granted	25.3 dB/K	1.3 dB	10%
02/08/2016	Granted	30.9 dB/K	3.5 dB	26%
02/08/2016	Granted	30.9 dB/K	3.5 dB	26%
05/27/2016	Granted	30.9 dB/K	3.5 dB	26%
09/08/2017	Pending	29.8 dB/K	2.9 dB	22%



**Figure 1 – Impact of Aggregate EPFD<sub>UP</sub> From Multiple NGSO FSS Systems in the Band Operating at §25.146(a)(2) Limit<sup>6</sup>**

In addition to those authorized, or pending authorization, in the U.S., there are over 300 GSO FSS satellites with coordination (“C”) notices in the ITU-R Space Networks Systems (SNS) database with uplink beams operating in the 27.5 – 28.6 GHz and/or 29.5 – 30 GHz bands whose uplink beams would experience at least an 8% throughput reduction ( $G/T > 24$  dB/K) from a single NGSO FSS system operating at the EPFD<sub>UP</sub> limit. Two NGSO FSS systems operating in the band at the limit would result in at least a 14% throughput reduction, 3 systems at least a 19% reduction, and 11 systems at least a 42% reduction.

<sup>4</sup> Computed using Equations (3) and (4) from the Appendix.

<sup>5</sup> Computed using Equation (9) from the Appendix.

<sup>6</sup> Computed using Equations (3) and (6) from the Appendix.

Whether, and to what extent the §25.146(a)(2) single entrant EPFD<sub>UP</sub> limit would be met by any given NGSO FSS system with respect to a given GSO FSS satellite receive beam depends in large part on the actual operation of the NGSO FSS system, including the number, location, density, and antenna patterns of its transmit earth stations. Such parameters are not constrained by the terms of the Commission's grants following the processing round, and depend entirely on business plans and market circumstances, which are subject to change.

## Appendix – $epfd_{\uparrow}$ Technical Analysis

The  $epfd_{\uparrow}$  resulting from operation of a co-frequency NGSO FSS system is potential interference into a GSO FSS network uplink. The impact of this interference is characterized by the interference-spectral-density to thermal-noise-spectral-density ratio,  $I_0/N_0$ , which can be calculated as:

$$I_0/N_0 \text{ (dB)} = epfd_{\uparrow} \text{ (dBW/m}^2\text{)} - 10 \log_{10} B_R \text{ (Hz)} \\ + G/T \text{ (dBi/K)} - G_1 \text{ (dBi/m}^2\text{)} - k \text{ (dBW/(K} \cdot \text{Hz))} \quad (1)$$

Where  $epfd_{\uparrow}$  is effective PFD in the uplink direction (dBW/m<sup>2</sup>)

$B_R$  is the reference bandwidth associated with the  $epfd_{\uparrow}$  value (Hz)

$G/T$  is the GSO satellite receive beam  $G/T$  (dB/K)

$G_1$  is the ideal gain of a 1-meter squared area at the uplink frequency (dBi)

$$G_1 \text{ (dB)} = 10 \log_{10} \left[ \frac{4\pi \times F \text{ (Hz)}^2}{c \text{ (m/s)}^2} \right] \quad (2)$$

Where  $F$  is the uplink frequency (Hz)

$c$  is the speed of light, 299,792,458 m/s

$k$  is Boltzmann's constant, -228.6 dBW/(K×Hz).

Plugging in the 40-kHz reference bandwidth and using 28.72 GHz as the uplink frequency (< 0.2 dB error across the two bands), gives

$$I_0/N_0 \text{ (dB)} = epfd_{\uparrow} \text{ (dBW/m}^2\text{)} + G/T \text{ (dB/K)} + 132 \text{ dB} \quad (3)$$

The degradation experienced by a GSO FSS uplink is a function of the  $I_0/N_0$ . It can be calculated as:

$$\gamma \text{ (dB)} = 10 \log_{10} \left[ 1 + 10^{I_0/N_0 \text{ (dB)}/10} \right] \quad (4)$$

When there are multiple NGSO FSS systems operating in the band, the degradation is given by:

$$\gamma \text{ (dB)} = 10 \log_{10} \left[ 1 + 10^{\theta_1/10} + 10^{\theta_2/10} + \dots + 10^{\theta_N/10} \right] \quad (5)$$

Where  $N$  is the number of co-frequency NGSO networks operating in the band

$\theta_k$  is the  $I_0/N_0$  resulting from the  $k$ -th NGSO network's epfd (dB)

If the epfd from each of the NGSO networks results in the same  $I_0/N_0$ , then Equation (5) reduces to:

$$\gamma \text{ (dB)} = 10 \log_{10} \left[ 1 + N \times 10^{I_0/N_0 \text{ (dB)}/10} \right] \quad (6)$$

Today's two-way satellite connections mainly carry Internet traffic, so maintaining connections is more important than providing a constant bit rate. Thus, even small amounts of link degradation have significant impact on GSO network performance. Modern GSO networks utilize adaptive coding and modulation (ACM) to improve spectral efficiency and transmission performance.

ACM combats the link degradation resulting from aggregate epfd<sub>↑</sub> by maintaining the connection, but with reduced throughput. This decrease in throughput results in decreased satellite capacity. The impact of aggregate epfd<sub>↑</sub> degradation is related to decrease in satellite link capacity by the slope of the ACM modem operating curve. Modem performance has improved significantly over the last two decades and is expected to continue improving in the future. Today's state-of-the-art modems provide DVB-S2X class performance.

