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

In the Matter of	)	
	)	
Viasat, Inc.	)	IBFS File No. SES-LIC-20200811-00852
	)	
Application for Blanket Earth Station License Using Ka-band Spectrum	)	Call Sign E202143
	)	

CONSOLIDATED OPPOSITION TO PETITION AND RESPONSE TO COMMENTS OF VIASAT, INC.

Viasat, Inc. submits this consolidated opposition to the petition to deny filed by Space Exploration Holdings, LLC ("SpaceX") and response to the comments filed by Kuiper Systems LLC ("Kuiper") and Verizon in the above-referenced proceeding involving Viasat's pending Application for authority to operate 1.8 meter and 2.4 meter earth stations on a blanket licensed basis in the Ka band to communicate with the ViaSat-3 satellite.[1] As explained below, no party raises any valid objection to Viasat's Application.

SpaceX's request that the Commission deny the Application is based on SpaceX's false assertion that Viasat has not demonstrated its ability to protect SpaceX's NGSO system in the 18.8-19.3 GHz and 28.6-29.1 GHz band segments (the "Shared Bands"). But Viasat *has* provided extensive technical analysis to the Commission demonstrating as much, on *multiple* occasions. And, tellingly, SpaceX provides no basis for concluding that Viasat's proposed operations would pose an unacceptable risk of harmful interference.

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1 *See* Petition to Deny of Space Exploration Holdings, LLC, IBFS File No. SES-LIC-20200811-00852 (filed July 16, 2021) ("SpaceX Petition"); Comments of Kuiper Systems LLC, IBFS File No. SES-LIC-20200811-00852 (filed July 16, 2021) ("Kuiper Comments"); Comments of Verizon, IBFS File No. SES-LIC-20200811-00852 (filed July 16, 2021) ("Verizon Comments").

For similar reasons, Kuiper's request for a license condition requiring Viasat to demonstrate how it would protect NGSO systems in the Shared Bands is unnecessary and moot (as Viasat has already made the technical demonstrations the condition would require). That said, Viasat appreciates Kuiper's willingness to re-engage with Viasat in coordination discussions and fully expects to continue these discussions until coordination is complete.

Verizon's comments focus on its oft-repeated complaints about the existing out-of-band emission ("OOBE") limits applicable to earth station operations in the 28.35-28.6 GHz band. Notably, Verizon does *not* allege that Viasat's proposed operations would violate any Commission rule or policy. Rather, its comments improperly attempt to relitigate issues already resolved in rulemakings of general applicability.

Accordingly, the Commission should grant the Application without delay.

I. SPACEX'S PETITION IS WITHOUT MERIT

SpaceX's Petition identifies *no* technical defect in Viasat's Application, and *no* basis for concluding that the operations proposed therein would pose any risk of harmful interference to the SpaceX system in the Shared Bands. Instead, SpaceX asserts that Viasat allegedly has made "no showing of non-interference" with respect to its proposed operations in the Shared Bands and suggests that it would be inappropriate to grant the Application for this reason.[2] SpaceX's position is without merit.

As an initial matter, Viasat has already established that the ViaSat-3 network would operate in the Shared Bands without posing any risk of harmful interference to NGSO systems, including Starlink. Notably, the authorization for the ViaSat-3 satellite was issued after Viasat provided technical analysis specifically demonstrating that it could and would protect such

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[2] SpaceX Petition at 1.

systems, and the subsequent ViaSat-3 authorization incorporates conditions designed to ensure that the ViaSat-3 network operates in a manner consistent with that demonstration. Viasat's Application references those conditions—and, implicitly, the underlying technical analysis in which they are grounded.[3] The Commission has already found that analysis, and the resulting conditions, to be sufficient to protect NGSO operations in the Shared Bands. There is no basis for revisiting that decision now.

