Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Viasat, Inc.	)	IBFS File Nos. SES-LIC-20170401-00357
	)	SES-LIC-20190411-00503
Operation of Earth Stations Aboard Aircraft	)	SES-MOD-20191216-01737
in the 18.8-19.3 GHz and 28.6-29.1 GHz	)	
Bands	)	

RESPONSE OF VIASAT, INC. TO SHOW CAUSE REQUEST

Viasat, Inc. ("Viasat") responds to the Request for Order to Show Cause filed by Space Exploration Holdings, LLC ("SpaceX") on September 18, 2020 in the above-referenced proceedings.[1] The Commission should summarily deny the Request.

Specifically, SpaceX's Request suffers from two fundamental flaws:

- First, SpaceX gets basic facts wrong about the licenses it discusses and ignores other dispositive information of which it is well aware, thus fatally undermining its claims.
- Second, SpaceX ignores that (i) Viasat *has* made the very technical showings that SpaceX claims are required and (ii) in June 2019 SpaceX had agreed to terms designed to ensure the compatibility of the Viasat GSO network and the SpaceX NGSO system.

Either of these flaws would be sufficient on its own to deny SpaceX's Request. Together, they compellingly demonstrate that SpaceX's Request is frivolous. Indeed, as shown in the motion to strike that Viasat is filing concurrently with this Response, SpaceX's failure to address information already known to it and otherwise perform even simple factual diligence before filing warrants summarily disposing of its Request as frivolous under Commission rules and policy. Moreover, it is apparent that SpaceX has interposed the Request (i) to seek the delay of matters currently pending before the Commission regarding these earth stations, and (ii) as retribution for Viasat's advocacy in

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[1] *See* Request for Order to Show Cause of Space Exploration Holdings, LLC, IBFS File Nos. SES-LIC-20170401-00357, SES-LIC-20190411-00503, and SES-MOD-20191216-01737 (filed Sep. 18, 2020) ("*SpaceX Request*").

a variety of unrelated Commission proceedings. In any event, in light of the factual record set forth below, the Commission should readily find that Viasat has satisfied the relevant conditions in the licenses at issue.

DISCUSSION

I. SPACEX'S REQUEST GETS BASIC FACTS WRONG AND IGNORES OTHER DISPOSITIVE INFORMATION OF WHICH IT IS WELL AWARE

SpaceX's Request is riddled with material factual misrepresentations and ignores other dispositive information of which it is well aware. Among other things, SpaceX's Request omits key information that is already on the record or that it already knows. The attached chronology (the "Chronology") summarizes the critical facts, including the demonstrations made by Viasat in connection with the licenses at issue, and Viasat's coordination history with SpaceX.

As noted in paragraph 9 of the Chronology, in June 2019, SpaceX agreed to terms that "will ensure mutual compatibility between the SpaceX non-geostationary satellite system and Viasat GSO satellite networks." These conditions apply to the 18.8-19.3 GHz and 28.6-29.1 GHz band segments, including the operation of all Viasat earth stations at issue here.

As to factual misstatements, most notably, SpaceX's assertion that Viasat has made no submission providing the technical showing contemplated in the conditions in Viasat's authorizations[2] ignores that (i) Viasat *has made three such submissions* (see paragraphs 2-3, 15-16, and 19 of the Chronology), (ii) SpaceX responded at the time as to two of those submissions (see paragraphs 2 and 15 of the Chronology), and (iii) Viasat again provided two of those submissions to SpaceX in the days before SpaceX filed its Request (see paragraphs 17 and 18 of the Chronology).

[2] *Id.* at 5.

SpaceX also erroneously lumps E170088 in with E190201 and E180006, and refers to all three as licenses for "Earth Stations Aboard Aircraft ('ESAAs')."[3] This mischaracterization by SpaceX is central to the core claim in its Request that "Viasat has continued to operate its ESAAs without satisfying" the conditions in these licenses.[4] And in making this claim, SpaceX repeatedly refers specifically to E170088 as an ESAA authorization.[5] Of course, as SpaceX is well aware, E170088 actually is a blanket authorization for *fixed* earth stations (see paragraphs 1-2 of the Chronology).[6] SpaceX's claims about Viasat's operation of ESAAs thus have no bearing whatsoever on E170088 or Viasat's satisfaction of the condition under that fixed earth station license.

SpaceX *knows* that these allegations in its Request are untrue—through SpaceX's participation in these proceedings over three years, its negotiations with Viasat, and its direct receipt of Viasat's technical demonstrations and other information throughout the relevant time period, including the day before SpaceX filed its Request. As the motion to strike filed concurrently with this response shows, these misrepresentations warrant striking SpaceX's Request and taking such

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[3] *Id.* at 1.

[4] *Id.* at 2.

[5] *See, e.g.*, *id.* (asserting that, "[b]eginning in 2017, Viasat sought authority to *operate ESAAs* in these bands," and that "[t]he first application was filed in April 2017," which is when the application for E170088 was filed (emphasis supplied)); *id.* at 3 (stating that "Viasat certified to the Commission that it had commenced operations under its *ESAA authorization* on the day it was issued – i.e., November 9, 2017," which is the authorization date for E170088 (emphasis supplied)); *id.* at 8 (referring erroneously to Viasat's "2017 ESAA authorization" and "2017 ESAA license").

[6] *See* Viasat, Inc., IBFS File No. SES-LIC-20170401-00357, Call Sign E170088, Grant (IB rel. Nov. 19, 2017); *see also* Viasat, Inc., IBFS File No. SES-LIC-20170401-00357, Narrative, at 1 (filed Apr. 1, 2017) (seeking "authority to deploy four million 0.75 m and ten thousand 1.8 m *fixed* earth stations" (emphasis supplied)); Opposition of Space Exploration Holdings, LLC, IBFS File No. SES-LIC-20170401-00357, at 1 (filed Dec. 26, 2017), attached hereto as Exhibit A-2 (describing E170088 as a "blanket license to deploy millions of *fixed* earth stations throughout the United States for communications in the 28.6-29.1 GHz band with two of Viasat's geostationary satellite orbit ('GSO') space stations" (emphasis supplied)).

other measures as the Commission deems appropriate. At the very least, these misrepresentations rob SpaceX of any credibility in its Request.

II. SPACEX'S CLAIMS ARE BASELESS

SpaceX fails to demonstrate that Viasat is violating any of the licenses at issue. As more fully detailed in paragraph 13 of the Chronology, condition 90257 in call signs E190201 and E180006 requires that, as a condition to operating, "[i]n the event another NGSO FSS system commences operation in the 18.8-19.3 and 28.6-29.1 GHz frequency bands," Viasat must either have "coordinated with the new NGSO system operator" or "demonstrate[] that such operation" of ESAAs "will not cause harmful interference to the new NGSO system."[7]

As detailed in paragraphs 4-11 of the Chronology, Viasat and SpaceX *had agreed* that the terms specified in June 2019 and included as Exhibit B "will ensure mutual compatibility between the SpaceX non-geostationary satellite system and Viasat GSO satellite networks."

Moreover, on May 18, 2020, Viasat made a demonstration with regard to E190201 and E180006 and SpaceX's system, as detailed in paragraphs 15-16 of the Chronology, and by means of the submission in Exhibit C. SpaceX also is flat wrong in claiming to hold some sort of veto right over the sufficiency of Viasat's demonstration under condition 90257,[8] particularly given SpaceX's agreement in June 2019. (See paragraphs 4-11 of the Chronology.)

Even if there were no such agreement, the Commission has stated unequivocally: "[I]n the event that NGSO FSS operators and GSO FSS operators do not reach an agreement on how protection of the NGSO system in the 18.8-19.3 GHz and 28.6-29.1 GHz bands will be achieved, . . .

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[7] Call Sign E190201, condition 90257; Call Sign E180006, condition 90257.

[8] *See SpaceX Request* at 5.

this question may be taken to the Commission."[9] Thus, not surprisingly, the Commission, and not SpaceX, has the final say in this scenario. The language SpaceX cites from a recent order states that a GSO system "is expected to show"—but not *required* to show—"to the NGSO system satisfaction, that it is capable of protecting the NGSO's operation."[10] Moreover, that order imposes on the NGSO operator a "burden . . . to examine the GSO showing in good faith to determine its acceptability."[11]

Under SpaceX's view of the world, an NGSO operator could deem a GSO operator's demonstration insufficient unilaterally, arbitrarily, and without Commission review, providing the NGSO operator free rein to do whatever it wanted and prevent the spectrum sharing that the Commission expects under its policy for GSO access to the 28.6-29.1 GHz and 18.8-19.3 GHz band segments: "GSO FSS networks should be given some access to this band, because doing so will increase spectrum use *and can be done compatibly with NGSO FSS operations*."[12]

Nevertheless, SpaceX would like a world in which it could block GSO operations on a whim and impede rival services. Or one in which SpaceX could employ a self-professed "iterative design" process that manifests itself in a never-ending series of NGSO system modifications, never settling on a baseline that enables the spectrum sharing provided for in the Commission's band plan. Or one in which SpaceX could use those serial changes to its system as the basis for reneging on sharing terms to which it agreed over 15 months ago, before it dreamed up the third significant Starlink

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[9] *See 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 ¶ 16 (2017) ("*2017 NGSO Order*").

[10] *See SpaceX Request* at 5 (quoting *Facilitating the Communications of Earth Stations in Motion with Non-Geostationary Orbit Space Stations*, 35 FCC Rcd 5137 ¶ 19 (2020) ("*2020 ESIM Order*")).

[11] *2020 ESIM Order* ¶ 19.

[12] *2017 NGSO Order* ¶ 14 (emphasis supplied).

system redesign that now is pending before the Commission.[13] Neither condition 90257 nor Commission policy grants SpaceX such power over competition or consumers.

SpaceX also fails to establish any violation of condition 90447 in call sign E170088. To begin with, as noted above, SpaceX's repeated claims regarding ESAA authorizations[14] have no bearing on call sign E170088, which is a blanket authorization for *fixed* earth stations. Moreover, with regard to condition 90447:

- In 2017 and 2018, Viasat submitted technical demonstrations to the Commission, serving SpaceX, and showing that its fixed earth stations' operations in the 18.8-19.3 GHz and 28.6-29.1 GHz band segments will not cause harmful interference to SpaceX—and the 2018 demonstration remains unrebutted. (See paragraphs 2-3 of the Chronology.)
- In June 2019, SpaceX and Viasat *reached agreement* as to terms that "will ensure mutual compatibility between the SpaceX non-geostationary satellite system and Viasat GSO satellite networks" including the GSO earth stations operated under those networks. (See paragraphs 4-11 of the Chronology.)
- In May 2020, Viasat submitted to the Commission, serving SpaceX, the technical means by which it would protect SpaceX operations in the 18.8-19.3 GHz and 28.6-29.1 GHz band segments. (See paragraphs 15-16 of the Chronology.)
- Viasat recently filed a license modification application with respect to E170088 and its satisfaction of condition 90447. (See paragraph 19 of the Chronology.)

Given these facts, which SpaceX conveniently omits, the Commission should find, *nunc pro tunc* if need be, that condition 90447 has been satisfied.[15]

Finally, SpaceX's references to other operators are misplaced.[16] As to call sign E170088, in 2017 Viasat made the showing included in Exhibit A-1 demonstrating that its fixed earth stations

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[13] *See* Space Exploration Holdings, LLC, IBFS File No. SAT-MOD-20200417-00037 (filed Apr. 17, 2020).

[14] *See SpaceX Request* at 5, 8.

[15] The primary case on which SpaceX's relies, *L3Harris*, has no bearing here. That case involved a licensee that: (i) deliberately operated in spectrum that had never been authorized by the Commission; (ii) disclosed as much to the Commission but then continued the unauthorized behavior; and (iii) entered into a voluntary consent decree. *See L3Harris Technologies, Inc.*, 34 FCC Rcd 12211 (EB 2019). In contrast, Viasat has been authorized to use the NGSO spectrum and has never conceded that any such use is or was unauthorized.

[16] *See SpaceX Request* at 4, 8.

would not cause harmful interference to O3b's system.[17] As to call signs E190201 and E180006, a condition (90531) specific to O3b's NGSO FSS system allows Viasat ESIM to operate without a coordination agreement so long as Viasat "maintain[s] a separation angle of 7.6 degrees for each ESAA from O3b's system."[18] As to Telesat, its launching of a single prototype satellite in 2018 plainly did not trigger the conditions discussed above[19] with respect to the "launch" of an "NGSO FSS satellite system" under condition 90447 in call sign E170088 or "commenc[ing] operation" of an NGSO FSS network under condition 90257 in call signs E190201 and E180006. Commission staff informally confirmed this understanding in discussions with Viasat personnel before that one satellite was launched.[20]

CONCLUSION

SpaceX's Request is riddled with material factual misrepresentations and ignores other dispositive information of which SpaceX is well aware—including Viasat's prior showings and what SpaceX agreed to during coordination. The Request is not just meritless; it is frivolous.

As a final note, it is both ironic and tone-deaf for SpaceX to make its Request when SpaceX itself faces mounting evidence that its own operations materially depart from its commitments to the

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17 *See* Exhibit A-1.

18 *See* Call Sign E190201, condition 90531; Call Sign E180006, condition 90531.

19 *See* Caleb Henry, *Telesat Preparing for Mid-2020 Constellation Manufacturer Selection*, Space News, May 1, 2020, https://spacenews.com/telesat-preparing-for-mid-2020-constellation-manufacturer-selection/ ("Telesat has only a single prototype satellite launched 28 months ago to demonstrate the low-latency broadband experience promised by LEO constellations."); Letter of Henry Goldberg, Counsel to Telesat, to Marlene H. Dortch, Secretary, FCC, IBFS File No. SAT-PDR-20161115-00108 (filed Feb. 25, 2020) (describing meeting with Commission staff in which Telesat described various *pre-operational* initiatives, including "the progress [it] has made with satellite, launch, and ground system vendors and the steps Telesat has taken to advance the financing of its system," "the evolution of Telesat's system design," and "lessons learned" from operating its prototype).

20 In any event, in 2017 Viasat made the showing included in Exhibit A-1 demonstrating that its fixed earth stations under would not cause harmful interference to Telesat's system.

Commission in licensing proceedings[21] and call into question the bases for its prior Commission authorizations.[22]

For the reasons provided in the accompanying Motion to Strike, the Commission should promptly strike, dismiss, or deny SpaceX's Request.

Respectfully submitted,

/s/
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[21] *See, e.g.*, Petition to Deny or Defer of Viasat, Inc., IBFS File No. SAT-MOD-20200417-00037, at 26-37 (filed July 13, 2020) ("*Viasat Petition re SpaceX Third Modification*"); Reply of Viasat, Inc. to Opposition of Space Exploration Holdings, LLC, IBFS File No. SAT-MOD-20200417-00037, at 15-21 (filed Aug. 7, 2020).

[22] *See, e.g.*, *Viasat Petition re SpaceX Third Modification* at 26-37.

CHRONOLOGY: E170088, E180006, AND E190201

1. The Commission granted the license for call sign E170088 on November 9, 2017.[1] That license is a blanket authorization for *fixed* earth stations[2] to communicate with GSO spacecraft. It is not a license for "Earth Stations Aboard Aircraft," as SpaceX wrongly claims.[3] Earth Stations Aboard Aircraft ("ESAA") can (and do) transmit signals while the aircraft to which they are affixed are in motion. The earth stations licensed under E170088 remain at fixed locations while transmitting and are not designed to transmit while in motion.

2. On December 11, 2017, Viasat submitted a petition for reconsideration with respect to condition 90447 in the E170088 license. Viasat included a detailed technical demonstration of how it would protect the NGSO FSS satellite systems referenced in that condition with respect to the 28.6-29.1 GHz and 18.8-19.3 GHz band segments and thereby comply with the terms of that condition. SpaceX responded to Viasat's analysis regarding those "fixed earth stations."[4] Viasat's reply included a further demonstration that corrected SpaceX's errors and that remains unrebutted. **Exhibits A-1, A-2, and A-3** contain the parties' submissions in that proceeding involving fixed earth stations, including Viasat's related technical demonstrations.

3. As detailed in Exhibits A-1 and A-3, Viasat's technical demonstrations (i) explain the results of a series of simulations, and (ii) demonstrate the absence of predicted harmful interference from the fixed earth station operations authorized by call sign E170088 into NGSO systems operating in the 28.6-29.1 GHz and 18.8-19.3 GHz band segments. Even without maintaining any angular separation, harmful uplink interference would not reasonably be expected to occur. Moreover, if the level of unwanted emissions resulting from the absence of angular separation were deemed to be "harmful," the separation angles for each NGSO system identified in Table 1 of Exhibit A-1 with respect to the GSO arc readily could be used as the trigger point for ceasing (and resuming) transmissions with respect to any such NGSO system when that system is operating in the 28.6-29.1 GHz and 18.8-19.3 GHz band segments at a separation angle greater than that identified in that Table 1. Any cessation of fixed earth station uplink operations in the 28.6-29.1 GHz band segment correspondingly would result in a cessation of downlink transmissions in the 18.8-19.3 GHz band segment.

