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October 18, 2017

<u>VIA ELECTRONIC FILING</u>

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

Re: ViaSat, Inc., *Ex Parte* Submission Responding to Inmarsat, SES and O3b, GN Docket No. 14-177; IB Docket Nos. 15-256 & 97-95; RM-11664; WT Docket No. 10-112

ViaSat submits this letter to address the co-existence of satellite earth station receivers and 5G terrestrial transmitters in the 37.5-40 GHz and 42-42.5 GHz band segments, including the relevance of the October 13, 2017 *ex parte* submission of Inmarsat, SES, and O3b.[1]

As an initial matter, it bears emphasis that the satellite/5G sharing framework adopted in the July 2016 *Spectrum Frontiers Order* is based on the use of mitigation techniques—namely shielding and other forms of signal attenuation that facilitate shared use of band segments by earth stations and 5G operations. Indeed, both the technical inputs that underlie that decision, and the reasoning of the decision itself, are replete with references to using such engineering techniques to facilitate satellite and 5G coexistence.[2]

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[1] *See* Inmarsat Inc., SES Americom, Inc., O3b Limited, Written *Ex Parte* Submission, GN Docket No. 14-177, *et al*. (filed Oct. 12, 2017) ("Inmarsat/SES/O3b *Ex Parte*").

[2] *See Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Report and Order, 31 FCC Rcd 8014 ¶ 46 n.100 (2016) ("*Spectrum Frontiers Order*") ("*Site-shielding* of earth station antennas is a well-established technique."); *id*. at ¶ 92 ("satellite operators can substantially reduce the sizes of the exclusion zones that they require by constructing artificial *site shields* or by taking advantage of naturally occurring terrain features," such as "geographic depressions, which are capable of providing natural *site-shielding* in all directions. For earth stations that communicate only with geosynchronous satellites, more limited *site shielding* would typically suffice."); *id.* at ¶ 93 ("The FSS applicant may self-define this protection zone, but it must demonstrate using reasonable engineering methods that the designated protection zone is no larger than necessary to protect its earth station."); *id.* at nn.94 & 115 (citing ViaSat comments for the proposition that "any areas of

Thus, the existing sharing framework is not based on theoretical worst-case scenarios. Rather, in order to facilitate earth station deployment near population centers when such deployment would affect "a small percentage (or even none) of the population,"[3] the *Spectrum Frontiers Order* relies heavily on the mitigating effects of shielding.[4] That decision also recognizes that different types of shielding may be appropriate for different types of satellite networks, and in different places.[5]

ViaSat has recently submitted three studies into the record that build on this framework, with a view toward extending it to the V band.[6] Each of those papers details the way in which shielding techniques can greatly facilitate:

(i) shared use of the V band by satellite earth stations and 5G facilities located in close proximity to one another, and

(ii) the deployment of satellite gateway facilities in the areas where they are needed—*distributed across the country, in PEAs and counties of all types*, in order to

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incompatibility would likely occur in an area no more than about 160 meters from the earth station, and that area could be further reduced by *shielding*"); *id.* at ¶ 46 (explaining that NGSO earth stations can improve compatibility by "tak[ing] advantage of *shielding or other mitigation techniques*) (quoting Comsearch's observation that when dealing with shared frequency bands, "it is still true that the most important aspect of a site is its *shielding*" and observing that "*shielding* can also be provided by creating berms or other man-made barriers"); *id.* at ¶ 55 ("this zone could be reduced further by reducing the preclusive distance around the earth station, using *mitigation techniques such as shielding*"); *id.* at Appendix C (identifying geographic locations that offer natural *shielding* and, therefore, might be ideal locations for earth stations "required to point in any direction in order to track non-geosynchronous satellites") (emphasis supplied in all cases).

[3] *Spectrum Frontiers Order* at ¶ 60.

[4] *See supra* n. 2.

[5] *See Spectrum Frontiers Order* at ¶ 46 & Appendix C (recognizing that "that sharing may be more difficult for non-geostationary satellite systems," and identifying geographic locations that offer natural shielding and thus might be ideal locations for earth stations "required to point in any direction in order to track non-geosynchronous satellites").

[6] *See* ViaSat, Inc., Notice of *Ex Parte* Presentation, GN Docket No. 14-177, *et al*. (filed Oct. 11, 2017) ("ViaSat October 11 *Ex Parte*"); *see also* ViaSat, Inc., *Ex Parte* Submission, GN Docket No. 14-177, *et al.*, (filed Oct 18, 2017).