Viasat has also separately demonstrated, on multiple occasions, that its earth station operations in the Shared Bands would not pose any risk of harmful interference into NGSO operations. For example:

- In December 2017, Viasat provided the Commission with a detailed technical analysis demonstrating that Viasat earth station operations in the Shared Bands would not pose a risk of harmful interference into existing and proposed NGSO systems.[4] That analysis is attached hereto as Exhibit 1.
- In January 2018, Viasat provided the Commission with additional technical analysis responding to questions that SpaceX had raised with respect to Viasat's earlier analysis. Viasat responded in short order and addressed those questions, further demonstrating that Viasat earth station operations would not cause harmful interference to SpaceX operations in the Shared Bands (SpaceX did not reply).[5] That analysis is attached hereto as Exhibit 2.
- In May 2020, Viasat provided the Commission with a summary of technical coordination terms that had been mutually identified by Viasat *and* SpaceX as sufficient to protect SpaceX's NGSO operations in the Shared Bands from Viasat earth station operations.[6] That summary is attached hereto as Exhibit 3.

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3 *See* IBFS File No. SES-LIC-20200811-00852, Exh. A at 2 (filed Aug. 11, 2020) ("Viasat Narrative").

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

5 *See* Reply of Viasat, Inc., IBFS File No. SES-LIC-20170401-00357, Att. 1 (Jan. 8, 2018).

6 *See* Letter of Viasat, Inc. to FCC, Call Signs E170088, E180006 and E190201 (filed May 18, 2020).

- In April 2021, Viasat provided the Commission with still further technical analysis, this time modelling the potential for interference from Viasat earth station operations into SpaceX's modified NGSO system.[7] Again, Viasat's analysis established that the risk of harmful interference into SpaceX's authorized system is negligible.[8] That analysis is attached hereto as Exhibit 4.

The earth stations that are the subject of the instant Application pose even less of an interference risk than those evaluated in the above-referenced technical analyses. The earth stations that Viasat proposes in the instant Application are optimized for use in Viasat's satellite access nodes ("SANs") and transmit with maximum gains that are about a dB lower than is the case with the earth stations analyzed previously. In addition, the proposed earth stations would transmit with lower EIRP density (about 3.4 dB lower) across a much wider modulated bandwidth. The result is a further reduction in any possibility of harmful interference.

Perhaps knowing that it has no valid technical objection to Viasat's Application, SpaceX next claims that Viasat's Application should not be granted based on false *allegations* that SpaceX has made in another proceeding with respect to other, existing Viasat earth station

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7 *See* Consolidated Opposition to Petition and Response to Comments of Viasat, Inc., IBFS File No. SES-MOD-20200923-01031, Technical Annex (filed Apr. 29, 2021) ("April 2021 Opposition").

8 Notably, SpaceX's authorization requires it to operate with an 18-degree exclusion angle from the GSO arc. *See Space Exploration Holdings, LLC*, FCC 21-48, at ¶ 45 (rel. Apr. 27, 2021); *see also id.* ¶ 97(s) ("SpaceX must operate consistent with the technical specifications provided to the Commission, including any supplemental specifications, in connection with this Third Modification Application, including antenna beam patterns and other technical information."). The implementation of this exclusion angle was a critical assumption in SpaceX's underlying interference analysis. *See* Consolidated Opposition to Petitions and Response to Comments of Space Exploration Holdings, LLC, IBF File No. SAT-MOD-20200417-00037, at A8 (filed July 27, 2020) (responding to O3b's interference concerns by asserting that "O3b's analysis appears not to have accounted for the 18 degree GSO avoidance angle observed by the SpaceX system which will continue to prevent these in-line events"). The exclusion of the GSO arc similarly helps to reduce the potential for interference between the SpaceX and Viasat systems. *See* April 2021 Opposition at 4-6 & Technical Annex.

operations.[9] Viasat has already demonstrated in the context of that proceeding that SpaceX's allegations: (i) are premised upon claims that SpaceX knows to be false; (ii) fail to disclose key facts to the Commission, demonstrating a stunning lack of candor; and (iii) are otherwise without merit.[10] Viasat has also demonstrated that SpaceX's allegations are part of a broader pattern of bad-faith conduct intended to retaliate against Viasat for its advocacy in still other Commission proceedings.[11] SpaceX has never even *attempted* to explain its misconduct, claiming only that it "feels no need to respond."[12] The Commission should not countenance SpaceX's efforts to extend its abuse of Commission processes to the instant application proceeding.