4. In the meantime, Viasat and SpaceX pursued coordination of Viasat's GSO network and SpaceX's NGSO system. Notably, as of June 21, 2019, the terms being discussed between the parties and reflected in a draft coordination agreement included provisions that would not constrain Viasat's operation of its earth stations for its GSO networks, because **{{BEGIN CONFIDENTIAL}}**

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1 *See* Viasat, Inc., IBFS File No. SES-LIC-20170401-00357, Call Sign E170088, Grant (IB rel. Nov. 19, 2017).

2 *See id.*; *see also* Viasat, Inc., IBFS File No. SES-LIC-20170401-00357, Narrative, at 1 (filed Apr. 1, 2017) (seeking "authority to deploy four million 0.75 m and ten thousand 1.8 m *fixed* earth stations" (emphasis supplied)).

3 *See* Request for Order to Show Cause of Space Exploration Holdings, LLC, IBFS File Nos. SES-LIC-20170401-00357, SES-LIC-20190411-00503, and SES-MOD-20191216-01737, at 1 (filed Sep. 18, 2020).

4 Opposition of Space Exploration Holdings, LLC, IBFS File No. SES-LIC-20170401-00357, at 1 (filed Dec. 26, 2017), attached hereto as Exhibit A-2.

{{END CONFIDENTIAL}} in the 28.6-29.1 GHz and 18.8-19.3 GHz band segments. **{{BEGIN CONFIDENTIAL}}**

{{END CONFIDENTIAL}}

5. On June 21, 2019, **{{BEGIN CONFIDENTIAL}}**

{{END CONFIDENTIAL}}

6. On June 24, 2019, SpaceX responded as follows: "We have accepted your edits except for the sentence on ESIMs. We prefer to keep ESIMs out of this agreement. *Other than that we are good to sign*."

7. On June 25, 2019, when asked whether SpaceX had a "technical or operational" issue with ESIM that Viasat could address, SpaceX replied "I think the issue is that we would like not to conflate the on-going proceeding on ViaSat's earth stations at the FCC with this coordination agreement." SpaceX elaborated: "If ESIM operation is covered by our agreement to your UK networks, ***then there is no need to call them out explicitly, you are free to operate***. *What we don't want is our 9.12A agreement to be used against us in the on-going FCC ESIMs proceeding*." At that time, Viasat already had been operating ESIM (including ESAA) within the parameters of its ITU filings for years.

8. On June 26, 2019, Viasat reached out to SpaceX to express its willingness to discuss SpaceX's stated concerns with ongoing ESIM rulemaking proceedings at the FCC.

9. The terms agreed in June 2019 were designed to "ensure mutual compatibility between the SpaceX non-geostationary satellite system and Viasat GSO satellite networks." In the 28.6-29.1 GHz band, **{{BEGIN CONFIDENTIAL}}** **{{END CONFIDENTIAL}}** In the 18.8-19.3 GHz range, **{{BEGIN CONFIDENTIAL}}** **{{END CONFIDENTIAL}}**

10. Viasat's *fixed* earth stations authorized under call sign E170088, as well as its *ESAA* stations now licensed under E190201 and E180006, will operate within the parameters of the specified Viasat ITU network filings.

11. Thus, as of June 25, 2019, SpaceX and Viasat had reached agreement on terms for coordinating the operation of Viasat's *fixed* earth stations authorized under call sign E170088 as well as its *ESAA* stations now licensed under E190201 and E180006. **Exhibit B** contains

a record of this June 24-25, 2019 correspondence as well as the version of the coordination agreement attached to SpaceX's June 24, 2019 email.

12. Approximately two years after E170088 was granted and after Viasat made the submission described in paragraph 2 above, the Commission granted, or modified as to the 18.8-19.3 GHz and 28.6-29.1 GHz band segments, the two other Viasat licenses at issue, call signs E190201 and E180006 (on November 15, 2019 and November 25, 2019, respectively).[5] Unlike call sign E170088, these licenses are ESAA authorizations. Notably, *these licenses do not contain condition 90447, but rather contain a new and very different condition (90257).*

13. New condition 90257 in the ESAA licenses provides that (i) the authorized ESAAs "must be in compliance with the terms of coordination agreements with operators of [NGSO FSS] space stations operating in the 18.8-19.3 and 28.6-29.1 GHz band," and (ii) "[i]n the event that another NGSO FSS system commences operations in the 18.8-19.3 and 28.6-29.1 GHz frequency bands, ESAAs operating pursuant to this authorization must cease operation unless and until such operation has been coordinated with the new NGSO system operator or the ESAA licensee demonstrates that such operation will not cause harmful interference to the new NGSO system."[6]

14. Those two ESAA licenses *also* contain a new, specific, and different condition (90531) with respect to O3b's NGSO FSS system on which Viasat has relied as to that system: "Unless and until the licensee successfully completes coordination of its operations in the 18.8-19.3 GHz and 28.6-29.1 GHz bands with O3b Limited (O3b), the licensee must use its Network Management System to maintain a separation angle of 7.6 degrees for each ESAA from O3b's system."[7]

15. On May 18, 2020, in light on the uncertainty about when SpaceX may begin to provide service in the United States, Viasat made a submission to the Commission, serving SpaceX, and detailing how Viasat proposed to operate in order to protect SpaceX from harmful interference. Viasat requested that the Commission consider the *technical provisions* included in that submission as the means by which conditions 90447 and 90257 are satisfied with respect to, respectively, call sign E170088, and call signs E190201 and E180006. The key technical provisions specified are: **{{BEGIN CONFIDENTIAL}}**

{{END CONFIDENTIAL}} Viasat made clear that it was prepared to operate under those provisions "in order to ensure that Viasat protects

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[5] *See* Viasat, Inc., IBFS File No. SES-LIC-20190411-00503, Call Sign E190201, Grant (IB rel. Nov. 15, 2019); Viasat, Inc., IBFS File No. SES-MOD-20190212-00172, Call Sign E180006, Grant (IB rel. Nov. 25, 2019).

[6] Call Sign E190201, condition 90257; Call Sign E180006, condition 90257.

[7] Call Sign E190201, condition 90531; Call Sign E180006, condition 90531.

SpaceX from harmful interference." SpaceX responded on June 4, 2020. **Exhibit C** contains a copy of this Viasat submission.

16. Notably, the technical provisions specified in that May 18, 2020 submission include: (i) **{{BEGIN CONFIDENTIAL}}** **{{END CONFIDENTIAL}}** in the 28.6-29.1 GHz and 18.8-19.3 GHz band segments that SpaceX had proposed, and was willing to sign up to, a year earlier, (ii) the same commitment as before that Viasat GSO satellites and earth stations will operate **{{BEGIN CONFIDENTIAL}}** **{{END CONFIDENTIAL}}**

17. On September 9, 2020, Viasat provided SpaceX a copy of Exhibit C.

18. On September 17, 2020, **{{BEGIN CONFIDENTIAL}}** **{{END CONFIDENTIAL}}** Viasat provided SpaceX an aeronautical ESIM (i.e., ESAA) analysis, consisting of an overview of the results, as well as two large SIM files that SpaceX could run through Visualyse software. Viasat also provided copies of the fixed terminal analyses contained in Exhibits A-1 and A-3.

19. On September 18, 2020, Viasat submitted a license modification for call sign E170088, once again providing the Commission with the demonstrations discussed above with respect to that call sign, and explaining that the Commission should deem condition 90447 satisfied through these demonstrations. **Exhibit D** contains that modification filing.

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[8] **{{BEGIN CONFIDENTIAL}}** **{{END CONFIDENTIAL}}**

CERTIFICATE OF SERVICE

I, Kayla Ernst, hereby certify that on this 1st day of October, 2020, I caused to be served a true copy of the foregoing Response of Viasat, Inc. to Show Cause Request via first-class mail upon the following:

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/s/
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EXHIBIT A-1

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

In the Matter of	)	
Viasat, Inc.	)	IBFS File No. SES-LIC-20170401-00357
Application for Authority to Expand an Existing Earth Station Network	)	Call Sign E170088

PETITION FOR PARTIAL RECONSIDERATION OF VIASAT, INC.

Viasat, Inc. ("Viasat") respectfully requests partial reconsideration by the International Bureau of the authority granted to Viasat on November 9, 2017 in response to the above-captioned license application (the "Application"), which provided a blanket license to communicate with the Viasat-2 spacecraft over a number of earth stations across the Ka band (the "Licensed Operations"). Specifically, Viasat respectfully requests that the Bureau modify Condition 90447 to the grant of authority, which provides:

> [N]o later than sixty days before the scheduled initial launch of each NGSO FSS satellite system licensed or granted market access in the United States to operate in the 18.8-19.3 GHz and 28.6-29.1 GHz frequency bands, the licensee must either: (1) notify the Commission in writing when an agreement has been reached with the NGSO satellite system operator, or (2) seek and obtain the Commission's approval of a modification of this license including detailed technical demonstrations of how the licensee will protect the NGSO FSS satellite system. If neither condition is met, the licensee must cease earth station operations in the 18.8-19.3 GHz and 28.6-29.1 GHz frequency bands pursuant to this license until such time as compliance is demonstrated.

Notably, this new condition differs from the one previously imposed with respect to Viasat's use of the NGSO-primary band segments on Viasat-2, which specifies that Viasat-2 operations must

not cause harmful interference to, and must accept interference from, NGSO FSS systems operating in these band segments.[1]

Specifically, the new condition (90447) requires that, unless certain conditions otherwise are satisfied, Viasat cease operating its earth stations in the NGSO primary bands simply because of the upcoming scheduled launch of an NGSO satellite, and regardless whether harmful interference reasonably would be expected to occur from Viasat's operations after that NGSO satellite comes into service.

The basis for this new condition appears to be the submissions of O3b and SpaceX on the Application, including claims by SpaceX that uplink interference in the 28.6-29.1 GHz band segment could occur from the proposed GSO earth station operations into NGSO spacecraft in certain circumstances.[2] Viasat believes that it fully addressed these O3b and SpaceX submissions and demonstrated how Viasat's proposed operations would not reasonably cause harmful interference into NGSO operations in NGSO-primary band segments. Moreover, Viasat indicated that in the event of harmful interference into an NGSO system, it would cease uplink operations in the 28.6-29.1 GHz band segment, which correspondingly would result in a cessation of downlink transmissions in the 18.8-19.3 GHz band segment.[3]

In support of this Petition, and in an effort to obviate the need for the type of subsequent license modification applications contemplated by the new condition, Viasat provides the

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[1] *See* Viasat, Inc., File No. SAT-MOD-20160527-00053, Call Sign S2902, Attachment to Grant ¶¶ 3, 8 (granted Jan. 12, 2017) (authorizing U.S. market access using Viasat-2 at 69.9º W.L.).

[2] Petition to Defer of O3b Limited, File No. SES-LIC-20170401-00357 (filed June 2, 2017); Reply of O3b Limited, File No. SES-LIC-20170401-00357 (filed June 27, 2017); Comments of Space Exploration Holdings, LLC, File No. SES-LIC-20170401-00357; Reply of Space Exploration Holdings, LLC, File No. SES-LIC-20170401-00357 (filed June 26, 2017).

[3] Opposition and Response of Viasat, Inc., File No. SES-LIC-20170401-00357 (filed June 15, 2017).

enclosed technical analysis that (i) discusses the results of a series of simulations, and (ii) demonstrates the absence of predicted harmful uplink interference from the Licensed Operations into any of the NGSO systems that filed in the Ka band processing round for access to the NGSO primary spectrum. As that analysis explains, even without maintaining any angular separation, harmful uplink interference would not reasonably be expected to occur. Moreover, if the level of unwanted emissions resulting from the absence of angular separation is deemed to be "harmful," the separation angles for each NGSO system identified in Table 1 of that analysis readily could be used as the trigger point for ceasing (and resuming) uplink transmissions with respect to any such NGSO system in the NGSO primary spectrum.

This demonstration obviates the need for Condition 90447, and shows that it would be more than sufficient to impose once again the same type of condition that the Commission previously has applied, which generally requires that Viasat-2 operations not cause harmful interference into authorized NGSO uses of the NGSO-primary bands.[4]

Respectfully submitted,

/s/

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December 11, 2017

See Viasat, Inc., File No. SAT-MOD-20160527-00053, Call Sign S2902, Attachment to Grant ¶¶ 3, 8 (granted Jan. 12, 2017) (authorizing U.S. market access using Viasat-2 at 69.9º W.L.).

Exhibit 1

Viasat has conducted simulations using Visualyse software from Transfinite Systems, Ltd., on the filed characteristics of each of the various NGSO systems proposed or authorized in the NGSO application processing round covering the NGSO-primary portion of the Ka band, and the characteristics of the ViaSat-2 blanket license earth stations ("VS-2 Earth Stations") to determine the potential for causing harmful interference into those NGSO systems under various operating conditions. The simulation software produces, as one of its outputs, a Cumulative Distribution Function (CDF) with the I/N value given as a percentage of time. In the case of NGSO systems where links are not static and are constantly changing, I/N as a function of time is a more useful metric than a static snapshot of a single I/N value being exceeded or not. This analysis considers the resulting I/N when there is no angular separation between the ViaSat-2 network and the various NGSO systems. It also considers the results when different minimal angular separations are maintained. Consistent with the technical analyses provided during the application process, this analysis focuses on the uplink case.

O3b System

Currently, O3b operates an NGSO system with an equatorial orbit and has filed applications both to increase the number of satellites in the equatorial plane and to add two additional inclined planes with eight satellites each for a total of 60 operational satellites, and a subsequent amendment to reduce the total number of operational satellites to 42 – 32 satellites in a non-inclined orbital plane and 5 each in two 70 degree inclined orbital planes. Viasat evaluated both systems and found that the results were not markedly different for the two systems so only the results for the latest amendment are included here. To analyze the O3b system, the simulations were broken down into three scenarios. First, an examination of the

equatorial orbit only was performed. Second, an examination of the inclined orbits only, and finally, an examination considering both the equatorial and inclined orbits of the O3b system was performed.

In each of these cases, the scenarios were run assuming a 1% TDMA burst duty cycle representing a sustained heavy traffic upload condition for the VS-2 Earth Stations over the simulation period.

In the case of the equatorial only orbit, VS-2 Earth Station operations in CONUS and Puerto Rico will result in a minimum separation angle of approximately 10.4 degrees when an O3b satellite passes under the VS-2 satellite potentially communicating with an earth station located in Puerto Rico. The associated I/N was calculated as -30.9 dB by Visualyse, based on a scenario in which the VS-2 Earth Station is located in close proximity with an O3b gateway station such that the O3b satellite's beam center is pointed at the VS-2 Earth Station. As the VS-2 Earth Station and the O3b gateway are moved further north, the minimum separation angle between the O3b equatorial orbit satellite and VS-2 in GSO increases and the I/N continues to decrease. From this analysis, it is very clear that, just as in the case of ViaSat-1 earth stations authorized under Call Sign E100143, no reduction in EIRP density or inhibition of transmissions from VS-2 Earth Stations is needed to operate compatibly with the O3b equatorial orbit for any of the U.S. territories served by VS-2.

In the case of the O3b inclined orbital planes, several simulations were performed at various locations to determine the frequency and magnitude of in-line events. The simulation results produce a Cumulative Distribution Function (CDF) of I/N versus percentage of time. The worst-case alignment during the simulation period resulted in an I/N of 9 dB. Notably, the duration of the alignment that results in an I/N of 9 dB is very brief, only two seconds long, and

occurs only once during the 30 day simulation period. Lower I/N values occur more frequently according to the CDF but the aggregate time percentage for the aggregate of all in-line events within the 30 day simulation period when an I/N of -12.2 dB level is exceeded is very small—a total of only 22 seconds. In other words, for more than 99.999% of the time, the I/N would be less than -12.2 dB; conversely, the I/N would exceed -12.2 dB only 8.13×10^{-4}% of the time. These results are summarized in Table 1 below. Also shown in Table 1 below are values for when the separation angle from GSO is set to the value proposed by O3b in order to meet the Article 22 epfd limits. The difference between the two cases is 22 seconds per month.

SpaceX System

Due to the density of the SpaceX constellation and the larger number of identical inclined orbital planes, it was not necessary to propagate the orbits over a 30-day period to develop reliable statistics for I/N values, so a 24 hour period was used instead. Multiple tracking strategies were evaluated for the SpaceX simulation, including scenarios in which the SpaceX earth station is communicating with a satellite in the constellation that (i) is the nearest, (ii) has the highest elevation, (iii) has the longest hold time, and (iv) avoids the GSO arc by 22 degrees, which is what SpaceX proposes in its application in order to meet the Article 22 epfd limits in band segments where those limits apply. In no case was a -12.2 dB I/N exceeded in any of the scenarios. These results are summarized in Table 1 below.

