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	)	File No. SES-LIC-20170401-00357

REPLY OF SPACE EXPLORATION HOLDINGS, LLC

Space Exploration Holdings, LLC ("SpaceX") hereby replies to the Opposition and Response[1] filed by ViaSat, Inc. ("ViaSat") in response to filings by SpaceX and O3b Limited ("O3b") on ViaSat's application for a blanket license to deploy four million 0.75 meter and ten thousand 1.8 meter fixed earth stations throughout the United States.[2] Both SpaceX and O3b raised concerns about ViaSat's proposal to use the 28.6-29.1 GHz band – which the Commission has designated for non-geostationary satellite orbit ("NGSO") operations on a primary basis – for its earth station communications with two of its geostationary satellite orbit ("GSO") space stations. Unfortunately, ViaSat's Response did not provide a sufficient demonstration that its proposed operations in this band will not cause harmful interference to NGSO systems.

ViaSat has previously been authorized to operate a version of the 0.75 meter earth station at issue in this proceeding in the NGSO bands, under call sign E100143. It has also been granted authority to provide service in the United States using these bands from

[1] *See* Opposition and Response of ViaSat, Inc., IBFS File No. SES-LIC-20170401-00357 (June 15, 2017) ("ViaSat Opposition").

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

two GSO satellites, ViaSat-1 and ViaSat-2. In each case, however, ViaSat was required not to cause harmful interference to any system authorized to operate on a primary basis in the 28.6-29.1 GHz band.[3] Both SpaceX and O3b have requested that ViaSat demonstrate that the proposed earth stations can comply with this requirement before the Commission grants this application.

ViaSat did not provide a technical non-interference analysis with its Opposition. Rather, it asserted that its ability to cease transmission in the NGSO bands during periods when an NGSO satellite and a ViaSat satellite are "in line" (*i.e.*, separated by a specified "trigger angle" when viewed from the surface of the Earth) will be sufficient to prevent interference.[4] ViaSat noted that it had similarly relied upon such an avoidance of in-line events analysis in its market access applications for ViaSat-1 and ViaSat-2.[5] Although ViaSat conceded (as SpaceX and O3b argued) that those previous analyses did not reflect the sorts of systems proposed in the current NGSO processing round,[6] it argued that this fact is irrelevant because, to the extent additional NGSO systems launch, "the chance of an in-line event with ViaSat-2 may increase, but the mitigation technique ViaSat will employ will be the same."[7]

Yet it is not just the chance of an in-line event that will change, but the nature of such events as well. In the analyses submitted with the ViaSat-1 and ViaSat-2

---

[3] *See* Radio Station Authorization, IBFS File No. SES-LIC-20101217-01585, Special Provision 9970 (Oct. 20, 2011); ViaSat-1 Authorization, IBFS File No. SAT-LOI-20080107-00006, Attachment at preamble (Aug. 18, 2009); ViaSat-2 Authorization, IBFS File No. SAT-LOI-20130319-00040, Attachment at ¶ 9 (Dec. 12, 2013).

[4] *See* ViaSat Opposition at 4-5.

[5] *See id.* at 2-3.

[6] *See* Public Notice, Applications Accepted for Filing, DA 17-524 (IB, rel. May 26, 2017).

[7] ViaSat Opposition at 4.

application, ViaSat evaluated its potential impact on three systems – O3b's mid-Earth orbit ("MEO") system of eight satellites and a single gateway earth station, and two other proposed NGSO systems in highly elliptical orbit ("HEO").[8] Significantly, because of the particular characteristics of these systems, the smallest possible separation angle between a ViaSat satellite and an NGSO satellite was very large – 30 degrees for O3b and 27.4 degrees for the HEO systems. As a result, the analysis showed ΔT/T well below the 6% level that the Commission has used as the metric to conclude that a GSO system will not cause harmful interference to NGSO operations.[9]