II. NO OTHER PARTY PROVIDES A BASIS FOR DENYING VIASAT'S APPLICATION

Neither Kuiper's nor Verizon's comments with respect to Viasat's Application provides a basis for denying the Application or imposing conditions on any grant thereof.

A. Kuiper

Kuiper does not object to grant of Viasat's Application, but requests that the Commission condition any grant on Viasat completing coordination with Kuiper or demonstrating that it will

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9 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 Sept. 18, 2020).

10 *See* Reply of Viasat, Inc., IBFS File Nos. SES-LIC-20170401-00357, SES-LIC-20190411-00503, and SES-MOD-20191216-01737, at 1-4 (filed Oct. 26, 2020); Response of Viasat, Inc. to Show Cause Request, IBFS File Nos. SES-LIC-20170401-00357, SES-LIC-20190411-00503, and SES-MOD-20191216-01737, at 1-4 (filed Oct. 1, 2020); Motion to Strike of Viasat, Inc., IBFS File Nos. SES-LIC-20170401-00357, SES-LIC-20190411-00503, and SES-MOD-20191216-01737, at 1-11 (filed Oct. 1, 2020).

11 *Id.*

12 Consolidated Reply of Space Exploration Holdings, LLC, IBFS File Nos. SES-LIC-20170401-00357, SES-LIC-20190411-00503, and SES-MOD-20191216-01737, at 5 n.6 (filed Oct. 14, 2020).

not cause harmful interference to the Kuiper system.[13] There is simply no need for such a condition. Kuiper acknowledges that Viasat's existing space station authorization *and* the Commission's rules already protect NGSO systems operating in the Shared Bands.[14] At the same time, Kuiper fails to provide *any* technical analysis showing that there would be a risk of harmful interference to its system from Viasat's proposed earth station operations.

In any event, and as discussed above, Viasat *has* provided extensive technical analysis demonstrating that Viasat earth station operations in the Shared Bands would not cause harmful interference to NGSO systems operating within their expected parameters. Thus, the premise underlying Kuiper's request—that Viasat has not addressed these matters previously—simply is not true.[15] This technical analysis effectively demonstrates that the condition requested by Kuiper has *already* been satisfied, rendering its request moot.

Regardless, Viasat has long stood ready to coordinate with Kuiper (as Kuiper recognizes) and agrees that the parties should be able to coexist peacefully in the Shared Bands.[16] Toward that end, Viasat notes that it has reinitiated coordination discussions with Kuiper and fully expects to continue these discussions until coordination is complete.

B. Verizon

Viasat's Application seeks authority to operate earth stations in the 18.3–19.3 GHz and 19.7–20.2 GHz downlink frequencies, and the 28.35–29.1 GHz and 29.5–30.0 GHz uplink

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[13] Kuiper Comments at 1.

[14] *Id.* at 2.

[15] *See id.* at 3.

[16] *Id.*

frequencies.[17] Verizon suggests that Viasat's operations may cause harmful interference to terrestrial operations in the adjacent 27.5-28.35 GHz band.[18] Upon closer inspection, it is clear that Verzion's issue is not with the specific operations proposed by Viasat in its Application, but rather with the existing OOBE limits applicable to earth station operations in the 28.35-28.6 GHz band. Indeed, Verizon concedes that "Viasat's operations will comply with the OOBE limit in Section 25.202(f),"[19] and does not allege that Viasat's proposed operation would violate *any* Commission rule.

Contrary to Verizon's suggestion, the *Part 25 Streamlining Order* does not give Verizon *carte blanche* to use this proceeding to make collateral attacks on the Commission's established licensing procedures. Verizon quotes that order in misleading fashion, claiming that "the Commission stressed that 'adjacent-band terrestrial operators will have an opportunity to . . . request additional information regarding the earth station operations' in response to a satellite operator's technical submissions."[20] Verizon fails to mention that the statement was made: (i) with respect to applications for new "unified licenses" (which are not implicated here); (ii) after the Commission *rejected* Verizon's request to require applicants to submit more detailed information about planned operations under a proposed "unified license;" and (iii) merely to note that Verizon would nevertheless remain free to comment on applications once they went on public notice.[21] Verizon also ignores that, in the very same order, the Commission explicitly

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17 Viasat Narrative at 1.