SpaceX in their June 26, 2017 reply comment presented calculations for a 10 degree separation angle. However, in practice when implemented in the Visualyse simulation software, such an alignment does not occur during the simulation of the network's operation. At all times in Visualyse, each of the selected tracking strategies resulted in very large separations from GSO. In fact, this seems consistent with SpaceX's application and public statements regarding

user terminals which will employ flat-panel antennas “roughly the size of a laptop” and which will use phased-array technology to track the satellites. Optimal scanning angles for phased-array terminals would suggest that higher elevations well-removed from the GSO orbit in most cases would be used in order to minimize scan losses and maximize link performance. Notably, SpaceX did not include an actual orbital simulation showing that the smaller separation angle of 10 degrees actually would be used. Additionally as explained in Exhibit 1 of Viasat’s Opposition and Response filed on June 15, 2017, SpaceX used the operational EIRP densities of Viasat’s earth stations that would typically be employed only during faded conditions, not clear sky, thus SpaceX incorrectly uses unrealistically high power densities for the VS-2 Earth Stations in their calculations. Accordingly, the Visualyse results here represent a more realistic operating scenario.

Additional NGSO Systems and Combined Results

In addition to the O3b and SpaceX systems, Viasat also evaluated seven other NGSO systems in the Ka band NGSO processing round with plans to operate in the NGSO-primary spectrum. Because Audacy and Kepler have not proposed systems operating in the 28.6-29.1 GHz band, they were not evaluated. Also, results were not evaluated for OneWeb as coordination has already been completed between Viasat and OneWeb for that system.

Table 1 below shows the results of the simulations for each system. A reference I/N of -12.2 dB is used for illustrative purposes to demonstrate the level and frequency of unwanted energy emitted toward the NGSO satellite in the circumstances described. That reference I/N is not intended as a threshold for when harmful interference would occur.

Table 1: I/N Results for VS-2 Earth Stations into NGSO Systems

System	Operator Separation Angle (deg)	Simulation Separation Angle (deg)	Tracking Strategy	I/N Exceeded	% Time	% of time meeting -12.2 dB	Worst I/N (dB)	Total Exceeded (s) / month	Longest Event (s)
Audacy		N/A	No links in "NGSO" band						
Boeing	6	N/A	Nearest	No	0	100.000	-15.69	0	0
Karousel	20	N/A	Nearest	No	0	100.000	-44.34	0	0
Leosat		N/A	Nearest	Yes	0.013872	99.986	23.76	360	4
Leosat	7	7	Avoid GSO	Yes	0.000055	100.000	-11.79	2	1
O3b Equatorial Only		N/A	Nearest	No	0	100.000	-30.9	0	0
O3b		N/A	Nearest	Yes	0.000813	99.999	9.09	22	2
O3b	7.6	7.6	Avoid GSO	No	0	100.000	-27.67	0	0
OneWeb		N/A	Not examined due to coordination already completed						
SpaceX		N/A	Nearest	No	0	100.000	-16.21	0	0
SpaceX	22	22	Avoid GSO	No	0	100.000	-18.97	0	0
Space Norway		N/A	No links in "NGSO" band in VS-2 coverage area						
Telesat		N/A	Nearest	Yes	0.006164	99.994	20.64	160	3
Telesat	11.9	11.9	Avoid GSO	No	0.000000	100.000	-19.57	0	0
Theia Holdings		N/A	Nearest	Yes	0.002057	99.998	19.47	22	2
Theia Holdings	10	10	Avoid GSO	No	0	100.000	-14.43	0	0

The results in Table 1 are provided for each system for several different separation angles. For each system, the results are provided for using a tracking strategy with no GSO avoidance and a separation angle of 0 degrees input into the tracking strategy, as well as for other values for minimum separation angle from GSO if an exceedance of the -12.2 dB I/N value was observed for 0 degrees separation angle. For example, in the case of Leosat, in-line events could occur resulting in an I/N exceeding -12.2 dB for a brief period (i.e., up to 4 seconds). Increasing the separation angle to the 7 degrees, which is the angular separation at which Leosat proposes to operate in the bands where Article 22 epfd limits apply results in -12.2 dB I/N essentially all of the time. In the case of Boeing, Karousel, Telesat, and Theia Holdings, the same holds true, with operation at the GSO angular separation each operator proposes to employ for similar reasons resulting in the -12.2 dB I/N never being exceeded.

In the case of Boeing and Karousel, adding a separation angle in Visualyse over choosing a tracking strategy such as nearest or highest, or longest hold time, had no real effect in that the -12.2 dB I/N is met at all times for those systems.

The orbits of each of these NGSO systems are readily predicted using long-proven orbital propagation routines, and the orbital element data for the orbits available from sources such as Space Track, a U.S. government resource, or from the NGSO operators themselves. The orbital separation from the NGSO satellites and VS-2 can be easily determined. We do not believe that VS-2 Earth Station operations would result in harmful interference in NGSO-primary band segments under any circumstances, but the shut-off capabilities Viasat has previously described will in any event protect NGSO systems from harmful interference from VS-2 Earth Stations. Specifically, the VS-2 satellite has been designed with the capability to cease operations in the 28.6-29.1 GHz uplink band (and in the associated 18.8-19.3 GHz downlink band) on a beam by beam basis in any spot beams where the predicted physical alignment of either (i) an NGSO space station and an earth station communicating with the VS-2 satellite, or (ii) the VS-2 satellite and an earth station communicating with an NGSO space station, occurs, such that the angular separation between operational links of the two satellite networks would be equal to or less than a specified minimum line-of-sight separation angle. In addition, as all earth stations in the VS-2 network operate under control of a Network Management System (NMS) that coordinates the real-time operations of the TDMA scheduler for each beam on the satellite, cease transmission commands can be sent to individual earth stations for the duration of the brief period when the separation angle falls below the specified minimum as calculated by the NMS using data from Space Track or the NGSO operators.

DECLARATION

I hereby declare that I am the technically qualified person responsible for preparation of the engineering information contained in this Petition for Partial 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.

Daryl T. Hunter, P.E.
Chief Technology Officer, Regulatory Affairs
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December 11, 2017

CERTIFICATE OF SERVICE

I, Kayla Ernst, hereby certify that on this 11th day of December, 2017, I served a true copy of the foregoing Petition for Partial Reconsideration of Viasat, Inc. via first-class mail upon the following:

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/s/
Kayla K. Ernst

EXHIBIT A-2

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
VIASAT, INC.	)	Call Sign: E170088
Application for Blanket Earth Station License Using Ka-band Spectrum	)	IBFS File No. SES-LIC-20170401-00357

OPPOSITION OF SPACE EXPLORATION HOLDINGS, LLC

Space Exploration Holdings, LLC ("SpaceX") hereby opposes the Petition for Partial Reconsideration filed by Viasat, Inc. ("Viasat").[1] Viasat requests that the Commission modify a condition imposed in its blanket license to deploy millions of fixed earth stations throughout the United States for communications in the 28.6-29.1 GHz band with two of Viasat's geostationary satellite orbit ("GSO") space stations.[2] That condition was imposed in response to concerns raised by non-geostationary satellite orbit ("NGSO") system operators (including SpaceX) about Viasat's GSO use of the band, which the Commission has designated specifically for primary use by uplinks for NGSO systems. Viasat seeks to remove the requirements to either coordinate with NGSO systems in the band, submit a detailed technical analysis demonstrating how NGSO systems would be protected, or cease operations in the band. For the reasons discussed below, the Commission should find that Viasat has failed to provide the detailed technical

[1] *See* Petition for Partial Reconsideration of Viasat, Inc., IBFS File No. SES-LIC-20170401-00357 (Dec. 11, 2017) ("Viasat Petition").

[2] *See* Radio Station Authorization, Call Sign E170088 (Nov. 9, 2017) ("Viasat Blanket License").

demonstration necessary to confirm that its earth station operations would protect NGSO systems in this band, and therefore deny Viasat's request to modify the condition.

1. Background

Viasat has been licensed to deploy up to four million 0.75 meter and ten thousand 1.8 meter earth stations across the United States. These earth stations will operate in several bands, including the 18.8-19.3 GHz downlink and 28.6-29.1 GHz uplink bands that have been designated by the Commission for primary use by NGSO systems. Under the Commission's rules, any GSO system operating in these bands must do so on a non-interference, non-protected basis.[3]

Both SpaceX and O3b Limited ("O3b") raised concerns in response to Viasat's blanket license application in the NGSO uplink band.[4] SpaceX provided an initial analysis of two interference scenarios, illustrating the effect on SpaceX's proposed NGSO system assuming angular separation of 10, 20, and 30 degrees from a Viasat earth station uplink transmission. While the results varied depending upon the scenario and the earth station considered, the calculated $\Delta T/T$ impact ranged from 15% to 452% at 20 degrees and from 6% to 164% at 30 degrees.[5] Subsequently, after reviewing these calculations further, SpaceX has discovered that these interference calculations actually *understate* the potential interference impact by 10 dB, such that the $\Delta T/T$ would actually be *ten times worse*. The initial assessment was based on earth station EIRPs in 40 kHz bandwidth, when the actual EIRPs proposed by ViaSat were in 4 kHz. After adjusting

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[3] *Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, 32 FCC Rcd. 7809, ¶ 14 (2017) ("*NGSO Update Order*").

[4] *See, e.g.,* Reply of Space Exploration Holdings, LLC, File No. SES-LIC-20170401-00357 (June 26, 2017) ("SpaceX Reply"); Petition to Defer of O3b Limited, File No. SES-LIC-20170401-00357 (June 2, 2017).

[5] *See* SpaceX Reply at 3-6.

for that updated assumption, all of these values reveal a far more significant interference effect than the 6% ΔT/T standard for non-interference previously claimed by ViaSat.[6] Given the large potential impact on NGSO operations, both SpaceX and O3b requested that the Commission deny or defer licensing until Viasat demonstrated that its operations would adequately protect NGSO operations in the NGSO-primary band.

In apparent response to this concern, the Commission imposed Condition 90447 on the Viasat Blanket License, which provides in pertinent part:

> [N]o later than sixty days before the scheduled initial launch of each NGSO FSS satellite system licensed or granted market access in the United States to operate in the 18.8-19.3 GHz and 28.6-29.1 GHz frequency bands, the licensee must either: (1) notify the Commission in writing when an agreement has been reached with the NGSO satellite system operator, or (2) seek and obtain the Commission's approval of a modification of this license including detailed technical demonstrations of how the licensee will protect the NGSO FSS satellite system. If neither condition is met, the licensee must cease earth station operations in the 18.8-19.3 GHz and 28.6-29.1 GHz frequency bands pursuant to this license until such time as compliance is demonstrated.

This condition clearly anticipates that Viasat would attempt to reach coordination agreements with affected NGSO system operators, which presumably could be easily achieved if there is truly no potential for harmful interference. Indeed, Viasat reports that it has already completed coordination with one proposed NGSO system, OneWeb.[7] For some reason, Viasat has abandoned this path of seeking additional coordination agreements with the many other NGSO operators and proposed systems, and instead has

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[6] *See, e.g.,* ViaSat-1 Application, IBFS File No. SAT-AMD-20080623-00131, Narrative at 7 (June 23, 2008) (citing *contactMEO Communications, LLC*, 21 FCC Rcd. 4035, ¶ 33 (IB 2006)). *See also Northrop Grumman Space & Mission Systems Corp.*, 24 FCC Rcd. 2330, ¶ 86 (IB 2009) (concluding that the proposed GSO system would not cause harmful interference to NGSO systems where impact was less than 6% ΔT/T).

[7] *See* Viasat Petition, Exhibit 1 at 4.

filed its Petition "in an effort to obviate the need for the type of subsequent license modification applications contemplated by the new condition."[8]

While Viasat has submitted what it describes as a technical analysis, which "discusses the results of a series of simulations," this information falls far short of the detail needed to successfully demonstrate that operations under the Viasat Blanket License would not result in harmful uplink interference into any of the Ka-band NGSO systems involved in the current processing round.[9] The "analysis" provided offers only a very high level description of the type of simulation used and a tabular presentation of the results. In that presentation, Viasat uses -12.2 dB I/N as a reference "for illustrative purposes," but concedes that it "is not intended as a threshold for when harmful interference would occur."[10] Nonetheless, based on this illustrative information, Viasat "do[es] not believe that VS-2 Earth Station operations would result in harmful interference in NGSO-primary band segments under any circumstances."[11] It therefore requests that the Commission delete Condition 90447, and replace it with a simple non-interference requirement.[12]

2. Discussion

The efficacy of Viasat's Petition depends upon the validity of the simulation that leads to its conclusion that the authorized earth stations will not cause harmful interference to NGSO systems. Any simulation is only as good at the model and the assumptions used to set it up. Viasat has not provided the details of its analysis at a level

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8 Viasat Petition at 2.

9 *See id.* at 2-3 and Exhibit 1.

10 *Id.*, Exhibit 1 at 4.

11 *Id.* at 6.

12 *See* Viasat Petition at 3.

that would enable the Commission and other interested parties not only to reproduce the results, but also to evaluate the reasonableness of the assumptions made and the soundness of the model employed in order to determine the validity of those results. For example, Viasat does not disclose:

- how many Viasat and NGSO earth stations are used in the simulation;
- how its model assumes those earth stations are arranged geographically;
- the uplink EIRP assumed in the simulation for the Viasat earth stations;[13] and
- whether the analysis uses Viasat's 0.75 meter antennas, its 1.8 meter antennas, or a mixture of the two (and if so, in what proportions).

In addition, the analysis appears to refer only to earth stations communicating with the ViaSat-2 satellite,[14] but Viasat's authorization includes transmissions in the relevant bands with ViaSat-1 as well – and it is not clear that this was considered. Without such key inputs to Viasat's simulation, it is not possible to evaluate the results.

By comparison, SpaceX has provided complete information in support of the analysis previously presented in this proceeding. Viasat criticizes that analysis because it included a 10 degree separation angle, even though SpaceX has announced its intention to observe a 22-degree separation from the GSO arc.[15] Yet Viasat failed to recognize the additional examples that SpaceX presented of the proposed earth stations' impact at

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[13] Viasat asserts that the EIRP levels requested in its application and included in its authorization, which SpaceX used in its earlier evaluation in this proceeding, "would typically be employed" only during faded conditions (*see* Viasat Petition, Exhibit 1 at 4), yet it has never provided the EIRP value anticipated for its operations in clear sky conditions. Nothing in the Viasat Blanket License indicates or requires different EIRP limits during clear sky conditions.

[14] *See, e.g.,* Viasat Petition, Exhibit 1 at 1 (referring to simulations based on "the characteristics of the ViaSat-2 blanket license earth stations") and 6 (discussing the "orbital separation from the NGSO satellites and VS-2").

[15] *See id.* at 3.

separation angles as large as 30 degrees – which still show significant interference risk. Viasat has not explained why those calculations are not valid or applicable.

ViaSat also faults SpaceX's analysis for not including an orbital simulation. But such simulation details are largely beside the point when the results clearly indicate a serious interference risk at an angular separation of 30 degrees, which is certain to occur regardless of the details of any orbital simulation. Indeed, the fact that Viasat's model apparently concludes that such interference will *not* happen – and therefore fails to identify this significant interference risk – is sufficient reason to doubt the results of that simulation. Because Viasat failed to provide complete information on the assumptions and methodology underlying its simulation, there is no way to determine the reason for this failure. Until that information is provided, the Commission cannot rely on the described (but not substantiated) results of Viasat's analysis.

3. Conclusion

The Commission has only designated one uplink and one downlink band (18.8-19.3 GHz and 28.6-29.1 GHz) for use by NGSO FSS systems on a primary basis. As it recently confirmed, "preserving the 18.8-19.3 GHz and 28.6-29.1 GHz bands for more intensive use by burgeoning NGSO FSS systems will serve the public interest."[16] If the Commission were to allow GSO systems to compromise that spectrum without regard to the interference impact on NGSO operations, the Commission would put at risk a new generation of high-capacity, low-latency satellite broadband services. Although Viasat has described the results of a simulation, it has failed to provide a "detailed technical demonstration" of how its earth stations would protect NGSO satellite systems from harmful interference. Accordingly, the Commission should maintain the modest

[16] *NGSO Update Order*, ¶ 14.

condition that requires ViaSat to either complete coordination with NGSO systems or demonstrate with a detailed technical showing that it can operate on a non-interference basis with NGSO systems in the NGSO-primary bands.