> ensure that next-generation satellite networks have the requisite capabilities to meet consumer demands.[7]

ViaSat also explained that while its studies are focused in small (1.8 meter-diameter) gateway earth stations associated with its next-generation geostationary spacecraft, these sharing concepts easily can be scaled to accommodate larger gateway earth stations and NGSO constellations.[8]

Notably, some ways to achieve shielding are simply the by-product of earth station site installations that otherwise would be used to provide aesthetic screening, satisfy local zoning requirements, afford site security, or ensure RF safety. Figure 1 below depicts a block wall surrounding a 1.8 meter earth station that readily could be employed for any or all of these purposes, and that also would provide at least 20 dB of signal attenuation through shielding.[9]

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[7] *See, e.g.*, ViaSat, Inc., Notice of *Ex Parte* Presentation, GN Docket No. 14-177, *et al*., Attachment B at 2 (filed Sept. 25, 2017) ("ViaSat September 25 *Ex Parte*"); ViaSat October 11 *Ex Parte*, Attachment 1 at 12.

The capacity of satellites determines the quantity and quality of broadband services delivered by satellite. A proxy for satellite capacity is the total bandwidth of a satellite's gateway terminals which connect users to the internet; the total gateway bandwidth is the number of gateways times the bandwidth used by each gateway. This is why ViaSat has made significant R&D investments to drive down gateway size, footprint and cost, and ensure compatibility with 5G applications in millimeter wave frequencies. *See* Transcript of FY18 Q1 Results Earnings Call, ViaSat, Inc. (Aug. 8, 2017), *available at* https://seekingalpha.com/article/4096690-viasat-vsat-q1-2018-results-earnings-call-transcript.

Contrary to the suggestion in paragraph 92 of the *Spectrum Frontiers Order*, to achieve the required capacity of next-generation V-band satellites, satellite operators also need to deploy 37.5-40 GHz gateways in the smaller, more densely populated PEAs. Doing so is feasible by employing reasonable and proven engineering techniques, such as those described in the ViaSat materials cited in footnote 6 above.

[8] *See* ViaSat October 11 *Ex Parte* at 1-2 & Attachment 1 at 13.

[9] *See id.* at Attachment 2.

Figure 1 Illustration of 1.8 meter earth station shielding

One of the submissions made over a year ago in this proceeding simply does not take into account the effects of shielding, and thus significantly overstates the area within which a well-engineered earth station installation might not be compatible with nearby 5G operations in the 37.5-40 GHz band segment.[10]

In an apparent effort to provide a substitute for that now-outdated submission, the October 13, 2017 *ex parte* submission of Inmarsat, SES, and O3b includes a U.S. contribution to ITU Task Group 5/1 (TG5/1), Document 5-1/108-E.[11] Significantly, the *ex parte* letter covering that submission draws an unfounded conclusion about the technical analysis attached to that U.S. contribution. That technical analysis actually is an incomplete work-in-progress that does not even purport to depict a well-engineered means of ensuring satellite earth station/5G coexistence in the 37.5-40 GHz band segment.

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[10] *See* Comments of EchoStar Satellite Operating Corporation, Hughes Network Systems, and Alta Wireless, Inc., GN Docket No. 14-177, *et al.*, at 33 (filed Jan. 27, 2016); *Spectrum Frontiers Order* at ¶ 90. More fundamentally, that submission is no longer valid because it was based on assumptions about 5G network parameters that are considerably different than the parameters that since have been identified by the 5G community as relevant for purposes of conducting compatibility analyses. For example, EchoStar used a BS EIRP density of 65 dBm/100 MHz; the ITU study used an EIRP density of 44.4 dBm/100 MHz—a value that is over 200 times lower. EchoStar also misstated the earth station receiver noise floor level by at least 2.5 dB in the more sensitive direction.

[11] While the U.S. contribution paper uses the terminology “IMT-2020,” this analysis uses the shorthand reference “5G.”

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ViaSat is the primary author of that technical analysis, and thus is uniquely qualified to explain the draft nature of the analysis, and its limitations and missing components.