18 Verizon Comments at 2.

19 *Id.* at 5.

20 *Id.* at 4-5 (quoting *Further Streamlining Part 25 Rules Governing Satellite Services*, 35 FCC Rcd 13285, at ¶ 21 (2020) ("*Part 25 Streamlining Order*")).

21 *See Part 25 Streamlining Order* ¶ 21.

"reject[ed] any suggestion by Verizon" that it was necessary to "revisit blanket FSS licensing" in "bands adjacent to UMFUS operations."[22]

In short, the issues raised by Verizon are outside of the scope of this proceeding, which should not be used to relitigate issues resolved in rulemakings of general applicability.

III. CONCLUSION

As no party raises any valid objection to the Commission granting Viasat's Application, the Commission should proceed to do so without delay.

Respectfully submitted,

/s/

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July 29, 2021

[22] *Id.* ¶ 19.

DECLARATION

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

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July 29, 2021

EXHIBIT 1

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 x 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.

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December 11, 2017

EXHIBIT 2

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)

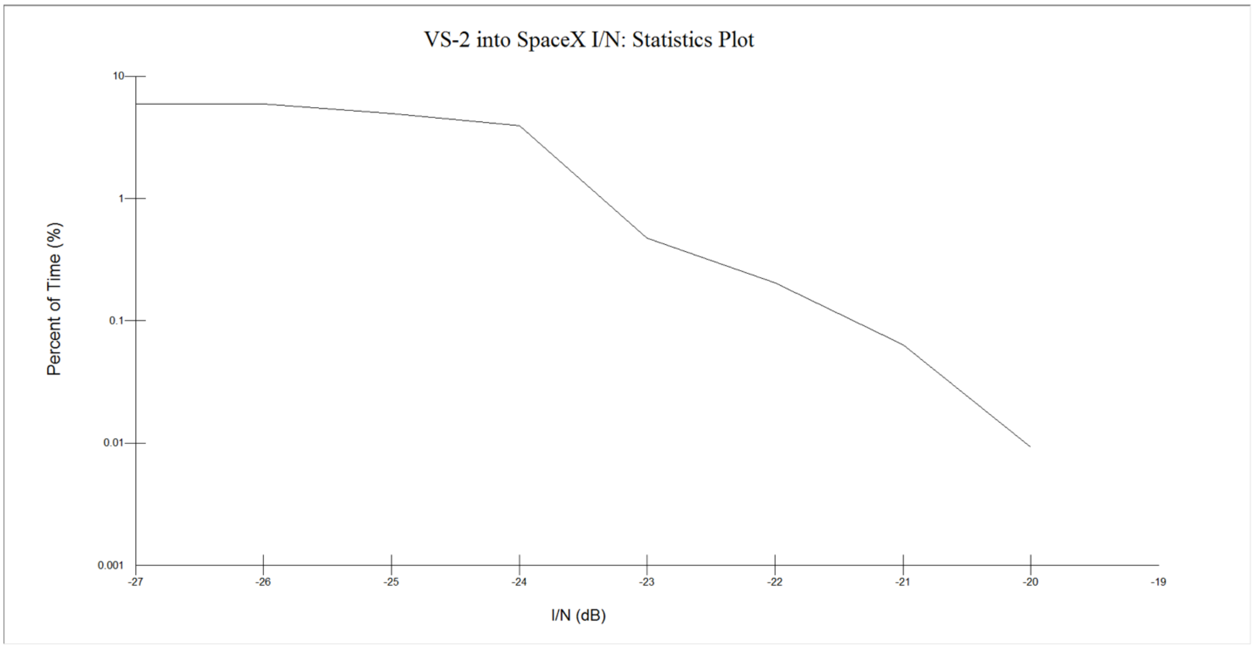
The nature of the SpaceX network operations described in its FCC license application therefore precludes the type of in-line event described in Scenario 1, because no SpaceX satellite will operate within 22° of the GSO arc. This impossibility of Scenario 1 ever arising was confirmed in the June 9, 2017 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.