Respectfully submitted,

SPACE EXPLORATION HOLDINGS, LLC

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Counsel to SpaceX

December 26, 2017

ENGINEERING CERTIFICATION

The undersigned hereby certifies to the Federal Communications Commission as follows:

(i) I am the technically qualified person responsible for the engineering information contained in the foregoing Opposition,

(ii) I am familiar with Part 25 of the Commission's Rules, and

(iii) I have either prepared or reviewed the engineering information contained in the foregoing Opposition, and it is complete and accurate to the best of my knowledge and belief.

Signed:

/s/ Mihai Albulet

Mihai Albulet, PhD
Principal RF Engineer
SPACE EXPLORATION TECHNOLOGIES CORP.

December 26, 2017

Date

CERTIFICATE OF SERVICE

I hereby certify that, on this 26th day of December, 2017, a copy of the foregoing Opposition was served by First Class mail upon:

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/s/ *Abigail D. Hylton*
Abigail D. Hylton

EXHIBIT A-3

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

In the Matter of	)	
Viasat, Inc.	)	IBFS File No. SES-LIC-20170401-00357
Application for Authority to Expand an Existing Earth Station Network	)	Call Sign E170088

REPLY OF VIASAT, INC.

Viasat, Inc. ("Viasat") replies to the opposition of Space Exploration Holdings, LLC ("SpaceX") to Viasat's Petition for Partial Reconsideration ("Petition") of Viasat's Ka band earth station license, granted November 9, 2017.[1]

In the Petition, Viasat requested reconsideration of license Condition 90447 that requires Viasat, no later than 60 days before the "scheduled initial launch of each NGSO FSS satellite system licensed or granted market access in the United States to operate in the 18.8-19.3 GHz and 28.6-29.1 GHz frequency bands," to either notify the Commission when an agreement has been reached with the NGSO satellite system operator, or seek and obtain Commission approval of a technical demonstration showing how Viasat will protect the NGSO FSS satellite system.[2] The basis for this new condition appears to be the submissions of O3b and SpaceX on the underlying application, including claims by SpaceX on June 26, 2017 that uplink interference in the 28.6-29.1 GHz band segment could occur from the proposed GSO earth station operations

[1] Opposition of Space Exploration Holdings, LLC, File No. SES-LIC-20170401-00357 (filed Dec. 26, 2017) ("SpaceX Opposition").

[2] Call Sign E170088, Condition 90447; *see also* Petition for Partial Reconsideration of Viasat, Inc., File No. SES-LIC-20170401-00357 (filed Dec. 11, 2017) ("Petition").

into NGSO spacecraft in certain circumstances.[3] To address such concerns, Viasat provided the results of simulations demonstrating the absence of predicted harmful interference from its licensed operations in the NGSO primary spectrum into any of the NGSO systems that filed in the Ka band processing round.[4]

Of the ten NGSO applicants in the current Ka band processing round (not including Viasat), only SpaceX has raised any concerns. SpaceX reiterates its claim of purported interference potential in the 28.6-29.1 GHz NGSO uplink band, relying principally on its June 26 Reply submission, and claims that Viasat's technical demonstration is inadequate.[5] SpaceX also asserts: "For some reason, Viasat has abandoned . . . seeking coordination agreements with the many other NGSO operators and proposed systems and instead has filed its Petition . . . ."[6]

As an initial matter, SpaceX's claim that Viasat has "abandoned" efforts to seek coordination with NGSO operators is baseless and untrue. As SpaceX acknowledges, Viasat successfully completed coordination with OneWeb many months ago. Moreover, Viasat engaged with SpaceX to start sharing technical and operational information in June 2017. Viasat remains committed to honor its coordination obligations and continues to engage in coordination discussions with NGSO operators.

The main thrust of SpaceX's objection to Viasat's technical demonstration in the Petition is SpaceX's claim that Viasat has not provided the earth station parameters or assumptions underlying its simulations. For purposes of clarity, Viasat details this information in the

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[3] *See* Reply of Space Exploration Holdings, LLC, File No. SES-LIC-20170401-00357 (filed June 26, 2017) ("June 26 Reply").

[4] *See* Petition at Exhibit 1.

[5] *See* SpaceX Opposition at 5-6.

[6] *Id.* at 3.

Technical Response attached as Attachment 1. However, it bears emphasis that this information is not new. Rather, it comes from Viasat's underlying earth station application, SpaceX's NGSO system application, and discussions the parties had last June. Nevertheless, SpaceX has failed to account for critical aspects of this information in its June 26 Reply and in its Opposition. Instead, SpaceX has relied on unrealistic assumptions and incorrect data.

Most significantly, SpaceX assumes alignments between SpaceX NGSO spacecraft and earth stations, and Viasat GSO earth stations that simply will never occur. As explained in Attachment 1, SpaceX has indicated on multiple occasions that its NGSO spacecraft will operate with a minimum orbital isolation of 22 degrees from the GSO arc. Therefore, the interference that SpaceX predicts for isolation angles less than 22 degrees will not occur. Attachment 1 also demonstrates that, at isolation angles of 22 degrees, Viasat's earth stations would generate a $\Delta T/T$ into SpaceX of less than 1% for 99.9 percent of the time, and a $\Delta T/T$ of only 1.2% in a worst case scenario. At the 30 degree isolation angle that SpaceX discusses, the $\Delta T/T$ never exceeds 1.01%. Notably, the majority of the time, the actual isolation angle will be much larger than 30 degrees.

In addition, SpaceX commits a number of other errors that substantially overstate the level of unwanted energy received by the SpaceX space station during a near in-line event. First, SpaceX generally uses higher-than-normal power density levels in its analysis, which, as Viasat has explained to SpaceX, will only be used during rain-faded conditions. Carriers used in a rain-fade situation are intended merely to overcome atmospheric attenuation on the way to outer space, and are designed to result in the same power being received by a target satellite as in clear-sky conditions. Thus, the very same atmospheric attenuation that reduces the received signal level at the Viasat satellite correspondingly reduces the received level at the SpaceX

satellite. SpaceX, however, ignores the significant level of signal attenuation from the atmosphere, and the corresponding reduction in the level of unwanted energy that would be received by a SpaceX satellite during near in-line events.

Second, SpaceX's analysis does not reflect the actual bandwidth of a Viasat earth station's emission during a near in-line event. For example, in the case of a 5 MHz channel, unwanted energy would be emitted into only 1/100 of the bandwidth of the SpaceX receiver. SpaceX, however, assumes that unwanted energy would be transmitted uniformly across the entire 500 MHz range in the 28.6-29.1 GHz band segment, effectively assuming the simultaneous operation of as many as 100 Viasat earth stations operating in the direction of the SpaceX satellite. However, the Viasat network employs MF-TDMA and, thus, only one Viasat earth station can utilize a channel on a given frequency within a Viasat beam at any given time. The earth station transmissions would burst within a channel bandwidth for the given carrier, and not the entire 500 MHz. Moreover, it is unlikely that multiple Viasat earth stations would be co-located near the SpaceX gateway earth station and in the center of the SpaceX satellite's receive beam, and would transmit simultaneously in adjacent frequencies within the 500 MHz SpaceX receive channel. Rather, those earth stations are likely to be spread around the entire coverage area of the Viasat satellite beam, and thus are likely to have increased angular isolation from the SpaceX satellite, and also be further removed from the SpaceX beam center.

* * * * *

Viasat's analysis in the Petition, as supplemented by Attachment 1 hereto, demonstrates that the Condition 90447 is unnecessary to protect authorized NGSO systems from harmful interference from Viasat's earth station operations in the NGSO-primary bands. SpaceX—the only party to object to Viasat's Petition—has not offered a reliable or accurate assessment of the

potential impact of Viasat's earth stations to SpaceX's NGSO operations. Viasat respectfully requests that the condition be modified to be consistent with the more general and typical requirement that Viasat's GSO earth station operations not cause harmful interference into NGSO operations in the NGSO-primary bands.

Respectfully submitted,

/s/

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January 8, 2018

Attachment 1

Technical Response to SpaceX Opposition

The following responds to technical arguments in SpaceX's Opposition, filed on December 26, 2017, to Viasat's petition requesting reconsideration of a condition in Viasat's earth station blanket license, Call Sign, E170088 ("Petition").

I. VIASAT HAS PROVIDED SPACEX WITH THE PARAMETERS AND ASSUMPTIONS USED IN VIASAT'S ANALYSIS

In its Opposition, SpaceX argues that the technical demonstration in Viasat's Petition is insufficient because Viasat has not delineated certain technical parameters and assumptions used in the underlying simulations. Below, Viasat details the inputs and assumptions used in its simulations, which further demonstrates that SpaceX's NGSO operations in the 28.6-29.1 GHz band would not experience significant interference from Viasat's earth station operations in this band segment.

As an initial matter, the following underlying inputs and assumptions were used in the simulations in the Petition:

- Technical parameters from Viasat's blanket license earth station application and SpaceX's FCC license application, as detailed in the Tables below.
- A single Viasat earth station co-located with a SpaceX earth station within CONUS, with other locations 0.25° - 2.0° latitude away from SpaceX earth station also tested as noted below.
- The EIRP and EIRP density were, as noted below in Tables 1 and 2, taken from Viasat's FCC license application for 80 MBd and 160 MBd carriers for the 75 cm and 1.8 m antennas respectively, each representative of edge of coverage operation in clear sky for the respective antennas.

- The analysis considered both the 75 cm and the 1.8 m antennas. Each was analyzed in its own separate Visualyse simulation.

As discussed in more detail below, Viasat utilized these parameters and data provided in its ongoing coordination discussions with SpaceX. Viasat and SpaceX have exchanged technical information about their respective systems, which Viasat has used as the basis for the simulations in the Petition and in the analysis below. Viasat provided this information to SpaceX many months ago, but SpaceX's filings with the Commission continue to disregard this information.

II. SPACEX'S ANALYSIS IS BASED ON UNREALISTIC ASSUMPTIONS AND INCORRECT DATA

In its Opposition, SpaceX continues to rely on its analysis in its June 26, 2017 submission to Viasat's blanket license earth station application ("June 26 Reply") to claim that Viasat's operations would have a "large potential impact on NGSO operations." See Opposition at 3. SpaceX claims that the ΔT/T impact into its NGSO system, calculated for transmissions by Viasat earth stations, would range from 15% to 452% with 20 degrees of orbital isolation and from 6% to 164% with 30 degrees of orbital isolation. See Opposition at 2. SpaceX's analysis, however, does not reflect the actual geometry of the earth stations and the GSO and SpaceX orbits and does not use the correct operating parameters for Viasat earth stations. The following discussion reconciles Viasat's analysis and underlying simulations provided in the Petition with SpaceX's unrealistic and unsubstantiated calculations.

SpaceX's June 26 Reply presents ΔT/T calculations based on two assumed in-line scenarios. In Scenario 1, a SpaceX NGSO satellite is in the main beam of the Viasat GSO earth station uplink. In Scenario 2, a SpaceX earth station is collocated with a Viasat earth station, and their respective satellites are at the edge of an in-line event. SpaceX's analysis considers orbital

isolation angles of 10°, 20°, and 30° in two different geometrical configurations for each of the two scenarios.

A. Scenario 1

Scenario 1, in which a SpaceX satellite would operate when directly in-line with Viasat's GSO satellite, would not occur if SpaceX operates its proposed NGSO network under the terms of its FCC license application. SpaceX specifies a minimum orbital isolation of 22 degrees in both its discussion of GSO arc avoidance in that application, and in a letter to Viasat dated June 9, 2017 where GSO arc avoidance is also discussed for purposes of coordination.

In its FCC application narrative, SpaceX states:

> "Specifically, SpaceX will turn off the transmit beam on the satellite and user terminal whenever the angle between the boresight of a GSO earth station (***assumed to be collocated with the SpaceX user***) and the direction of the SpaceX satellite transmit beam is 22 degrees or less. Because of the number and configuration of satellites in the SpaceX System, there will be ample alternate satellites in view to provide uninterrupted service to a user from satellites operating outside of the exclusion zone around the GSO arc." (emphasis added)

The nature of the SpaceX network operations described in its FCC license application therefore precludes the type of in-line event described in Scenario 1, because no SpaceX satellite will operate within 22° of the GSO arc. This impossibility of Scenario 1 ever arising was confirmed in the June 9, 2017 letter, where SpaceX confirmed that it will also maintain a ±22-degree separation angle from the GSO arc in the 28.6-29.1 GHz band segment (among others).

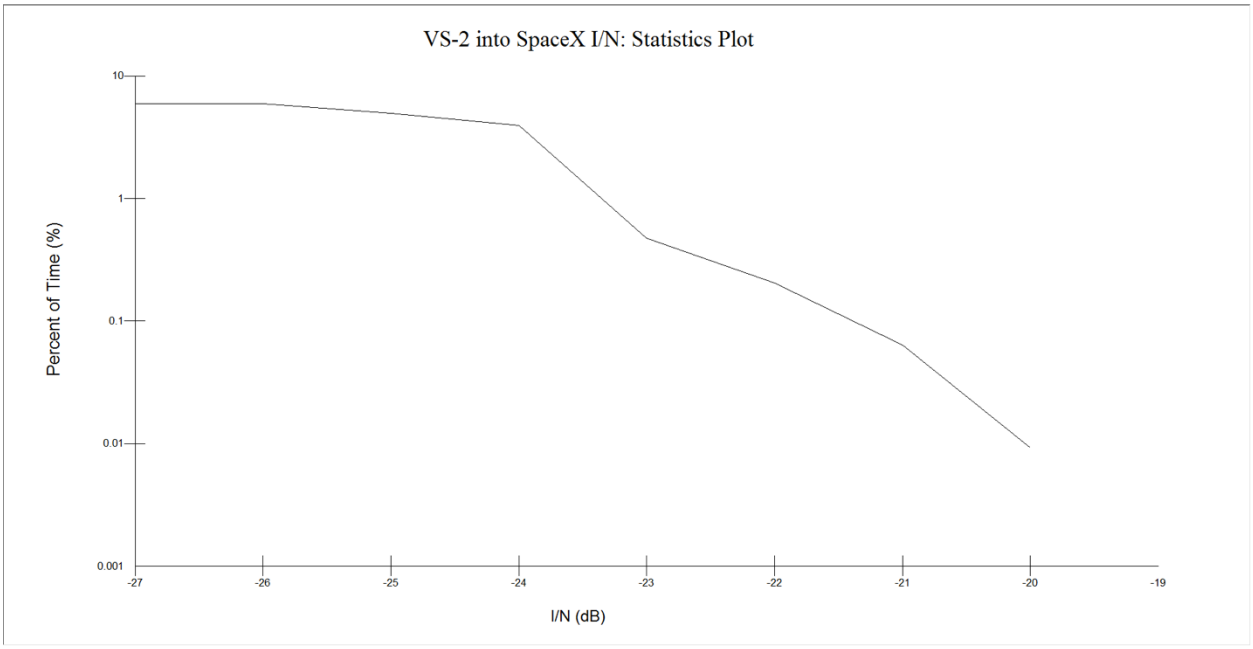
B. Scenario 2

In SpaceX's Scenario 2, the SpaceX and Viasat earth stations are collocated in the same manner assumed in Viasat's analysis in the Petition. SpaceX asserts that at a 30º isolation angle, SpaceX's calculation yields a 6% $\Delta T/T$ for a 75 cm earth station and 11% for a 1.8 m earth station, but does not provide any time statistics for how frequently it expects these events to

occur. SpaceX also identified its calculations for 10º and 20º isolation angles, but as discussed above, isolation angles of less than 22º would not occur according to SpaceX.

As noted in Viasat's Petition, an analysis using the 22° isolation angle from GSO that SpaceX specifies in its application and letter produced a worst case I/N of about -19 dB, which equates to a ΔT/T of only 1.2% over a 24 hour orbital simulation run. The cumulative distribution function (CDF) plot of the run in Figure 1 below shows just how infrequently this occurs.

Figure 1: Plot of I/N as a Percent of Time for 75 cm earth station



The plot shows that 99.99% of the time the I/N is less than -20 dB and less than a 1% ΔT/T. Normally, between GSO networks, a coordination trigger of 6% ΔT/T is used. Due to the static nature of the alignments between earth stations and satellites in GSO networks, it is assumed that the 6% ΔT/T would be present 100% of the time. In the case of GSO vs NGSO networks, the alignments are not static, especially for LEO NGSOs having shorter duration

alignments. Therefore, consideration of the magnitude, duration, and frequency of I/N events is necessary and appropriate.