As an initial matter, even a cursory glance at the draft technical analysis reveals that it is not yet finished. One of three main sections, entitled "Summary and analysis of the results of studies" contains nothing more than a note in brackets, indicating that this to-be-completed portion of the draft may later contain a discussion of "*mitigation techniques.*"[12]

This is precisely why the draft analysis underlying the U.S. contribution does not yet address the means of ensuring successful coexistence between satellite networks and 5G networks, or otherwise take into account the use of the types of shielding that (i) the Commission's sharing framework for the 37.5-40 GHz band segment expects to be employed where feasible,[13] and (ii) the IEEE paper on which that framework relies concludes "is indeed an effective method in many cases."[14] The technical analysis simply is not yet complete.

With this background, it should be apparent that the draft technical analysis underlying the U.S. contribution is an introductory work, and very much in the early stages of development. Moreover, consistent with the mandate of the ITU process, that analysis relies upon input characteristics defined by ITU WP4A, including the outer bounds of possible earth station characteristics. Namely, that analysis considers earth station parameters deemed most vulnerable to interference from 5G systems, and parameters that are not representative of earth stations typically deployed in the United States for communications with GSO satellites, such as antennas operating at low elevation angles (10º), with narrow band carriers (50 MHz), and which have lower receive noise temperatures than are typical (≤250 K at V band).

In this respect, ViaSat emphasizes that, despite its efforts to have them included, the ITU-mandated inputs do not include the salient characteristics of ViaSat's satellite networks, which, as explained above,[15] specifically have been designed to facilitate co-existence with 5G networks. Nor does the draft analysis yet take into account the positive impact on coexistence from the use of beam nulling or MIMO techniques at 5G base stations.[16]

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[12] Inmarsat/SES/O3b *Ex Parte*, Attachment at 9.

[13] *See Spectrum Frontiers Order* at ¶ 93 (FSS applicant must "demonstrate using reasonable engineering methods that the designated protection zone is no larger than necessary to protect its earth station.").

[14] S.A. Bokhari, *et al*., *Site Shielding of Earth-Station Antennas*, IEEE Antennas and Propagation Magazine, Vol. 37, No. 1 Feb. 1995, at 21 (IEEE accession number 1045-9243/93); *see also Spectrum Frontiers Order* at ¶ 92 n.220.

[15] *See supra* n.7.

[16] *See* ViaSat September 25 *Ex Parte*, Attachment A at 19-20.

Putting aside all of these limitations of the analysis in its current state, SES/Inmarsat/O3b are incorrect in implying that the draft analysis supports the conclusion that a separation distance of 1,100 meters is required to protect FSS earth stations from 5G deployment in the 37.5-40 GHz band segment. In fact, a simple extension of that analysis that factors in the impact of shielding shows quite the opposite.

The draft technical analysis considers three cases for further examination, each addressing what percentage of different combinations of FSS earth station and 5G deployments would result in the earth stations experiencing a target I/N in excess of -6, -10, or -12.2 dB, assuming (i) the most interference-vulnerable earth station links identified by ITU WP4A are employed, and (ii) no reasonable engineering methods are used to mitigate the effect of unwanted energy from 5G transmitters. Case 1 involves the random deployment of combinations of earth stations and 5G transmitters within a 1 km square area. Case 2 involves separating the earth station from the middle of the 5G deployment by 800 meters. Case 3 involves separating the earth station from the middle of the 5G deployment by 1100 meters. Thus, Case 1 represents the worst-case situation—an earth station in the midst of a 5G network.

Having established the outer boundaries of worst-case, theoretical scenarios, this analytical framework is readily extendable to examine the impact of employing reasonable engineering solutions to ensure earth station/5G compatibility, as the *Spectrum Frontiers Order* contemplates doing.

Based on the data from the draft analysis defining the scope of the worst-case, additional analysis illustrates the mitigating effect of applying one of a variety of potential sharing solutions.

Table 1 below summarizes the worst-case results of the draft analysis underlying the U.S. contribution—the percentage of time, assuming random combinations of FSS earth station and 5G deployments within a 1 km square area, when FSS earth stations theoretically would not achieve the desired I/N levels, assuming no mitigation. Even without any mitigation measures, the results are quite favorable. In the vast majority of the situations, earth stations would not even conceivably need to be distanced from the center of the 5G network, before any mitigation efforts are considered.