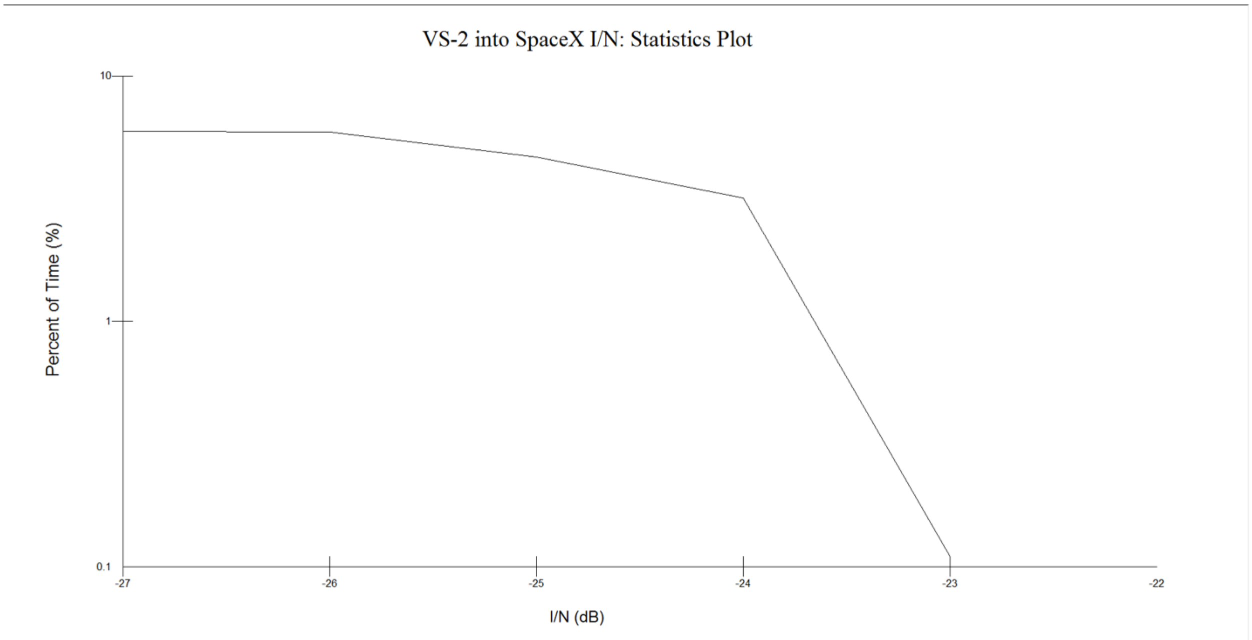
Second, SpaceX does not use the correct bandwidth for each system when performing its interference analysis. FCC and ITU filings include emission designators and EIRP density specifically for this reason so that carriers of different sizes can be evaluated with respect to each other. In its analysis, 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 ΔT/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.

REGISTERED PROFESSIONAL ENGINEER · DARYL T HUNTER · E 16610 · ELECTRICAL · STATE OF CALIFORNIA

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January 8, 2018

EXHIBIT 3

[REDACTED]

EXHIBIT 4

<u>TECHNICAL ANNEX</u>

Viasat's Application provides detailed technical analysis demonstrating the absence of predicted harmful uplink interference from the operations under E170088 into various NGSO systems using the NGSO-primary spectrum.