There are several deficiencies in SpaceX's ΔT/T calculations. The technical Exhibit A in the SpaceX June 26 Reply does not indicate how the asserted ΔT/Ts were calculated, what underlying data was used, where the various input values came from, or how they were derived. For example, SpaceX does not indicate which Viasat emission designator is being analyzed, or how much antenna gain is assumed at the various off-axis angles. Moreover, some of the input values appear muddled, such as using a value for EIRP when it seems SpaceX may have intended EIRP density, and the provided mathematical formula lacks an entry for the bandwidth for either system. In addition, SpaceX's Opposition indicates that it based its initial calculations on Viasat earth station EIRPs in a 40 kHz bandwidth, which SpaceX has since corrected to reflect the EIRPs actually specified by Viasat in a 4 kHz bandwidth.

In addition, SpaceX's analysis shows a fundamental misunderstanding of the Viasat's technology and operating parameters. First, SpaceX uses higher power density emissions which are intended for use only in faded conditions. SpaceX ignores clarifying information that Viasat provided in a June 15, 2017 call with SpaceX to discuss Viasat's earth station operations. During this call, Viasat engineers clearly identified that most of the emission designators would only be used during faded conditions, and that it was simply the Viasat practice to list the various emission designators and use the maximum EIRP and EIRP density for each that complies with Section 25.138, and that the 160 MBd symbol rate was the nominal clear sky emission designator for the 75 cm earth station and that the 320 MBd symbol rate was nominally used for the 1.8 m earth station. Further, in some cases, one step down, i.e. 80 MBd and 160 MBd, might be used in edge of coverage for the 75 cm and 1.8 m antennas respectively. Nevertheless,

SpaceX generally used values intended for rain fade conditions in its June 26 Reply even though, as discussed with SpaceX in the case of faded operation and a near in-line event, these carriers would be faded for both Viasat and SpaceX receivers.

The purpose of the emissions to be used during faded operations is to compensate for rain and atmospheric attenuation in the path of the link to the satellite. The choice of emission and amount of power increase corresponds directly to the actual attenuation in the path due to the fading event. When higher power densities are used to offset the effects of rain fade and atmospheric attenuation, the Viasat satellite receiver sees the same power density during the fade as would normally be received in clear sky conditions. Because the SpaceX analysis is considering a near in-line event, the path through the atmosphere between the earth station and space will be attenuated equally for both the Viasat and SpaceX satellite receivers.

Second, SpaceX does not use the correct bandwidth for each system when performing its interference analysis. FCC and ITU filings include emission designators and EIRP density specifically for this reason so that carriers of different sizes can be evaluated with respect to each other. In its analysis, SpaceX converts the Viasat transmitted power to a per hertz value and then assumes that that this same power density will be received uniformly across the entire 500 MHz receive channel bandwidth of the SpaceX system. This method leads to erroneous conclusions for several reasons.

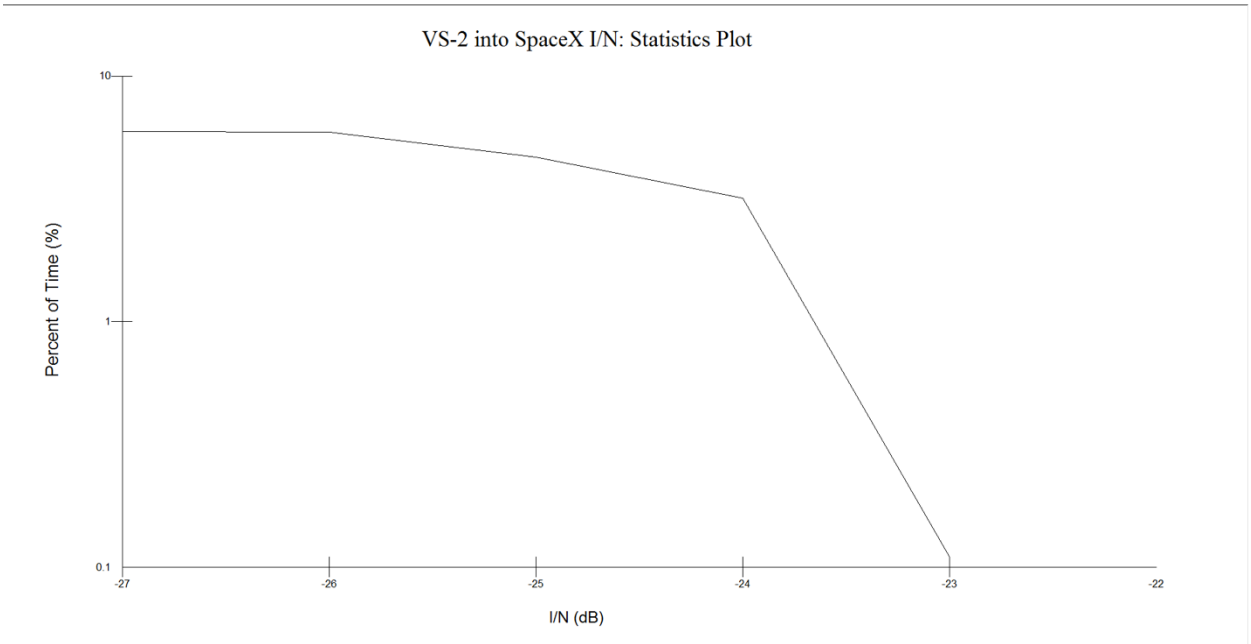
Viasat earth stations use MF-TDMA and only one station may transmit at a time on a given frequency within a satellite beam, but, a given earth station may in the next burst transmit on any other available frequency channel in the 28.6-29.1 GHz band or in any other sub-band available within the beam footprint as assigned by the MF-TDMA scheduler. Because Viasat earth stations are spread throughout its satellite beam, it is unlikely that there will be multiple

earth stations co-located with the SpaceX earth station that will transmit, both at the same time, and on adjacent frequency channels within the 500 MHz channel bandwidth of the SpaceX receiving beam. Rather, it is more likely that the other Viasat earth stations within the same Viasat beam will be at different locations reasonably removed from the SpaceX earth station and will not have the same near in-line alignment as the instant earth station being considered. These transmissions of these stations will be further reduced by the off-axis gain reduction of the SpaceX satellite receiving beam.

By choosing to use only the worst case faded carrier in their analysis and not accounting for the differences in the channel bandwidth, SpaceX is not accounting for the fact that only one, or a small handful, of 5 MHz wide carriers will be operating within their 500 MHz receive channel. Basically, they are assuming 100 times the power of an un-faded Viasat earth station will be operating in the 500 MHz SpaceX receiving channel.

Because Viasat's simulation for the SpaceX network yielded a $\Delta T/T$ of less than 6% at the minimum 22º isolation angle more than 99.99% of the time, Viasat did not provide the results of the simulation for a 30º isolation angle, because a greater isolation angle would result in an even lower $\Delta T/T$ with an even greater percentage of time not exceeding 6% $\Delta T/T$ – in fact, 100% of the time an I/N of -22 dB was never exceeded – see Figure 2.

Figure 2: 30° Isolation I/N vs Percentage of Time for 75 cm earth station



However, to respond to SpaceX's Opposition, Viasat provides an analysis of the 30 degree case. SpaceX does not provide a representative ΔT/T calculation for the 30° separation case of Scenario 2 but rather simply asserts that the calculated ΔT/T is 6% for a 75 cm earth station and 11% for a 1.8 m earth station. In Viasat's calculation here, values are used from the Viasat blanket license application and SpaceX license application as identified in the Tables below:

Table 1: 75 cm Antenna ΔT/T Analysis at ~30° Separation Angle

75 cm Antenna			
Item	Value	Unit	FCC Form 312 question or Comment text
Frequency	28850.0	MHz	(E43)
Antenna diameter	0.745	m	(E33)
Antenna gain	44.0	dBi	(E41)
Input power	25.0	W	(E38)
Emission bandwidth	80.0	MHz	(E47)
EIRP per carrier	57.9	dBW	(E48)
EIRP density	14.9	dBW/4 kHz	(E49)
Off-axis angle to SX satellite	29.0	degrees	As calculated from Visualyse look angles for VS and SX ES
Off-axis gain reduction	51.8	dBc	As calculated by Visualyse (actual VS ant patterns are 55 dBc)
EIRP density toward SX sat	-37.0	dBW/4 kHz	Calculated from EIRP density and off-axis gain reduction
Slant range to SX satellite	1347.0	km	As calculated by Visualyse (sat 490 of planes 1-32 in the simulation)
Path & atm loss to SX satellite	184.9	dB	As calculated by Visualyse
SX satellite receive gain	41.0	dBi	From SX Schedule S for receiving beam GU3/GU7
SX satellite G/T	13.7	dB/K	From SX Schedule S for receiving beam GU3/GU7
SX satellite receiver noise	537.0	K	Calculated from SX Rx Gain and G/T
SX Rx channel bandwidth	500.0	MHz	From SX Schedule S receiving channel CGU7
SX Receiver noise power	-114.3	dBW	Calculated using N=ktB equation and SX noise and bandwidth values
VS received power	-137.8	dBW	Calculated using VS off-axis EIRP density, path loss, and SX Rx gain
I/N	-23.5	dB	Calculated by subtracting SX Rx noise from VS Rx power
Delta T/T	0.447	%	Calculated by standard formula 10^(x/10)*100

In Table 1 above for a 75 cm antenna, the resulting ΔT/T value of 0.45% calculated for a 30° isolation angle is over twelve times lower than the 6% ΔT/T SpaceX reported for the 75 cm earth station using rain-faded EIRP density values (but apparently not accounting for atmospheric attenuation). See SpaceX June 26 Reply at 6.

Table 2 1.8 m Antenna ΔT/T Analysis at ~30° Separation Angle

1.8 m Antenna			
Item	Value	Unit	FCC Form 312 question or Comment text
Frequency	28850.0	MHz	(E43)
Antenna diameter	1.8	m	(E32)
Antenna gain	53.0	dBi	(E41)
Input power	25.0	W	(E38)
Emission bandwidth	160.0	MHz	(E47)
EIRP per carrier	67.0	dBW	(E48)
EIRP density	21.0	dBW/4 kHz	(E49)
Off-axis angle to SX satellite	29.0	degrees	As calculated from Visualyse look angles for VS and SX ES
Off-axis gain reduction	57.5	dBc	As calculated by Visualyse
EIRP density toward SX sat	-36.4	dBW/4 kHz	Calculated from EIRP density and off-axis gain reduction
Slant range to SX satellite	1347.9	km	As calculated by Visualyse (sat 493 of planes 1-32 in the simulation)
Path & atm loss to SX satellite	184.9	dB	As calculated by Visualyse
SX satellite receive gain	41.0	dBi	From SX Schedule S for receiving beam GU3/GU7
SX satellite G/T	13.7	dB/K	From SX Schedule S for receiving beam GU3/GU7
SX satellite receiver noise	537.0	K	Calculated from SX Rx Gain and G/T
SX Rx channel bandwidth	500.0	MHz	From SX Schedule S receiving channel CGU7
SX Receiver noise power	-114.3	dBW	Calculated using N=ktB equation and SX noise and bandwidth values
VS received power	-134.3	dBW	Calculated using VS off-axis EIRP density, path loss, and SX Rx gain
I/N	-20.0	dB	Calculated by subtracting SX Rx noise from VS Rx power
Delta T/T	1.01	%	Calculated by standard formula 10^(x/10)*100

Likewise, in Table 2 above for a 1.8 meter antenna, the 1.01% ΔT/T value calculated for a ~30° isolation angle by Viasat is ten times lower than the 11% value calculated by SpaceX.

It is important to note several assumptions related to the ΔT/T value calculated by Viasat. First, the symbol rates used in each case are the lowest to be used for normal clear sky operation representing an earth station located at the edge of beam coverage. Nominally, for the 75 cm antenna and the 1.8 m antenna the typical operating symbol rate will be one step higher. The terminal bursts at the same maximum 25 W power output and maximum EIRP, but at twice the bandwidth so the EIRP density is reduced by 3 dB, thereby also reducing the I/N by 3 dB. The ΔT/T however, is unchanged. This is because while the EIRP density is reduced by 3 dB, the transmitted bandwidth now being received by the SpaceX receiver is now doubled so the net Viasat power in the SpaceX receiver is unchanged. Similarly, if the operating symbol rate is reduced, the terminal still transmits at the same EIRP, but the EIRP density is now increased by

3 dB. However, the transmitted bandwidth now being received by the SpaceX receiver is halved, and again the resulting ΔT/T is unchanged. It is important to note here, as was also noted above, that SpaceX in their formula for I/N in Exhibit A of the June 26 filing does not include a bandwidth component, assuming wrongly that the received power density from a single Viasat uplink can be applied uniformly across the entire 500 MHz SpaceX receive channel. As described below, this is not the case.

In this simulation, the Viasat earth station and the SpaceX earth stations are assumed to be co-located and that the SpaceX satellite's receiving beam boresight is pointed at both the Viasat and SpaceX earth stations. The Visualyse simulation was configured to use a 41 dBi gain for the SpaceX satellite per the Schedule S filing. Visualyse has options for the antenna gain roll-off and in this case an ITU-R S.1528 recommendation was used with L = -15 dB.

As SpaceX stated in their FCC license application, in the Ka band, usage is limited to communications with SpaceX gateway earth stations. Accordingly, the receiving beams will be tightly focused on the gateways and only operated at elevation angles above 40° above the local horizon. If the Viasat earth station is not co-located with or very near by the SpaceX gateway earth station, the effective gain in the direction of the Viasat earth station is reduced and the I/N drops. In the Visualyse simulation, using the ITU-R roll-off model noted above, moving the Viasat earth station north in latitude by 0.25°, 0.5°, 1°, and 2° result in reductions of 1.2 dB, 8.9 dB, 13.2 dB, and 18.8 dB I/N, respectively.

Like the SpaceX example, the Viasat simulation uses only a single earth station for Viasat and for SpaceX, and separate simulations were performed for the 75 cm and 1.8 m antenna cases. This is reasonable and appropriate given that the Viasat network operates using MF-TDMA such that only a single earth station transmits within a given Viasat satellite beam on

a given frequency at a time. Thus, as discussed above, it is unlikely that multiple earth stations will be co-located near the SpaceX earth station and in the center of the SpaceX receiving beam and transmitting on adjacent frequencies within the 500 MHz receive channel bandwidth of the SpaceX receiver at the same time. Rather, it is realistic to expect that various Viasat earth stations transmitting within the 500 MHz SpaceX receive channel bandwidth will be spread around within Viasat's overall coverage area and most of them will have a larger isolation angle than the 30° assumed for the earth station in the simulation. Also, these earth stations will be further from the SpaceX beam center and as noted above will see a further reduction in the received I/N.

However, even in the worst case where for some brief time several Viasat earth stations transmitted on adjacent channels at the same time such that the entire 500 MHz SpaceX receive channel had Viasat carriers overlapping, the resulting $\Delta T/T$ as calculated above in Tables 1 and 2 would increase at worst by 500 MHz/80 MHz = 6.25 times or to 2.8% in the case of the 75 cm antenna, and 500 MHz/160 MHz = 3.14 times or to 3.14% in the case of the 1.8 m antenna.

Finally, it is worth noting that with respect to the I/N calculations, these are based on a snapshot alignment and do not in any way reflect the percentage of time such alignments might occur in the normal operation of the networks. The majority of the time, in any of the available tracking modes in Visualyse the isolation angle is much larger than 30°, especially given the 40° minimum elevation operational parameters that SpaceX identified in its FCC license application for its Ka band gateways. To even get Visualyse to produce a 30° isolation angle snapshot for analysis required that the range of pointing angles for the SpaceX earth station be limited in such a way as to artificially force the software to generate an alignment. Importantly, in any given 24

hour simulation run, a -12.2 dB I/N value was never observed and the highest value seen was -22 dB which equates to a $\Delta T/T$ of 0.6%.

III. OPERATION OF THE EARTH STATIONS WITH VIASAT-1 DOES NOT CHANGE THE ANALYSIS

SpaceX has noted that Viasat's analysis addressed earth stations communicating with ViaSat-2 and suggests that the analysis should also consider ViaSat-1 as well. As the Viasat earth stations would operate within the limits of the licensed parameters, the EIRP density of the earth stations will be no higher when communicating with ViaSat-1 than with ViaSat-2. A separate Visualyse simulation was performed using the earth station operating parameters as indicated above, except that the satellite point of communication was changed from ViaSat-2 at 69.6° W.L. to ViaSat-1 at 115.1° W.L. No change in I/N values or percentage of time for these values was observed in this alternative simulation.

DECLARATION

I hereby declare that I am the technically qualified person responsible for preparation of the engineering information contained in this Reply of Viasat, Inc. ("Reply"), 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 Reply, and that it is complete and accurate to the best of my knowledge, information and belief.