Future modem performance is bounded by the Shannon limit, which relates the maximum achievable spectral efficiency to the available carrier-to-noise ratio ( $C/N$ ) (in this context,  $N$  is the total noise in the link, including thermal and interference). The Shannon limit is:

$$\varepsilon(\text{bps/Hz}) = \log_2(1 + 10^{C/N \text{ (dB)}/10}) \quad (7)$$

Figure 2 shows the Shannon limit curve, the DVB-S2X modem MODCOD's, and the least squares 2<sup>nd</sup> degree polynomial fit to the MODCOD's.



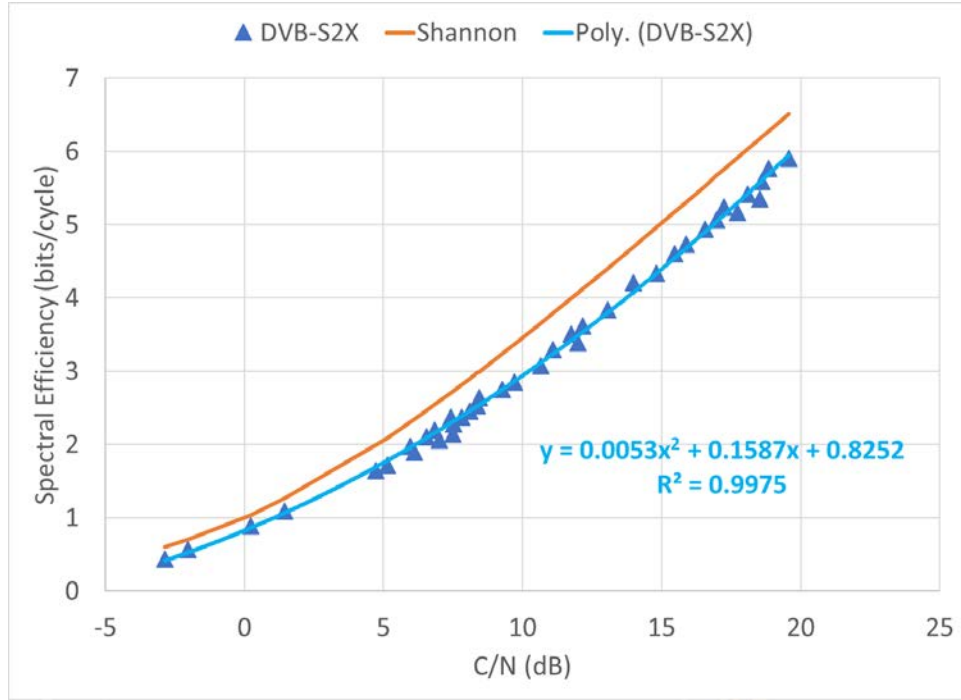


Figure 2 – Modem Operating Curve

The fit equation,

$$\varepsilon (bps/Hz) = 0.0053 \times (C/N)^2 + 0.1587 \times (C/N) + 0.8252 \quad (8)$$

Provides the DVB-S2X operating curve.

The ITU recently introduced the concept of “percent degraded throughput”, %DTp, as the appropriate metric for ACM links. The percent degraded throughput, %DTp, is given by

$$\%DTp(\rho, \gamma) = 100 \left[ 1 - \frac{\varepsilon(\rho - \gamma)}{\varepsilon(\rho)} \right] \quad (9)$$

Where

$\rho$  is the undegraded C/N

$\gamma$  is the degradation

$\varepsilon(x)$  is the spectral efficiency function.

## EXHIBIT B

### Specified EPFD<sub>UP</sub> Levels / Angular Isolation

Network	File Number	Cite	EPFD <sub>UP</sub> dB(W/(m <sup>2</sup> *40 kHz))	Isolation Angle
Audacy Corporation	SAT-LOA-20161115-00117	Response letter to FCC, at 4 (Apr. 3, 2017)	-188	**
Boeing	SAT-LOA-20161115-00109	Response letter to FCC, Attachment A at 3-9 (Apr. 11, 2017)	-162*	6° - 11°
Karousel LLC	SAT-LOA-20161115-00113	Response letter to FCC, Attachment 2, EPFD Supplement, at 19, 24 (Dec. 27, 2016)	-170.5	20°
LeoSat MA, Inc	SAT-PDR-20161115-00112	Application Technical Annex, at 26-27	-174.2	7°
O3b Limited	SAT-AMD-20161115-00116	Narr and Tech Annex, Attachment A, at 19	-163.7	7.6°
OneWeb	SAT-LOI-20160428-00041	Technical Narrative, Annex 2, at A2-4	-170.1	6°
Space Exploration Holdings, LLC	SAT-LOA-20161115-00118	Technical Attachment, at Annex 2-7, Annex 2-8	-163.3	22°
Space Norway	SAT-PDR-20161115-00111	Petition Decl. Ruling, Attachment A, at 49-51	-173.2	**
Telesat	SAT-PDR-20161115-00108	Telesat LOI, Appendix A at 19, 21	-162	11.9°
Theia Holding A, Inc.	SAT-LOA-20161115-00121	Technical Narrative, Appendix 1, at 82-84 of pdf	-187.7	**
Viasat, Inc.	SAT-PDR-20161115-00120	Attachment A, at 5-10	-162.0	3°

\* Boeing indicates it will reduce earth station power at smaller separation angles as required to comply with the EPFD limit.

\*\* Applicant did not specify an isolation angle.

## DECLARATION

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



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January 17, 2018