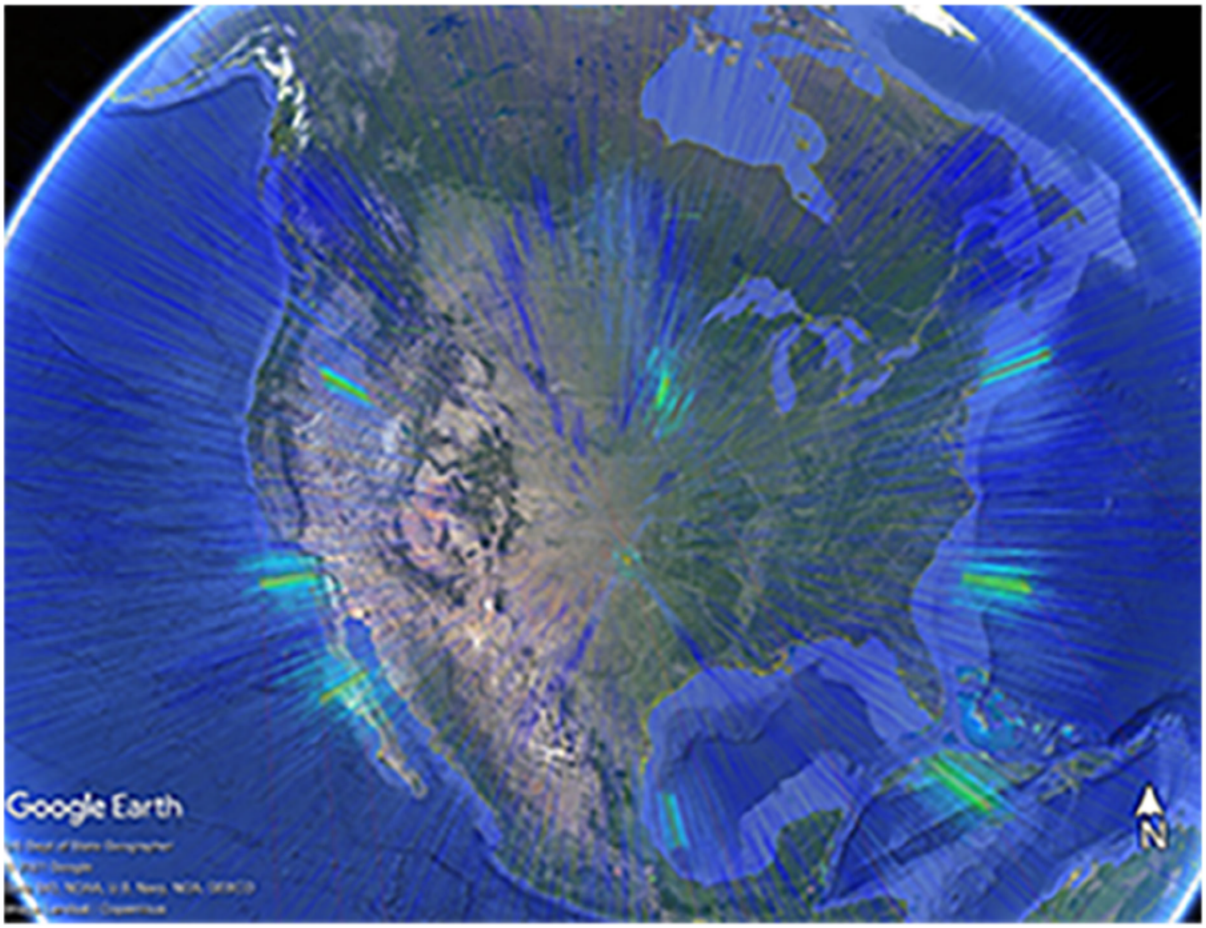
More specifically, Viasat conducted simulations using Visualyse software from Transfinite Systems, Ltd. on the filed characteristics of each of the various NGSO systems covering the NGSO-primary portion of the Ka band, and the characteristics of the ViaSat-2 blanket license earth stations, to determine the potential for causing harmful interference into those NGSO systems under various operating conditions. The simulation software produced, 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. Consistent with the technical analyses provided during the application process, this analysis focused on the uplink case.

In SpaceX's case, Viasat evaluated multiple tracking strategies, 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 had proposed at that time in order to meet the Article 22 epfd limits in band segments where those limits apply **{{BEGIN CONFIDENTIAL}}**

{{END CONFIDENTIAL}}. In no case was a -12.2 dB I/N exceeded in any of the scenarios.