Daryl T. Hunter, P.E.
Chief Technology Officer, Regulatory Affairs
Viasat, Inc.
6155 El Camino Real
Carlsbad, CA 92009

January 8, 2018

CERTIFICATE OF SERVICE

I, Kayla Ernst, hereby certify that on this 8th day of January 2018, I served a true copy of the foregoing Reply of Viasat, Inc. via first-class mail upon the following:

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Counsel to SpaceX

/s/
Kayla K. Ernst

EXHIBIT B

[REDACTED]

EXHIBIT C

[REDACTED]

EXHIBIT D

Approved by OMB
3060-0678

Date & Time Filed: Sep 18 2020 4:26:59:326PM
File Number: SES-MOD-INTR2020-02656

FCC APPLICATION FOR SPACE AND EARTH STATION:MOD OR AMD - MAIN FORM **FCC 312 MAIN FORM FOR OFFICIAL USE ONLY**	**FCC Use Only**

APPLICANT INFORMATION

Enter a description of this application to identify it on the main menu:
E170088 Demonstration of Compliance with License Condition

1-8. Legal Name of Applicant

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City:	Carlsbad	State:	CA
Country:	USA	Zipcode:	92009 -
Attention:	Mr Daryl T Hunter P.E.		

9-16. Name of Contact Representative

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City:	Washington	State:	DC
Country:	USA	Zipcode:	20001-
Attention:		Relationship:	

CLASSIFICATION OF FILING

17. Choose the button next to the classification that applies to this filing for both questions a. and b. Choose only one for 17a and only one for 17b.

- (●) a1. Earth Station
- ( ) a2. Space Station

- (N/A) b1. Application for License of New Station
- (N/A) b2. Application for Registration of New Domestic Receive-Only Station
- ( ) b3. Amendment to a Pending Application
- (●) b4. Modification of License or Registration
- b5. Assignment of License or Registration
- b6. Transfer of Control of License or Registration
- ( ) b7. Notification of Minor Modification
- (N/A) b8. Application for License of New Receive-Only Station Using Non-U.S. Licensed Satellite
- (N/A) b9. Letter of Intent to Use Non-U.S. Licensed Satellite to Provide Service in the United States
- (N/A) b10. Other (Please specify)
- (N/A) b11. Application for Earth Station to Access a Non-U.S.satellite Not Currently Authorized to Provide the Proposed Service in the Proposed Frequencies in the United States.

17c. Is a fee submitted with this application?

- (●) If Yes, complete and attach FCC Form 159.

If No, indicate reason for fee exemption (see 47 C.F.R.Section 1.1114).

○ Governmental Entity ○ Noncommercial educational licensee

○ Other(please explain):

17d.
Fee Classification CGV - Fixed Satellite VSAT System

18. If this filing is in reference to an existing station, enter:	19. If this filing is an amendment to a pending application enter both fields, if this filing is a modification please enter only the file number:
(a) Call sign of station: E170088	(a) Date pending application was filed: (b) File number: SESLIC2017040100357

TYPE OF SERVICE

20. NATURE OF SERVICE: This filing is for an authorization to provide or use the following type(s) of service(s): Select all that apply:

- ☑ a. Fixed Satellite
- ☐ b. Mobile Satellite
- ☐ c. Radiodetermination Satellite
- ☐ d. Earth Exploration Satellite
- ☐ e. Direct to Home Fixed Satellite
- ☐ f. Digital Audio Radio Service
- ☐ g. Other (please specify)

21. STATUS: Choose the button next to the applicable status. Choose only one.	22. If earth station applicant, check all that apply.
○ Common Carrier ◉ Non-Common Carrier	☑ Using U.S. licensed satellites ☑ Using Non-U.S. licensed satellites

23. If applicant is providng INTERNATIONAL COMMON CARRIER service, see instructions regarding Sec. 214 filings. Choose one.
Are these facilities:

○ Connected to a Public Switched Network ○ Not connected to a Public Switched Network ◉ N/A

24. FREQUENCY BAND(S): Place an 'X' in the box(es) next to all applicable frequency band(s).

☐ a. C-Band (4/6 GHz) ☐ b. Ku-Band (12/14 GHz)

☑ c.Other (Please specify upper and lower frequencies in MHz.)

Frequency Lower: 17700 Frequency Upper: 30000 (Please specify additional frequencies in an attachment)

TYPE OF STATION

25. CLASS OF STATION: Choose the button next to the class of station that applies. Choose only one.

- ○ a. Fixed Earth Station
- ○ b. Temporary-Fixed Earth Station
- ○ c. 12/14 GHz VSAT Network
- ○ d. Mobile Earth Station
- ○ e. Geostationary Space Station
- ○ f. Non-Geostationary Space Station
- ◉ g. Other (please specify) Ka band blanket license

26. TYPE OF EARTH STATION FACILITY:

◉ Transmit/Receive ○ Transmit-Only ○ Receive-Only ○ N/A

"For Space Station applications, select N/A."

PURPOSE OF MODIFICATION

27. The purpose of this proposed modification is to: (Place an 'X' in the box(es) next to all that apply.)

- ☐ a -- authorization to add new emission designator and related service
- ☐ b -- authorization to change emission designator and related service
- ☐ c -- authorization to increase EIRP and EIRP density

- [ ] d -- authorization to replace antenna
- [ ] e -- authorization to add antenna
- [ ] f -- authorization to relocate fixed station
- [ ] g -- authorization to change frequency(ies)
- [ ] h -- authorization to add frequency
- [ ] i -- authorization to add Points of Communication (satellites & countries)
- [ ] j -- authorization to change Points of Communication (satellites & countries)
- [ ] k -- authorization for facilities for which environmental assessment and radiation hazard reporting is required
- [ ] l -- authorization to change orbit location
- [ ] m -- authorization to perform fleet management
- [ ] n -- authorization to extend milestones
- [x] o -- Other (Please specify)

ENVIRONMENTAL POLICY

28. Would a Commission grant of any proposal in this application or amendment have a significant environmental impact as defined by 47 CFR 1.1307? If YES, submit the statement as required by Sections 1.1308 and 1.1311 of the Commission's rules, 47 C.F.R. 1.1308 and 1.1311, as an exhibit to this application.A Radiation Hazard Study must accompany all applications for new transmitting facilities, major modifications, or major amendments.	○ **Yes** ◉ **No** **Exhibit B**

ALIEN OWNERSHIP Earth station applicants not proposing to provide broadcast, common carrier, aeronautical en route or aeronautical fixed radio station services are not required to respond to Items 30-34.

29. Is the applicant a foreign government or the representative of any foreign government?	○ **Yes** ◉ **No**
30. Is the applicant an alien or the representative of an alien?	○ **Yes** ○ **No** ◉ **N/A**
31. Is the applicant a corporation organized under the laws of any foreign government?	○ **Yes** ○ **No** ◉ **N/A**
32. Is the applicant a corporation of which more than one-fifth of the capital stock is owned of record or voted by aliens or their representatives or by a foreign government or representative thereof or by any corporation organized under the laws of a foreign country?	○ **Yes** ○ **No** ◉ **N/A**
33. Is the applicant a corporation directly or indirectly controlled by any other corporation of which more than one-fourth of the capital stock is owned of record or voted by aliens, their representatives, or by a foreign government or representative thereof or by any corporation organized under the laws of a foreign country?	○ **Yes** ○ **No** ◉ **N/A**
34. If any answer to questions 29, 30, 31, 32 and/or 33 is Yes, attach as an exhibit an identification of the aliens or foreign entities, their nationality, their relationship to the applicant, and the percentage of stock they own or vote.	Exhibit C

BASIC QUALIFICATIONS

35. Does the Applicant request any waivers or exemptions from any of the Commission's Rules? If Yes, attach as an exhibit, copies of the requests for waivers or exceptions with supporting documents.	○ **Yes** ◉ **No**
36. Has the applicant or any party to this application or amendment had any FCC station authorization or license revoked or had any application for an initial, modification or renewal of FCC station authorization, license, or construction permit denied by the Commission? If Yes, attach as an exhibit, an explination of circumstances.	○ **Yes** ◉ **No**
37. Has the applicant, or any party to this application or amendment, or any party directly or indirectly controlling the applicant ever been convicted of a felony by any state or federal court? If Yes, attach as an exhibit, an explination of circumstances.	○ **Yes** ◉ **No**
38. Has any court finally adjudged the applicant, or any person directly or indirectly controlling the applicant, guilty of unlawfully monopolizing or attemptiing unlawfully to monopolize radio communication, directly or indirectly, through control of manufacture or sale of radio apparatus, exclusive traffic	○ **Yes** ◉ **No**

arrangement or any other means or unfair methods of competition?If Yes, attach as an exhibit, an explanation of circumstances

39. Is the applicant, or any person directly or indirectly controlling the applicant, currently a party in any pending matter referred to in the preceding two items? If yes, attach as an exhinit, an explanation of the circumstances.	○ **Yes** ◉ **No**
40. If the applicant is a corporation and is applying for a space station license, attach as an exhibit the names, address, and citizenship of those stockholders owning a record and/or voting 10 percent or more of the Filer's voting stock and the percentages so held. In the case of fiduciary control, indicate the beneficiary(ies) or class of beneficiaries. Also list the names and addresses of the officers and directors of the Filer.	
41. By checking Yes, the undersigned certifies, that neither applicant nor any other party to the application is subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Act of 1988, 21 U.S.C. Section 862, because of a conviction for possession or distribution of a controlled substance. *See 47 CFR 1.2002(b) for the meaning of "party to the application" for these purposes.*	◉ **Yes** ○ **No**
42a. Does the applicant intend to use a non-U.S. licensed satellite to provide service in the United States? If Yes, answer 42b and attach an exhibit providing the information specified in *47 C.F.R. 25.137, as appropriate*. If No, proceed to question 43.	◉ **Yes** ○ **No**
42b. What administration has licensed or is in the process of licensing the space station? If no license will be issued, what administration has coordinated or is in the process of coordinating the space station?United Kingdom, Canada	

43. Description. (Summarize the nature of the application and the services to be provided). See attached Narrative.Narrative

43a. Geographic Service Rule Certification By selecting A, the undersigned certifies that the applicant is not subject to the geographic service or geographic coverage requirements specified in 47 C.F.R. Part 25.	◉ **A**
By selecting B, the undersigned certifies that the applicant is subject to the geographic service or geographic coverage requirements specified in 47 C.F.R. Part 25 and will comply with such requirements.	○ **B**
By selecting C, the undersigned certifies that the applicant is subject to the geographic service or geographic coverage requirements specified in 47 C.F.R. Part 25 and will not comply with such requirements because it is not feasible as a technical matter to do so, or that, while technically feasible, such services would require so many compromises in satellite design and operation as to make it economically unreasonable. A narrative description and technical analysis demonstrating this claim are attached.	○ **C**

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CERTIFICATION

The Applicant waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise, and requests an authorization in accordance with this application. The applicant certifies that grant of this application would not cause the applicant to be in violation of the spectrum aggregation limit in 47 CFR Part 20. All statements made in exhibits are a material part hereof and are incorporated herein as if set out in full in this application. The undersigned, individually and for the applicant, hereby certifies that all statements made in this application and in all attached exhibits are true, complete and correct to the best of his or her knowledge and belief, and are made in good faith.

44. Applicant is a (an): (Choose the button next to applicable response.)

- ○ Individual
- ○ Unincorporated Association
- ○ Partnership
- ◉ Corporation
- ○ Governmental Entity
- ○ Other (please specify)

45. Name of Person Signing	46. Title of Person Signing
Daryl T. Hunter	Chief Technical Officer, Regulatory Affairs

WILLFUL FALSE STATEMENTS MADE ON THIS FORM ARE PUNISHABLE BY FINE AND / OR IMPRISONMENT (U.S. Code, Title 18, Section 1001), AND/OR REVOCATION OF ANY STATION AUTHORIZATION (U.S. Code, Title 47, Section 312(a)(1)), AND/OR FORFEITURE (U.S. Code, Title 47, Section 503).

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THE FOREGOING NOTICE IS REQUIRED BY THE PAPERWORK REDUCTION ACT OF 1995, PUBLIC LAW 104-13, OCTOBER 1, 1995, 44 U.S.C. SECTION 3507.

Narrative

On December 11, 2017, Viasat submitted a petition for reconsideration with respect to condition 90447 of its earth station license for call sign E170088, granted November 9, 2017. In support of that petition, Viasat included a detailed technical demonstration of how it would protect the NGSO FSS satellite systems referenced in that condition with respect to the 28.6-29.1 GHz and 18.8-19.3 GHz band segments and thereby comply with the terms of that condition. Viasat submitted that petition in an effort to obviate the need for future license modifications related to that condition. Viasat provided further technical analysis in response to comments made by the only party that responded to the petition.

That petition is still outstanding. Out of an abundance of caution, Viasat is filing this license modification application with respect to condition 90447, along with a copy of the technical analyses described above, which, as noted, currently are before the Commission with respect to call sign E170088. Those analyses are included here as Exhibits A and B. As Viasat explained in its petition, those analyses (i) discuss the results of a series of simulations, and (ii) demonstrate the absence of predicted harmful interference from the earth station operations authorized by call sign E170088 into NGSO systems operating in the 28.6-29.1 GHz and 18.8-19.3 GHz band segments. As Exhibit A explains, even without maintaining any angular separation, harmful uplink interference would not reasonably be expected to occur.

Moreover, if the level of unwanted emissions resulting from the absence of angular separation is deemed to be "harmful," the separation angles for each NGSO system identified in Table 1 of Exhibit A readily could be used as the trigger point for ceasing (and resuming) transmissions with respect to any such NGSO system when that system is operating in the 28.6-29.1 GHz and 18.8-19.3 GHz band segments at separation angles greater than the separation angle identified in Table 1. And as Viasat further explained at the time, any cessation of uplink operations in the 28.6-29.1 GHz band segment correspondingly would result in a cessation of downlink transmissions in the 18.8-19.3 GHz band segment.

Viasat also includes as Exhibit C a confidential submission it made on May 18, 2020 with respect to call sign E170088 and condition 90447. In that May 2020 submission, Viasat presented the terms of a draft international coordination agreement with an NGSO system, under which Viasat remains willing to operate, as a means by which the Commission also could deem condition 90447 satisfied with respect to that system. That agreement includes **{{BEGIN CONFIDENTIAL}}**

{{END CONFIDENTIAL}} to which Viasat is willing to agree as part of the overall terms of the agreement. Notably, the NGSO system's operations will be protected by that provision; namely **{{BEGIN CONFIDENTIAL}}**

{{END CONFIDENTIAL}}.

EXHIBIT A

Exhibit 1

Viasat has conducted simulations using Visualyse software from Transfinite Systems, Ltd., on the filed characteristics of each of the various NGSO systems proposed or authorized in the NGSO application processing round covering the NGSO-primary portion of the Ka band, and the characteristics of the ViaSat-2 blanket license earth stations ("VS-2 Earth Stations") to determine the potential for causing harmful interference into those NGSO systems under various operating conditions. The simulation software produces, as one of its outputs, a Cumulative Distribution Function (CDF) with the I/N value given as a percentage of time. In the case of NGSO systems where links are not static and are constantly changing, I/N as a function of time is a more useful metric than a static snapshot of a single I/N value being exceeded or not. This analysis considers the resulting I/N when there is no angular separation between the ViaSat-2 network and the various NGSO systems. It also considers the results when different minimal angular separations are maintained. Consistent with the technical analyses provided during the application process, this analysis focuses on the uplink case.

O3b System

Currently, O3b operates an NGSO system with an equatorial orbit and has filed applications both to increase the number of satellites in the equatorial plane and to add two additional inclined planes with eight satellites each for a total of 60 operational satellites, and a subsequent amendment to reduce the total number of operational satellites to 42 – 32 satellites in a non-inclined orbital plane and 5 each in two 70 degree inclined orbital planes. Viasat evaluated both systems and found that the results were not markedly different for the two systems so only the results for the latest amendment are included here. To analyze the O3b system, the simulations were broken down into three scenarios. First, an examination of the

equatorial orbit only was performed. Second, an examination of the inclined orbits only, and finally, an examination considering both the equatorial and inclined orbits of the O3b system was performed.

In each of these cases, the scenarios were run assuming a 1% TDMA burst duty cycle representing a sustained heavy traffic upload condition for the VS-2 Earth Stations over the simulation period.

In the case of the equatorial only orbit, VS-2 Earth Station operations in CONUS and Puerto Rico will result in a minimum separation angle of approximately 10.4 degrees when an O3b satellite passes under the VS-2 satellite potentially communicating with an earth station located in Puerto Rico. The associated I/N was calculated as -30.9 dB by Visualyse, based on a scenario in which the VS-2 Earth Station is located in close proximity with an O3b gateway station such that the O3b satellite's beam center is pointed at the VS-2 Earth Station. As the VS-2 Earth Station and the O3b gateway are moved further north, the minimum separation angle between the O3b equatorial orbit satellite and VS-2 in GSO increases and the I/N continues to decrease. From this analysis, it is very clear that, just as in the case of ViaSat-1 earth stations authorized under Call Sign E100143, no reduction in EIRP density or inhibition of transmissions from VS-2 Earth Stations is needed to operate compatibly with the O3b equatorial orbit for any of the U.S. territories served by VS-2.