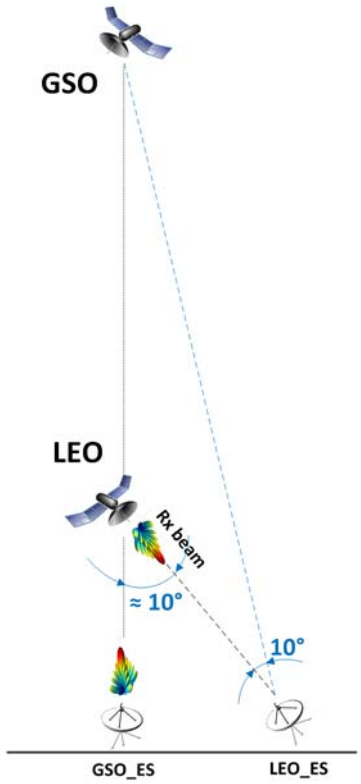
Because many of the NGSO system proposals currently under consideration (including SpaceX's) vary significantly from the MEO and HEO systems ViaSat previously evaluated, the prior analysis would be largely inapposite. For example, consider two in-line scenarios involving the system proposed by SpaceX, which will have 4,425 satellites operating in 83 orbital planes in low-Earth orbit ("LEO") at altitudes ranging from 1,110 km to 1,325 km. As illustrated below for a 10º separation angle, in Scenario 1, the SpaceX LEO satellite is in the main beam of the ViaSat GSO earth station uplink. This creates an in-line event from the ViaSat earth station's perspective, but SpaceX can redirect spectrum to provide service in areas outside the 10 degree impact

---

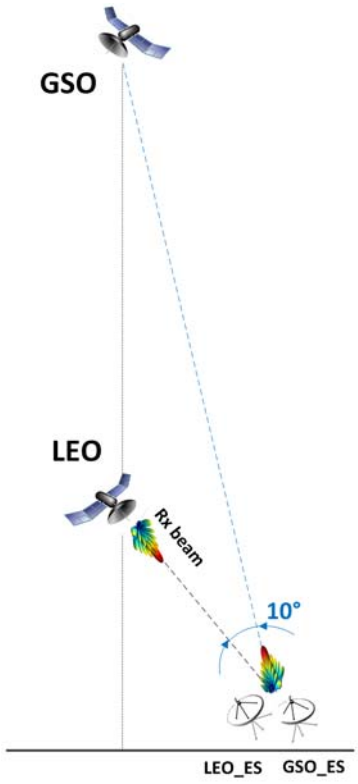
[8] *See* ViaSat-1 Application, IBFS File No. SAT-AMD-20080623-00131, Technical Annex at 15-19 (June 23, 2008); ViaSat-2 Application, File No. SAT-LOI-20130319-00040, Technical Annex at 10-16 (Mar. 19, 2013).

[9] *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).

zone.[10] In Scenario 2, the SpaceX and ViaSat earth stations are essentially collocated and their respective satellites are at the edge of an in-line event.



Scenario 1



Scenario 2

Using operational parameters from the SpaceX and ViaSat applications,[11] we can determine ΔT/T assuming various separation angles to define an in-line event.

Table 1 sets forth the analysis of the impact of ViaSat's proposed earth station operations in the 28.6-29.1 GHz band (for both the 75 cm and 1.8 m antennas) in Scenario 1 assuming separation angles of 10, 20, and 30 degrees.[12]

---

[10] Note that, given the extreme difference between LEO and GSO altitudes, the separation angle between GSO_ES and LEO_ES from the LEO satellite perspective is essentially the same as the angle between GSO and LEO from the LEO_ES perspective.

[11] For the following analysis, SpaceX used the lowest orbital altitude for its system (1,110 km), satellite receive antenna gain at nadir of 41 dB, satellite receive G/T at nadir of 13.7 dB/K, and determined off-axis gain using the formula 32-25log(ϕ) from Recommendation ITU-R S.465-6, *available at* https://www.itu.int/dms_pubrec/itu-r/rec/s/R-REC-S.465-6-201001-I!!PDF-E.pdf. The complete technical characteristics of the SpaceX NGSO system can be found at IBFS File No. SAT-LOA-20161115-00118.