In addition to the prior work using Visualyse, further analysis was performed to model the same -12.2 dB I/N case from locations in CONUS, as discussed below The orbits in the SpaceX mod 3 NGSO constellation were simulated and the received power from Viasat Earth Stations transmitting to the Viasat GSO system for each NGSO satellite for their orbital positions at each timestep in the simulation. From this, using the characteristics of the SpaceX NGSO and Viasat GSO systems, the interference-to-noise ratio ("I/N") was calculated for each satellite at each time step. If a satellite received interference near to (3 dB less) or in exceedance of the -12.2 dB reference value, a finer step (0.1 seconds) was used to loop over the position of that satellite until it is exited of the zone of interference to get an accurate measure of the total time said satellite was in exceedance of the reference from that transmitter. That result was added to the total exceedance time for that satellite. The results aligned with the previous analysis. Key findings from the simulations were (1) the percentage of time in which the -12.2 dB I/N was exceeded was 0.613% and (2) the average interference time across all cases was 0.029 seconds. These figures are based on clear sky conditions and do not take into account rain fading or other atmospheric conditions which would (a) decrease the recorded I/N values, and (b) reduce the percentage of time the I/N threshold was exceeded. Further, for simplicity in modeling, duty cycle was not considered. Taking these into account, the target I/N of -12.2 dB would be met > 99.9% of the time.

The map below illustrates the relative amount of interference from these terminals into each SpaceX satellite. Lines coming up toward the SpaceX system represent the peak I/N calculated to each satellite. Blue and Green lines denote values below and well below the threshold. Red lines represent satellites that have, at any point, received power above that level. The key takeaway is that hardly any red lines are visible on the map.



Analysis of Simulation Results included In SpaceX Petition to Deny

<u>SpaceX's Unrealistic Decision *Not* to Exclude the GSO Arc in Its Analysis</u>

The simulations underlying SpaceX's Petition are fatally flawed because they do not incorporate any exclusion angle with respect to the GSO arc. Consequently, the simulations in no way reflect reality. Indeed, practical considerations dictate that SpaceX *will* need to avoid the GSO arc:

1) NGSOs must comply with Article 22 epfd limits in the bands subject to Article 22. Compliance with these limits requires an 18° exclusion angle from GSO. While the Article 22 limits do not apply in the 28.6-29.1 GHz and 18.8-19.3 GHz bands, use of the remainder of the bands on each satellite effectively dictates these bands observe the same 18° exclusion angle.

2) As noted above, the Ku band user links on the SpaceX satellites are subject to Article 22 limits and must observe an 18° exclusion angle with respect to GSO. SpaceX has no user traffic in the 28.6-29.1 GHz or 18.8-19.3 GHz band and may only operate user links outside the defined 18° exclusion angle with GSO. Therefore, gateway transmissions within the exclusion angle with respect to the GSO arc do not pass traffic and have no useful purpose.

3) SpaceX completely ignores the 28.6-29.1 GHz and 18.8-19.3 GHz traffic from all other GSO satellites and focuses on only Viasat's uplink and downlink transmissions. Even if Viasat does not operate in this band in the US, SpaceX would still receive interference from other GSO operators in this band should it operate with no exclusion angle from GSO.

4) SpaceX ignores the fact that any operation with no exclusion angle from GSO would result in harmful interference into GSO Networks providing service outside the US, which have ITU date priority over SpaceX ITU filings.

5) When suggesting SpaceX will operate in the 28.6-29.1 GHz and 18.8-19.3 GHz bands with no exclusion angle with respect to GSO, SpaceX likewise ignores that uplink transmissions from earth stations of ITU Networks operating just outside the US or in international waters or airspace immediately outside the US will cause very high levels of interference into any SpaceX satellites operating without exclusion angle to GSO, rendering its US gateway links impaired well inside the US borders.

As noted above, Viasat's previous analysis *did* properly incorporate an exclusion angle from the GSO arc. Incorporating that exclusion angle, in and of itself, eliminates the interference that SpaceX predicts through its simulations.

This result was unsurprising given that SpaceX chose an 18° exclusion angle as part of its operational strategy for the Article 22 bands where it is afforded no protection from GSO transmissions – transmissions with the very same characteristics as the 28.6-29.1 GHz band. If SpaceX were expecting unacceptable interference from GSO earth stations at an 18° exclusion angle it would not have opted on its own to decrease the exclusion angle from 22° down to 18°.

<u>SpaceX's Unreasonable Choice of Interference Threshold</u>

In setting up its analysis, SpaceX has attempted to develop an I/N value it feels is acceptable rather than use the existing ITU-R Recommendation S.1323. Instead of relying on the work of global experts, SpaceX tries to back into a value it feels appropriate. The method SpaceX puts forth is inappropriate, however, as it does not consider the time varying component of interference between NGSOs and GSOs. SpaceX assumed its choice of a -17.7 dB I/N should apply 100% of the time. This criterion is wrong on several points.