In the case of the O3b inclined orbital planes, several simulations were performed at various locations to determine the frequency and magnitude of in-line events. The simulation results produce a Cumulative Distribution Function (CDF) of I/N versus percentage of time. The worst-case alignment during the simulation period resulted in an I/N of 9 dB. Notably, the duration of the alignment that results in an I/N of 9 dB is very brief, only two seconds long, and

occurs only once during the 30 day simulation period. Lower I/N values occur more frequently according to the CDF but the aggregate time percentage for the aggregate of all in-line events within the 30 day simulation period when an I/N of -12.2 dB level is exceeded is very small—a total of only 22 seconds. In other words, for more than 99.999% of the time, the I/N would be less than -12.2 dB; conversely, the I/N would exceed -12.2 dB only 8.13×10^{-4}% of the time. These results are summarized in Table 1 below. Also shown in Table 1 below are values for when the separation angle from GSO is set to the value proposed by O3b in order to meet the Article 22 epfd limits. The difference between the two cases is 22 seconds per month.

SpaceX System

Due to the density of the SpaceX constellation and the larger number of identical inclined orbital planes, it was not necessary to propagate the orbits over a 30-day period to develop reliable statistics for I/N values, so a 24 hour period was used instead. Multiple tracking strategies were evaluated for the SpaceX simulation, including scenarios in which the SpaceX earth station is communicating with a satellite in the constellation that (i) is the nearest, (ii) has the highest elevation, (iii) has the longest hold time, and (iv) avoids the GSO arc by 22 degrees, which is what SpaceX proposes in its application in order to meet the Article 22 epfd limits in band segments where those limits apply. In no case was a -12.2 dB I/N exceeded in any of the scenarios. These results are summarized in Table 1 below.

SpaceX in their June 26, 2017 reply comment presented calculations for a 10 degree separation angle. However, in practice when implemented in the Visualyse simulation software, such an alignment does not occur during the simulation of the network's operation. At all times in Visualyse, each of the selected tracking strategies resulted in very large separations from GSO. In fact, this seems consistent with SpaceX's application and public statements regarding

user terminals which will employ flat-panel antennas “roughly the size of a laptop” and which will use phased-array technology to track the satellites. Optimal scanning angles for phased-array terminals would suggest that higher elevations well-removed from the GSO orbit in most cases would be used in order to minimize scan losses and maximize link performance. Notably, SpaceX did not include an actual orbital simulation showing that the smaller separation angle of 10 degrees actually would be used. Additionally as explained in Exhibit 1 of Viasat’s Opposition and Response filed on June 15, 2017, SpaceX used the operational EIRP densities of Viasat’s earth stations that would typically be employed only during faded conditions, not clear sky, thus SpaceX incorrectly uses unrealistically high power densities for the VS-2 Earth Stations in their calculations. Accordingly, the Visualyse results here represent a more realistic operating scenario.

Additional NGSO Systems and Combined Results

In addition to the O3b and SpaceX systems, Viasat also evaluated seven other NGSO systems in the Ka band NGSO processing round with plans to operate in the NGSO-primary spectrum. Because Audacy and Kepler have not proposed systems operating in the 28.6-29.1 GHz band, they were not evaluated. Also, results were not evaluated for OneWeb as coordination has already been completed between Viasat and OneWeb for that system.

Table 1 below shows the results of the simulations for each system. A reference I/N of -12.2 dB is used for illustrative purposes to demonstrate the level and frequency of unwanted energy emitted toward the NGSO satellite in the circumstances described. That reference I/N is not intended as a threshold for when harmful interference would occur.

Table 1: I/N Results for VS-2 Earth Stations into NGSO Systems

System	Operator Separation Angle (deg)	Simulation Separation Angle (deg)	Tracking Strategy	I/N Exceeded	% Time	% of time meeting -12.2 dB	Worst I/N (dB)	Total Exceeded (s) / month	Longest Event (s)
Audacy		N/A	No links in "NGSO" band						
Boeing	6	N/A	Nearest	No	0	100.000	-15.69	0	0
Karousel	20	N/A	Nearest	No	0	100.000	-44.34	0	0
Leosat		N/A	Nearest	Yes	0.013872	99.986	23.76	360	4
Leosat	7	7	Avoid GSO	Yes	0.000055	100.000	-11.79	2	1
O3b Equatorial Only		N/A	Nearest	No	0	100.000	-30.9	0	0
O3b		N/A	Nearest	Yes	0.000813	99.999	9.09	22	2
O3b	7.6	7.6	Avoid GSO	No	0	100.000	-27.67	0	0
OneWeb		N/A	Not examined due to coordination already completed						
SpaceX		N/A	Nearest	No	0	100.000	-16.21	0	0
SpaceX	22	22	Avoid GSO	No	0	100.000	-18.97	0	0
Space Norway		N/A	No links in "NGSO" band in VS-2 coverage area						
Telesat		N/A	Nearest	Yes	0.006164	99.994	20.64	160	3
Telesat	11.9	11.9	Avoid GSO	No	0.000000	100.000	-19.57	0	0
Theia Holdings		N/A	Nearest	Yes	0.002057	99.998	19.47	22	2
Theia Holdings	10	10	Avoid GSO	No	0	100.000	-14.43	0	0

The results in Table 1 are provided for each system for several different separation angles. For each system, the results are provided for using a tracking strategy with no GSO avoidance and a separation angle of 0 degrees input into the tracking strategy, as well as for other values for minimum separation angle from GSO if an exceedance of the -12.2 dB I/N value was observed for 0 degrees separation angle. For example, in the case of Leosat, in-line events could occur resulting in an I/N exceeding -12.2 dB for a brief period (i.e., up to 4 seconds). Increasing the separation angle to the 7 degrees, which is the angular separation at which Leosat proposes to operate in the bands where Article 22 epfd limits apply results in -12.2 dB I/N essentially all of the time. In the case of Boeing, Karousel, Telesat, and Theia Holdings, the same holds true, with operation at the GSO angular separation each operator proposes to employ for similar reasons resulting in the -12.2 dB I/N never being exceeded.

In the case of Boeing and Karousel, adding a separation angle in Visualyse over choosing a tracking strategy such as nearest or highest, or longest hold time, had no real effect in that the -12.2 dB I/N is met at all times for those systems.

The orbits of each of these NGSO systems are readily predicted using long-proven orbital propagation routines, and the orbital element data for the orbits available from sources such as Space Track, a U.S. government resource, or from the NGSO operators themselves. The orbital separation from the NGSO satellites and VS-2 can be easily determined. We do not believe that VS-2 Earth Station operations would result in harmful interference in NGSO-primary band segments under any circumstances, but the shut-off capabilities Viasat has previously described will in any event protect NGSO systems from harmful interference from VS-2 Earth Stations. Specifically, the VS-2 satellite has been designed with the capability to cease operations in the 28.6-29.1 GHz uplink band (and in the associated 18.8-19.3 GHz downlink band) on a beam by beam basis in any spot beams where the predicted physical alignment of either (i) an NGSO space station and an earth station communicating with the VS-2 satellite, or (ii) the VS-2 satellite and an earth station communicating with an NGSO space station, occurs, such that the angular separation between operational links of the two satellite networks would be equal to or less than a specified minimum line-of-sight separation angle. In addition, as all earth stations in the VS-2 network operate under control of a Network Management System (NMS) that coordinates the real-time operations of the TDMA scheduler for each beam on the satellite, cease transmission commands can be sent to individual earth stations for the duration of the brief period when the separation angle falls below the specified minimum as calculated by the NMS using data from Space Track or the NGSO operators.

DECLARATION

I hereby declare that I am the technically qualified person responsible for preparation of the engineering information contained in this Petition for Partial 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.

Daryl T. Hunter, P.E.
Chief Technology Officer, Regulatory Affairs
Viasat, Inc.
6155 El Camino Real
Carlsbad, CA 92009

December 11, 2017

EXHIBIT B

Attachment 1

Technical Response to SpaceX Opposition

The following responds to technical arguments in SpaceX's Opposition, filed on December 26, 2017, to Viasat's petition requesting reconsideration of a condition in Viasat's earth station blanket license, Call Sign, E170088 ("Petition").

I. VIASAT HAS PROVIDED SPACEX WITH THE PARAMETERS AND ASSUMPTIONS USED IN VIASAT'S ANALYSIS

In its Opposition, SpaceX argues that the technical demonstration in Viasat's Petition is insufficient because Viasat has not delineated certain technical parameters and assumptions used in the underlying simulations. Below, Viasat details the inputs and assumptions used in its simulations, which further demonstrates that SpaceX's NGSO operations in the 28.6-29.1 GHz band would not experience significant interference from Viasat's earth station operations in this band segment.

As an initial matter, the following underlying inputs and assumptions were used in the simulations in the Petition:

- Technical parameters from Viasat's blanket license earth station application and SpaceX's FCC license application, as detailed in the Tables below.
- A single Viasat earth station co-located with a SpaceX earth station within CONUS, with other locations 0.25° - 2.0° latitude away from SpaceX earth station also tested as noted below.
- The EIRP and EIRP density were, as noted below in Tables 1 and 2, taken from Viasat's FCC license application for 80 MBd and 160 MBd carriers for the 75 cm and 1.8 m antennas respectively, each representative of edge of coverage operation in clear sky for the respective antennas.

- The analysis considered both the 75 cm and the 1.8 m antennas. Each was analyzed in its own separate Visualyse simulation.

As discussed in more detail below, Viasat utilized these parameters and data provided in its ongoing coordination discussions with SpaceX. Viasat and SpaceX have exchanged technical information about their respective systems, which Viasat has used as the basis for the simulations in the Petition and in the analysis below. Viasat provided this information to SpaceX many months ago, but SpaceX's filings with the Commission continue to disregard this information.

II. SPACEX'S ANALYSIS IS BASED ON UNREALISTIC ASSUMPTIONS AND INCORRECT DATA

In its Opposition, SpaceX continues to rely on its analysis in its June 26, 2017 submission to Viasat's blanket license earth station application ("June 26 Reply") to claim that Viasat's operations would have a "large potential impact on NGSO operations." See Opposition at 3. SpaceX claims that the ΔT/T impact into its NGSO system, calculated for transmissions by Viasat earth stations, would range from 15% to 452% with 20 degrees of orbital isolation and from 6% to 164% with 30 degrees of orbital isolation. See Opposition at 2. SpaceX's analysis, however, does not reflect the actual geometry of the earth stations and the GSO and SpaceX orbits and does not use the correct operating parameters for Viasat earth stations. The following discussion reconciles Viasat's analysis and underlying simulations provided in the Petition with SpaceX's unrealistic and unsubstantiated calculations.

SpaceX's June 26 Reply presents ΔT/T calculations based on two assumed in-line scenarios. In Scenario 1, a SpaceX NGSO satellite is in the main beam of the Viasat GSO earth station uplink. In Scenario 2, a SpaceX earth station is collocated with a Viasat earth station, and their respective satellites are at the edge of an in-line event. SpaceX's analysis considers orbital

isolation angles of 10°, 20°, and 30° in two different geometrical configurations for each of the two scenarios.

A. Scenario 1

Scenario 1, in which a SpaceX satellite would operate when directly in-line with Viasat's GSO satellite, would not occur if SpaceX operates its proposed NGSO network under the terms of its FCC license application. SpaceX specifies a minimum orbital isolation of 22 degrees in both its discussion of GSO arc avoidance in that application, and in a letter to Viasat dated June 9, 2017 where GSO arc avoidance is also discussed for purposes of coordination.

In its FCC application narrative, SpaceX states:

> "Specifically, SpaceX will turn off the transmit beam on the satellite and user terminal whenever the angle between the boresight of a GSO earth station (***assumed to be collocated with the SpaceX user***) and the direction of the SpaceX satellite transmit beam is 22 degrees or less. Because of the number and configuration of satellites in the SpaceX System, there will be ample alternate satellites in view to provide uninterrupted service to a user from satellites operating outside of the exclusion zone around the GSO arc." (emphasis added)

The nature of the SpaceX network operations described in its FCC license application therefore precludes the type of in-line event described in Scenario 1, because no SpaceX satellite will operate within 22° of the GSO arc. This impossibility of Scenario 1 ever arising was confirmed in the June 9, 2017 letter, where SpaceX confirmed that it will also maintain a ±22-degree separation angle from the GSO arc in the 28.6-29.1 GHz band segment (among others).

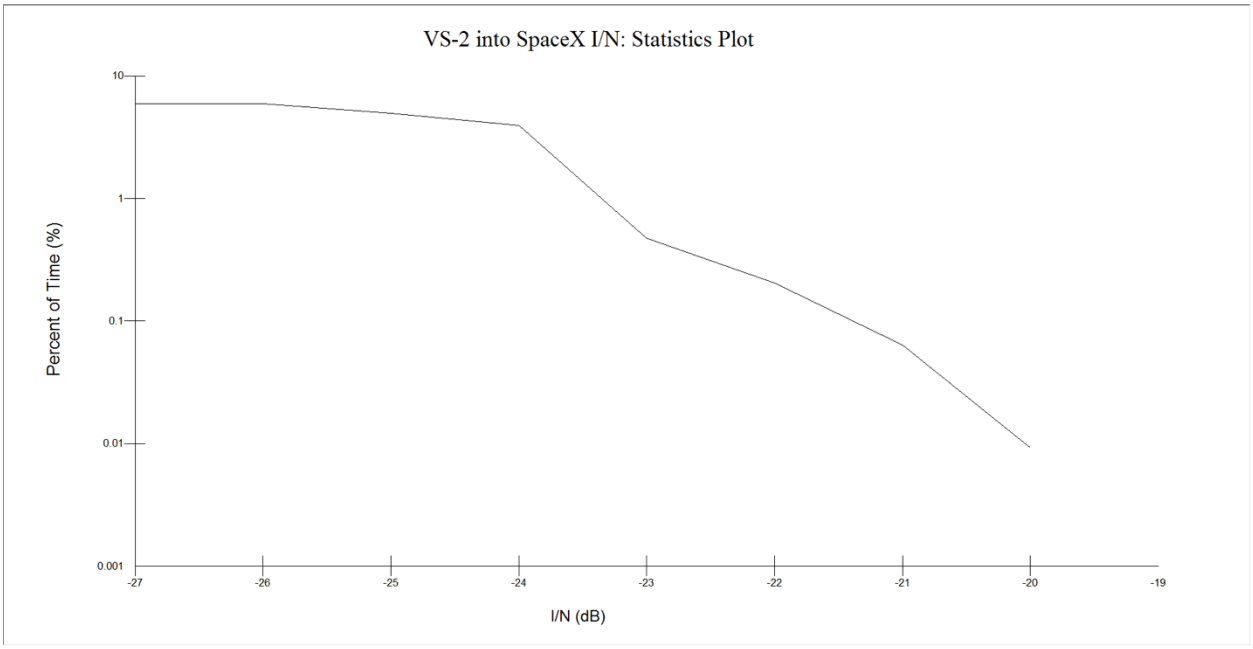
B. Scenario 2

In SpaceX's Scenario 2, the SpaceX and Viasat earth stations are collocated in the same manner assumed in Viasat's analysis in the Petition. SpaceX asserts that at a 30º isolation angle, SpaceX's calculation yields a 6% $\Delta T/T$ for a 75 cm earth station and 11% for a 1.8 m earth station, but does not provide any time statistics for how frequently it expects these events to

occur. SpaceX also identified its calculations for 10º and 20º isolation angles, but as discussed above, isolation angles of less than 22º would not occur according to SpaceX.

As noted in Viasat's Petition, an analysis using the 22° isolation angle from GSO that SpaceX specifies in its application and letter produced a worst case I/N of about -19 dB, which equates to a ΔT/T of only 1.2% over a 24 hour orbital simulation run. The cumulative distribution function (CDF) plot of the run in Figure 1 below shows just how infrequently this occurs.

Figure 1: Plot of I/N as a Percent of Time for 75 cm earth station



The plot shows that 99.99% of the time the I/N is less than -20 dB and less than a 1% ΔT/T. Normally, between GSO networks, a coordination trigger of 6% ΔT/T is used. Due to the static nature of the alignments between earth stations and satellites in GSO networks, it is assumed that the 6% ΔT/T would be present 100% of the time. In the case of GSO vs NGSO networks, the alignments are not static, especially for LEO NGSOs having shorter duration

alignments. Therefore, consideration of the magnitude, duration, and frequency of I/N events is necessary and appropriate.