Table 1

5G & FSS Earth Station Random Locations
(Inside and Outside the 5G Network)

FSS Antenna Diameter (m)	1	1	1	1	6.8	6.8	6.8	6.8
FSS Antenna Height (m)	12	12	12	12	4	4	4	4
FSS Elevation Angle (°)	10	10	35	35	10	10	35	35
FSS Bandwidth (MHz)	50	500	50	500	100	600	100	600
Percent of time -12.2 dB is not exceeded (%)	96.33	96.66	97.48	97.47	91.94	94.99	93.93	96.39
Percent of time -10 dB is not exceeded (%)	97.19	97.87	98.03	98.60	93.48	96.42	95.16	97.60
Percent of time -6 dB is not exceeded (%)	98.27	99.23	98.71	99.76	96.02	98.15	97.21	98.95

Table 2 below uses the same analytical framework and tools used in the draft analysis, and factors in the effect of shielding—namely, the minimum of 20 dB of signal attenuation that reasonably can be expected by the type of wall depicted above in Figure 1, and examined in ViaSat's prior submission in this proceeding.[17] As shown in Table 2, this simple mitigation technique alone produces even more favorable results, including a near three sigma level of operational certainty for all of the cases studied. Earth stations in this scenario would not even conceivably need to be distanced from the center of the 5G network.

Table 2

5G & FSS Earth Station Random Locations
(Inside and Outside the 5G Network)

FSS Antenna Diameter (m)	1	1	1	1	6.8	6.8	6.8	6.8
FSS Antenna Height (m)	12	12	12	12	4	4	4	4
FSS Elevation Angle (°)	10	10	35	35	10	10	35	35
FSS Bandwidth (MHz)	50	500	50	500	100	600	100	600
Percent of time -12.2 dB is not exceeded (%)	99.914	99.998	99.999	100.00	99.583	99.863	99.854	99.958
Percent of time -10 dB is not exceeded (%)	99.946	100.00	99.999	100.00	99.730	99.914	99.913	99.975
Percent of time -6 dB is not exceeded (%)	99.989	100.00	100.00	100.00	99.890	99.965	99.967	99.996

17 *See* ViaSat October 11 *Ex Parte* at Attachment 2.

Of course, the discussion above does not factor in other possible sources of mitigation solutions, such as:

(i) utilizing satellite carriers that are more resilient to interference (which is entirely feasible in the greenfield that is the V band), and not the most vulnerable types of satellite carriers;

(ii) the effects of beam nulling or MIMO techniques at the 5G base stations;[18]

(iii) operating earth stations at higher elevation angles than 10 degrees in the vicinity of 5G deployments (a likely requirement in any event in an urban setting, given line-of-sight issues); or

(iv) the likely practical need to deploy gateways smaller than 6.8 meters where 5G deployment is most likely (given the challenges associated with siting a 6.8 meter antenna in an urban setting), such as the 4.5 meter antenna depicted in Figure 2 below, which is currently in operation with a readily-deployable shielding wall on three sides, and a building providing shielding on the other side.

Figure 2 Example of 4.5 meter earth station shielding

[18] *See* ViaSat September 25 *Ex Parte*, Attachment A at 19-20.

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For all of the foregoing reasons, the analytical framework of the draft technical analysis actually supports the following conclusion. FSS earth station and 5G coexistence at 37.5-40 GHz is ensured by either:

(i) using the reasonable engineering methods discussed in the *Spectrum Frontiers Order* when siting and earth station in the midst of a 5G network (and not factoring in separation distances); or

(ii) making no effort at all to ensure earth station compatibility and simply relying on a separation distance that, in any event, depends entirely on the individual characteristics of the satellite network and its desired performance metrics.

Please contact the undersigned if you have any questions regarding this submission.

Respectfully submitted,

/s/

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<u>**DECLARATION**</u>

I, Daryl T. Hunter, hereby make the following declarations under penalty of perjury. I understand that this Declaration will be submitted to the Federal Communications Commission.

1. I am the Chief Technology Officer, Regulatory Affairs of ViaSat, Inc.

2. I am the technically qualified person responsible for preparation of the technical information contained in the foregoing *Ex Parte* Submission of ViaSat, Inc. Responding to Inmarsat, SES and O3b ("*Ex Parte* Submission").

3. I have either prepared or reviewed the information in the *Ex Parte* Submission, and the information contained therein is true and correct to the best of my knowledge, information and belief.

Daryl T. Hunter, P.E.

Executed October 18, 2017