	75 cm Earth Station	1.8 m Earth Station
ΔT/T [%] @ 10º separation	167%	2,556%
ΔT/T [%] @ 20º separation	30%	452%
ΔT/T [%] @ 30º separation	11%	164%

Table 1. ViaSat Impact Under Scenario 1 at Various Separation Angles

As this table demonstrates, the earth stations proposed by ViaSat would have a severe impact on SpaceX's operations in this band – far more than the 6% ΔT/T standard for non-interference previously used by ViaSat and the Commission even at separation angles of 30 degrees. It is worth noting that the 1.8 meter earth station – which was not analyzed or authorized in ViaSat's previous blanket earth station license – is particularly problematic, notwithstanding ViaSat's expectation that this larger antenna would be able to function with even smaller separation angles than the 75 cm earth station.[13]

Yet this analysis fails to capture the full impact of ViaSat's operations. In order to minimize the impact of in-line events – and thereby maximize the productive use of spectrum by each system – the acceptable separation angle must be minimized to the extent possible. A large separation angle will significantly limit the ability of a satellite with steerable beams to use a frequency subject to an in-line event in an unaffected area. This concept is illustrated in Figure 2, which shows the coverage area of a SpaceX satellite and the areas within which spectrum subject to an in-line event may not be used

---

[12] Exhibit A hereto shows the methodology for the calculations underlying Tables 1 and 2, as applied to the 10º separation angle used for spectrum sharing among NGSO systems. *See* 47 C.F.R. § 25.261. This analysis uses the maximum EIRP density requested in ViaSat's application for operations in the 28.6-29.1 GHz band. ViaSat asserts that it uses full power "mainly" in faded conditions (ViaSat Opposition, Exh. 1 at 1), but the requested authorization would include no such limitation. Moreover, contrary to ViaSat's assertion (*id.* at 1-2), the use of higher symbol rates will not reduce the EIRP density of earth station uplink transmissions.

[13] *See* ViaSat Opposition, Exh. 1 at 2 ("The 1.8 meter earth station also has a considerably reduced beam width as compared to a 75 cm earth station, and accordingly would have a lower separation angle for an NGSO system than a 75 cm earth station.")

in order to achieve a 10, 20, or 30 degree separation angle. Given that the maximum steering range of a SpaceX beam is just over 40 degrees, it is easy to see how larger separation angles preclude use of spectrum over significant portions of the footprint, reducing spectral efficiency and robbing the system of capacity for service to customers.

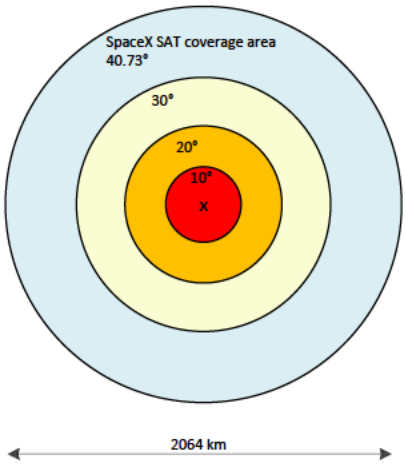


Figure 2. Limitations Imposed by Various Separation Angles

Table 2 sets for the ΔT/T effects of ViaSat's proposed earth stations in Scenario 2 assuming separation angles of 10, 20, and 30 degrees.

	75 cm Earth Station	**1.8 m Earth Station**
ΔT/T [%] @ 10° separation	86%	165%
ΔT/T [%] @ 20° separation	15%	29%
ΔT/T [%] @ 30° separation	6%	11%

Table 2. ViaSat Impact Under Scenario 2 at Various Separation Angles

Here again, the impact generally far exceeds the 6% ΔT/T level. Only in the case involving the smaller antenna and largest separation distance does it meet that metric – but in the process greatly restricts the areas where SpaceX could redirect its beam to avoid interference.