There are several deficiencies in SpaceX's ΔT/T calculations. The technical Exhibit A in the SpaceX June 26 Reply does not indicate how the asserted ΔT/Ts were calculated, what underlying data was used, where the various input values came from, or how they were derived. For example, SpaceX does not indicate which Viasat emission designator is being analyzed, or how much antenna gain is assumed at the various off-axis angles. Moreover, some of the input values appear muddled, such as using a value for EIRP when it seems SpaceX may have intended EIRP density, and the provided mathematical formula lacks an entry for the bandwidth for either system. In addition, SpaceX's Opposition indicates that it based its initial calculations on Viasat earth station EIRPs in a 40 kHz bandwidth, which SpaceX has since corrected to reflect the EIRPs actually specified by Viasat in a 4 kHz bandwidth.

In addition, SpaceX's analysis shows a fundamental misunderstanding of the Viasat's technology and operating parameters. First, SpaceX uses higher power density emissions which are intended for use only in faded conditions. SpaceX ignores clarifying information that Viasat provided in a June 15, 2017 call with SpaceX to discuss Viasat's earth station operations. During this call, Viasat engineers clearly identified that most of the emission designators would only be used during faded conditions, and that it was simply the Viasat practice to list the various emission designators and use the maximum EIRP and EIRP density for each that complies with Section 25.138, and that the 160 MBd symbol rate was the nominal clear sky emission designator for the 75 cm earth station and that the 320 MBd symbol rate was nominally used for the 1.8 m earth station. Further, in some cases, one step down, i.e. 80 MBd and 160 MBd, might be used in edge of coverage for the 75 cm and 1.8 m antennas respectively. Nevertheless,

SpaceX generally used values intended for rain fade conditions in its June 26 Reply even though, as discussed with SpaceX in the case of faded operation and a near in-line event, these carriers would be faded for both Viasat and SpaceX receivers.

The purpose of the emissions to be used during faded operations is to compensate for rain and atmospheric attenuation in the path of the link to the satellite. The choice of emission and amount of power increase corresponds directly to the actual attenuation in the path due to the fading event. When higher power densities are used to offset the effects of rain fade and atmospheric attenuation, the Viasat satellite receiver sees the same power density during the fade as would normally be received in clear sky conditions. Because the SpaceX analysis is considering a near in-line event, the path through the atmosphere between the earth station and space will be attenuated equally for both the Viasat and SpaceX satellite receivers.

Second, SpaceX does not use the correct bandwidth for each system when performing its interference analysis. FCC and ITU filings include emission designators and EIRP density specifically for this reason so that carriers of different sizes can be evaluated with respect to each other. In its analysis, SpaceX converts the Viasat transmitted power to a per hertz value and then assumes that that this same power density will be received uniformly across the entire 500 MHz receive channel bandwidth of the SpaceX system. This method leads to erroneous conclusions for several reasons.

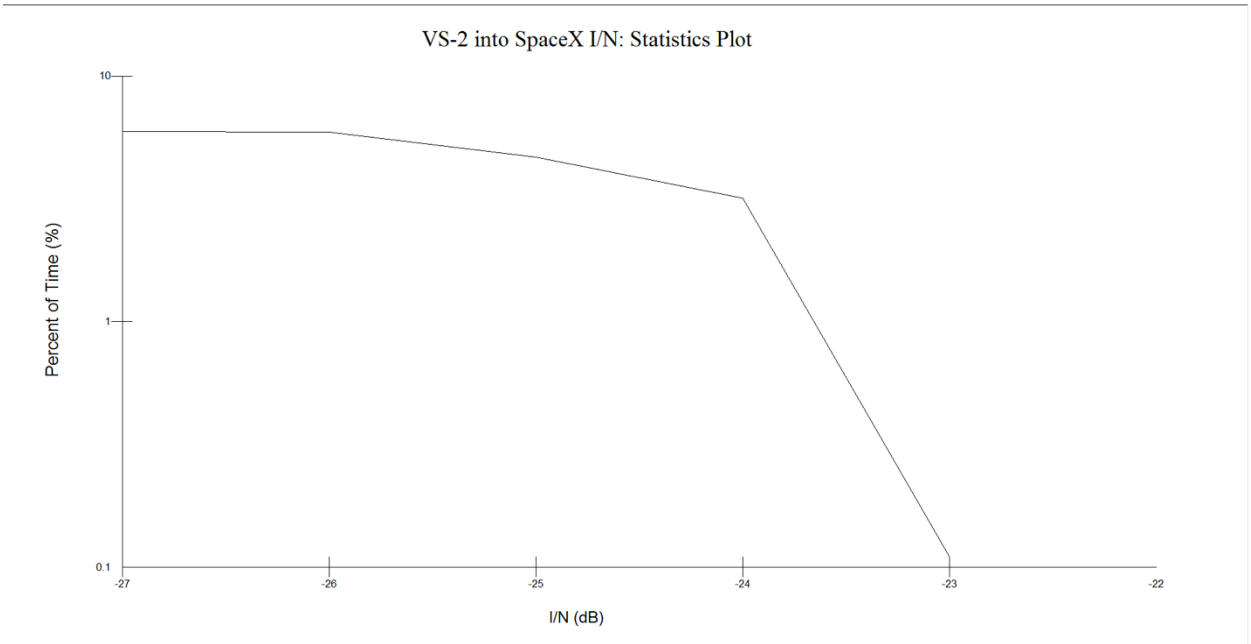
Viasat earth stations use MF-TDMA and only one station may transmit at a time on a given frequency within a satellite beam, but, a given earth station may in the next burst transmit on any other available frequency channel in the 28.6-29.1 GHz band or in any other sub-band available within the beam footprint as assigned by the MF-TDMA scheduler. Because Viasat earth stations are spread throughout its satellite beam, it is unlikely that there will be multiple

earth stations co-located with the SpaceX earth station that will transmit, both at the same time, and on adjacent frequency channels within the 500 MHz channel bandwidth of the SpaceX receiving beam. Rather, it is more likely that the other Viasat earth stations within the same Viasat beam will be at different locations reasonably removed from the SpaceX earth station and will not have the same near in-line alignment as the instant earth station being considered. These transmissions of these stations will be further reduced by the off-axis gain reduction of the SpaceX satellite receiving beam.

By choosing to use only the worst case faded carrier in their analysis and not accounting for the differences in the channel bandwidth, SpaceX is not accounting for the fact that only one, or a small handful, of 5 MHz wide carriers will be operating within their 500 MHz receive channel. Basically, they are assuming 100 times the power of an un-faded Viasat earth station will be operating in the 500 MHz SpaceX receiving channel.

Because Viasat's simulation for the SpaceX network yielded a $\Delta T/T$ of less than 6% at the minimum 22º isolation angle more than 99.99% of the time, Viasat did not provide the results of the simulation for a 30º isolation angle, because a greater isolation angle would result in an even lower $\Delta T/T$ with an even greater percentage of time not exceeding 6% $\Delta T/T$ – in fact, 100% of the time an I/N of -22 dB was never exceeded – see Figure 2.

Figure 2: 30° Isolation I/N vs Percentage of Time for 75 cm earth station



However, to respond to SpaceX's Opposition, Viasat provides an analysis of the 30 degree case. SpaceX does not provide a representative ΔT/T calculation for the 30° separation case of Scenario 2 but rather simply asserts that the calculated ΔT/T is 6% for a 75 cm earth station and 11% for a 1.8 m earth station. In Viasat's calculation here, values are used from the Viasat blanket license application and SpaceX license application as identified in the Tables below:

Table 1: 75 cm Antenna ΔT/T Analysis at ~30° Separation Angle

75 cm Antenna			
Item	Value	Unit	FCC Form 312 question or Comment text
Frequency	28850.0	MHz	(E43)
Antenna diameter	0.745	m	(E33)
Antenna gain	44.0	dBi	(E41)
Input power	25.0	W	(E38)
Emission bandwidth	80.0	MHz	(E47)
EIRP per carrier	57.9	dBW	(E48)
EIRP density	14.9	dBW/4 kHz	(E49)
Off-axis angle to SX satellite	29.0	degrees	As calculated from Visualyse look angles for VS and SX ES
Off-axis gain reduction	51.8	dBc	As calculated by Visualyse (actual VS ant patterns are 55 dBc)
EIRP density toward SX sat	-37.0	dBW/4 kHz	Calculated from EIRP density and off-axis gain reduction
Slant range to SX satellite	1347.0	km	As calculated by Visualyse (sat 490 of planes 1-32 in the simulation)
Path & atm loss to SX satellite	184.9	dB	As calculated by Visualyse
SX satellite receive gain	41.0	dBi	From SX Schedule S for receiving beam GU3/GU7
SX satellite G/T	13.7	dB/K	From SX Schedule S for receiving beam GU3/GU7
SX satellite receiver noise	537.0	K	Calculated from SX Rx Gain and G/T
SX Rx channel bandwidth	500.0	MHz	From SX Schedule S receiving channel CGU7
SX Receiver noise power	-114.3	dBW	Calculated using N=ktB equation and SX noise and bandwidth values
VS received power	-137.8	dBW	Calculated using VS off-axis EIRP density, path loss, and SX Rx gain
I/N	-23.5	dB	Calculated by subtracting SX Rx noise from VS Rx power
Delta T/T	0.447	%	Calculated by standard formula 10^(x/10)*100

In Table 1 above for a 75 cm antenna, the resulting ΔT/T value of 0.45% calculated for a 30° isolation angle is over twelve times lower than the 6% ΔT/T SpaceX reported for the 75 cm earth station using rain-faded EIRP density values (but apparently not accounting for atmospheric attenuation). See SpaceX June 26 Reply at 6.

Table 2 1.8 m Antenna ΔT/T Analysis at ~30° Separation Angle

1.8 m Antenna			
Item	Value	Unit	FCC Form 312 question or Comment text
Frequency	28850.0	MHz	(E43)
Antenna diameter	1.8	m	(E32)
Antenna gain	53.0	dBi	(E41)
Input power	25.0	W	(E38)
Emission bandwidth	160.0	MHz	(E47)
EIRP per carrier	67.0	dBW	(E48)
EIRP density	21.0	dBW/4 kHz	(E49)
Off-axis angle to SX satellite	29.0	degrees	As calculated from Visualyse look angles for VS and SX ES
Off-axis gain reduction	57.5	dBc	As calculated by Visualyse
EIRP density toward SX sat	-36.4	dBW/4 kHz	Calculated from EIRP density and off-axis gain reduction
Slant range to SX satellite	1347.9	km	As calculated by Visualyse (sat 493 of planes 1-32 in the simulation)
Path & atm loss to SX satellite	184.9	dB	As calculated by Visualyse
SX satellite receive gain	41.0	dBi	From SX Schedule S for receiving beam GU3/GU7
SX satellite G/T	13.7	dB/K	From SX Schedule S for receiving beam GU3/GU7
SX satellite receiver noise	537.0	K	Calculated from SX Rx Gain and G/T
SX Rx channel bandwidth	500.0	MHz	From SX Schedule S receiving channel CGU7
SX Receiver noise power	-114.3	dBW	Calculated using N=ktB equation and SX noise and bandwidth values
VS received power	-134.3	dBW	Calculated using VS off-axis EIRP density, path loss, and SX Rx gain
I/N	-20.0	dB	Calculated by subtracting SX Rx noise from VS Rx power
Delta T/T	1.01	%	Calculated by standard formula 10^(x/10)*100

Likewise, in Table 2 above for a 1.8 meter antenna, the 1.01% ΔT/T value calculated for a ~30° isolation angle by Viasat is ten times lower than the 11% value calculated by SpaceX.

It is important to note several assumptions related to the ΔT/T value calculated by Viasat. First, the symbol rates used in each case are the lowest to be used for normal clear sky operation representing an earth station located at the edge of beam coverage. Nominally, for the 75 cm antenna and the 1.8 m antenna the typical operating symbol rate will be one step higher. The terminal bursts at the same maximum 25 W power output and maximum EIRP, but at twice the bandwidth so the EIRP density is reduced by 3 dB, thereby also reducing the I/N by 3 dB. The ΔT/T however, is unchanged. This is because while the EIRP density is reduced by 3 dB, the transmitted bandwidth now being received by the SpaceX receiver is now doubled so the net Viasat power in the SpaceX receiver is unchanged. Similarly, if the operating symbol rate is reduced, the terminal still transmits at the same EIRP, but the EIRP density is now increased by

3 dB. However, the transmitted bandwidth now being received by the SpaceX receiver is halved, and again the resulting ΔT/T is unchanged. It is important to note here, as was also noted above, that SpaceX in their formula for I/N in Exhibit A of the June 26 filing does not include a bandwidth component, assuming wrongly that the received power density from a single Viasat uplink can be applied uniformly across the entire 500 MHz SpaceX receive channel. As described below, this is not the case.

In this simulation, the Viasat earth station and the SpaceX earth stations are assumed to be co-located and that the SpaceX satellite's receiving beam boresight is pointed at both the Viasat and SpaceX earth stations. The Visualyse simulation was configured to use a 41 dBi gain for the SpaceX satellite per the Schedule S filing. Visualyse has options for the antenna gain roll-off and in this case an ITU-R S.1528 recommendation was used with L = -15 dB.

As SpaceX stated in their FCC license application, in the Ka band, usage is limited to communications with SpaceX gateway earth stations. Accordingly, the receiving beams will be tightly focused on the gateways and only operated at elevation angles above 40° above the local horizon. If the Viasat earth station is not co-located with or very near by the SpaceX gateway earth station, the effective gain in the direction of the Viasat earth station is reduced and the I/N drops. In the Visualyse simulation, using the ITU-R roll-off model noted above, moving the Viasat earth station north in latitude by 0.25°, 0.5°, 1°, and 2° result in reductions of 1.2 dB, 8.9 dB, 13.2 dB, and 18.8 dB I/N, respectively.

Like the SpaceX example, the Viasat simulation uses only a single earth station for Viasat and for SpaceX, and separate simulations were performed for the 75 cm and 1.8 m antenna cases. This is reasonable and appropriate given that the Viasat network operates using MF-TDMA such that only a single earth station transmits within a given Viasat satellite beam on

a given frequency at a time. Thus, as discussed above, it is unlikely that multiple earth stations will be co-located near the SpaceX earth station and in the center of the SpaceX receiving beam and transmitting on adjacent frequencies within the 500 MHz receive channel bandwidth of the SpaceX receiver at the same time. Rather, it is realistic to expect that various Viasat earth stations transmitting within the 500 MHz SpaceX receive channel bandwidth will be spread around within Viasat's overall coverage area and most of them will have a larger isolation angle than the 30° assumed for the earth station in the simulation. Also, these earth stations will be further from the SpaceX beam center and as noted above will see a further reduction in the received I/N.

However, even in the worst case where for some brief time several Viasat earth stations transmitted on adjacent channels at the same time such that the entire 500 MHz SpaceX receive channel had Viasat carriers overlapping, the resulting $\Delta T/T$ as calculated above in Tables 1 and 2 would increase at worst by 500 MHz/80 MHz = 6.25 times or to 2.8% in the case of the 75 cm antenna, and 500 MHz/160 MHz = 3.14 times or to 3.14% in the case of the 1.8 m antenna.

Finally, it is worth noting that with respect to the I/N calculations, these are based on a snapshot alignment and do not in any way reflect the percentage of time such alignments might occur in the normal operation of the networks. The majority of the time, in any of the available tracking modes in Visualyse the isolation angle is much larger than 30°, especially given the 40° minimum elevation operational parameters that SpaceX identified in its FCC license application for its Ka band gateways. To even get Visualyse to produce a 30° isolation angle snapshot for analysis required that the range of pointing angles for the SpaceX earth station be limited in such a way as to artificially force the software to generate an alignment. Importantly, in any given 24

hour simulation run, a -12.2 dB I/N value was never observed and the highest value seen was -22 dB which equates to a $\Delta T/T$ of 0.6%.

III. OPERATION OF THE EARTH STATIONS WITH VIASAT-1 DOES NOT CHANGE THE ANALYSIS

SpaceX has noted that Viasat's analysis addressed earth stations communicating with ViaSat-2 and suggests that the analysis should also consider ViaSat-1 as well. As the Viasat earth stations would operate within the limits of the licensed parameters, the EIRP density of the earth stations will be no higher when communicating with ViaSat-1 than with ViaSat-2. A separate Visualyse simulation was performed using the earth station operating parameters as indicated above, except that the satellite point of communication was changed from ViaSat-2 at 69.6° W.L. to ViaSat-1 at 115.1° W.L. No change in I/N values or percentage of time for these values was observed in this alternative simulation.

DECLARATION

I hereby declare that I am the technically qualified person responsible for preparation of the engineering information contained in this Reply of Viasat, Inc. ("Reply"), 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 Reply, and that it is complete and accurate to the best of my knowledge, information and belief.

Daryl T. Hunter, P.E.
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Viasat, Inc.
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January 8, 2018

EXHIBIT C

[REDACTED]