S.1323 was developed specifically for use in the context of NGSO systems and considers both long term and short-term interferences. The recommendation considers a 6% increase in thermal noise a reasonable value to be exceeded not more than 10% of the time and allows for significantly higher values to be exceeded for small periods of time.

Further, as noted above, the received I value at SpaceX receivers from Viasat earth stations operating in the 28.6-29.1 GHz band is exactly the same as the I value in the Article 22 bands and SpaceX by choosing to change its exclusion angle from 22° to 18° has demonstrated that this level of interference is acceptable regardless of the criteria applied as the two interference values are equal.

SpaceX makes matters worse in its discussion of supposed "actual" interference received at its gateway sites. In that discussion, SpaceX dispenses with any interference threshold at all, and simply treats transmissions received as "harmful interference." But as SpaceX should know, merely receiving a signal from another operator does not make that signal "harmful" under the FCC's rules or relevant ITU-R recommendations. In any event SpaceX only is able to make such measurements by ignoring the 18° exclusion angle and statically pointing directly at certain satellites.

<u>Other Issues with SpaceX's Technical Analysis</u>

The technical analysis filed by Viasat in January 2018 (attached as Exhibit B to the Application) corrected numerous, faulty assumptions made by SpaceX in its December 2017 submission in connection with the E170088 license. SpaceX never responded to Viasat's analysis—even though it has been on the record for *years*. Worse, SpaceX now repeats many of its previous errors—including its reliance on bad data—and, thus, generates invalid results.

In addition to SpaceX's failure to incorporate any exclusion angle with respect to the GSO—which, in and of itself, is fatal—its technical analysis relies on deeply flawed assumptions about how Viasat's earth stations operate. For example:

- The use of a 100% duty cycle to represent traffic from Viasat's MF-TDMA network is wholly inappropriate. In normal operation user terminals transmit infrequently, averaging less than 1% duty cycle over time. In its filing, SpaceX wrongly construes the 6.25% worst case duty cycle information used in Viasat's Radiation Hazard Analysis as being the operational duty cycle for the terminal. This is wholly inappropriate, as the Viasat network has operated for years within the 1% threshold. The further leap from 6.25% to 100% has no basis in reality.

- The nominal clear sky emissions in the ViaSat-2 network are 80M0G7D and 160MG7D. Use of the 5M00G7D emission at the maximum input power to represent clear sky traffic grossly overstates the normal user terminal EIRP density. Viasat addressed this misapplication of data in its January 2018 technical demonstration. On page 5 of that submission, Viasat noted that SpaceX had "use[d] higher power density emissions which are intended for use only in faded conditions [and] ignore[d] clarifying information that Viasat provided in a June 15, 2017 call with SpaceX to discuss Viasat's earth station operations."

- SpaceX compounds the issue caused by its incorrect assumption by claiming that the mere fact that Viasat's license allows it to operate at full power implies that "Nothing in the terms of Viasat's license limits the power of its transmissions in clear sky condition." Yet, SpaceX knows that this is not the case for Viasat or any GSO operator. The ability to increase power or power density to mitigate rain fade is well understood in the industry and specifically allowed in the FCC Part 25 rules. SpaceX also knows that the increased power density used during these rain faded conditions is attenuated by the rain such that the power density into its systems is unchanged from clear sky conditions, just as it is into Viasat's. Further, the SpaceX argument is inconsistent with its own claims in other contexts. For example, when SpaceX requested the ability to exceed its power limits during satellite acquisition, SpaceX discussed the brief and infrequent use of the higher power. Yet, there is nothing in their grant that would limit them in such a way.

DECLARATION

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

Daryl T. Hunter, P.E.
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April 29, 2021

CERTIFICATE OF SERVICE

I, Kayla Ernst, hereby certify that on this 29th day of July 2021, I caused to be served a true copy of the foregoing Consolidated Opposition to Petition and Response to Comments of Viasat, Inc. via first-class mail upon the following:

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Kayla Ernst