In this proceeding, ViaSat does not commit to observe any particular separation angle to protect NGSO systems during in-line events. Nor does ViaSat commit to

observe the 6% ΔT/T criterion for protection of NGSO systems. Nor has it submitted any actual analysis of potential in-line events to demonstrate how it would propose to implement an avoidance of in-line events strategy to avoid causing interference to NGSO systems in the 28.6-29.1 GHz band. These are significant shortcomings for an applicant that seeks authority to operate on a non-interference basis.

The Commission has only designated two bands (18.8-19.3 GHz and 28.6-29.1 GHz) for use by NGSO systems on a primary basis. If it were to allow GSO systems to compromise that spectrum, the Commission would put at risk a new generation of high-capacity, low-latency satellite broadband services. Unless and until ViaSat demonstrates that it can operate on a non-interference basis with a range of NGSO systems (including LEO systems) in the 28.6-29.1 GHz band, or undertakes prophylactic commitments sufficient to ensure protection of NGSO systems, the Commission should defer consideration of this application.

Respectfully submitted,

SPACE EXPLORATION TECHNOLOGIES CORP.

By: */s/ Tim Hughes*
Tim Hughes
Senior Vice President, Global Business and Government Affairs

Patricia Cooper
Vice President, Satellite Government Affairs
SPACE EXPLORATION TECHNOLOGIES CORP.
1030 15th Street, N.W.
Suite 220E
Washington, DC 20005
202-649-2700 tel
202-649-2701 fax

William M. Wiltshire
Paul Caritj
HARRIS, WILTSHIRE & GRANNIS LLP
1919 M Street, N.W.
Suite 800
Washington, DC 20036
202-730-1300 tel
202-730-1301 fax

Counsel to SpaceX

June 26, 2017

EXHIBIT A
REPRESENTATIVE ΔT/T CALCULATION METHODOLOGY

Scenario 1 @ 10° Separation

SpaceX SAT Rx antenna G/T @ nadir [dB/K]	13.70
SpaceX SAT Rx antenna G/T @ 10° [dB/K]	-20.30
75 cm Earth Station	
ViaSat ES EIRP [dBW/40kHz]	22.43
ViaSat ES EIRP [dBW/Hz]	-23.59
I/N [dB]	2.24
ΔT/T [%]	**167%**
1.8 m Earth Station	
ViaSat ES EIRP [dBW/40kHz]	34.27
ViaSat ES EIRP [dBW/Hz]	-11.75
I/N [dB]	14.08
ΔT/T [%]	**2,556%**

Scenario 2 @ 10° Separation

SpaceX SAT Rx antenna G/T @ nadir [dB/K]	13.70
75 cm Earth Station	
ViaSat ES Gmax [dB]	43.90
ViaSat ES EIRP @ 10° [dBW/40kHz]	-14.47
ViaSat ES EIRP @ 10° [dBW/Hz]	-60.49
I/N [dB]	-0.66
ΔT/T [%]	**86%**
1.8 m Earth Station	
ViaSat ES Gmax [dB]	52.91
ViaSat ES EIRP @ φ [dBW/40kHz]	-11.64
ViaSat ES EIRP @ φ [dBW/Hz]	-57.66
I/N [dB]	2.17
ΔT/T [%]	**165%**

$$\frac{I}{N} = EIRP - 10\log(4\pi d^2) - 10\log\left(\frac{4\pi}{\lambda^2}\right) + \frac{G}{T} - 10\log(k)$$

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 Reply,

(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 Reply, 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.

June 26, 2017

Date

CERTIFICATE OF SERVICE

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

Daryl T. Hunter, P.E.
ViaSat, Inc.
6155 El Camino Real
Carlsbad, CA 92009

John P. Janka
Elizabeth R. Park
Latham & Watkins LLP
555 Eleventh Street, N.W.
Suite 1000
Washington, DC 20004

Suzanne Malloy
Vice President, Regulatory Affairs
O3b Limited
900 17th Street, N.W.
Suite 300
Washington, DC 20006

/s/ *Sabrina McMillin*
Sabrina McMillin