BEFORE THE

Federal Communications Commission

WASHINGTON, D.C. 20554

In the Matter of	)	
	)	
ViaSat, Inc.	)	File No. SES- LIC-20120427-00404
	)	Call Sign E120075
Application for Authority to Operate Up to 4,000 Transmit/Receive Aeronautical-Mobile Earth Stations in the Ka-band	)	

To: Chief, Satellite Division
International Bureau

COMMENTS OF ROW 44, INC.

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January 11, 2013

Summary

Row 44 is generally supportive of introducing aeronautical-mobile service (“AMSS”) to the Ka-band as an application of the fixed-satellite service (“FSS”). As the ViaSat Application is the first request for authority to provide such service, however, it warrants careful scrutiny.

ViaSat’s reliance on specific provisions of FCC Rules applicable to Ka-band FSS is misplaced. ViaSat is not proposing to operate FSS earth stations, but is instead proposing to operate AMSS-type earth terminals, a use for which there is no current licensing framework. ViaSat therefore has an affirmative obligation to demonstrate that it will not cause harmful interference to other spectrum users.

Accordingly, it is troubling that ViaSat has not filed any documentation that corroborates the completion of required interference coordination with operators potentially affected by deployment of its earth station network. Given the recent adoption of a coordination requirement governing Ku-band Earth Stations Aboard Aircraft, and more importantly for purposes of nascent Ka-band AMSS, the coordination obligations previously applied on an *ad hoc* basis to non-conforming AMSS providers in the Ku-band, this must reasonably considered a minimum threshold requirement.

Moreover, introduction of mobile applications at Ka-band poses distinct regulatory and policy questions because of the relatively early stage of development of Ka-band satellite services. Currently, many potentially usable orbital locations in the band are not yet licensed to any service provider. As a result, any rushed effort to implement non-conforming services in these bands, based solely on coordination agreements with the few existing FSS operators, could have unintended long-term consequences for the development of service in this band.

Finally, several specific technical issues concerning ViaSat's Mantarray M40 antenna remain to be addressed, including:

- the spacing of the feed horns in the M40 antenna is fundamentally inconsistent with typical engineering practice to reduce grating side lobes;
- ViaSat's consideration of azimuth error alone in predicting the extent of antenna mispointing significantly understates tracking error for its system; and
- the fundamental characteristics of grating lobes, which may make it impossible for ViaSat to ensure repeatability in the antenna manufacturing process, such that its antennas will not be truly technically identical, a critical requirement for blanket earth station licensing.

Row 44 respectfully urges the Bureau to consider the ViaSat Application carefully and not to take further action until ViaSat has supplemented its initial showing with additional information addressing the deficiencies outlined herein, and until the Bureau has also considered carefully the stage of development of Ka-band services and evaluated the potential impact of the ViaSat technical proposal upon such development.

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To: Chief, Satellite Division
International Bureau

<u>COMMENTS OF ROW 44, INC.</u>

Row 44, Inc. ("Row 44"), by counsel and pursuant to Section 25.154 of the Commission's Rules (47 C.F.R. § 25.154), hereby comments on the above-captioned application filed by ViaSat, Inc. ("ViaSat") on April 27, 2012. In the application, ViaSat seeks authority to operate up to 4,000 technically-identical aeronautical mobile-satellite service ("AMSS") earth station terminals in the 28.25-29.1 and 29.5-30.0 GHz bands in the Earth-to-space direction and the 18.3-19.3 GHz and 19.7-20.2 GHz bands in the space-to-Earth direction for the purpose of providing in-flight broadband services. These AMSS earth terminals would communicate with three previously authorized Ka-band geostationary ("GSO") fixed-satellite service ("FSS") satellites at the 115.1° W.L. and 111.1° W.L. orbital locations.[1] In these comments, Row 44 urges the Commission to adhere to procedures used in its consideration of past applications for non-conforming mobile uses in FSS bands, bearing in mind the precedent created in the recent

[1] *See* ViaSat Ka-band AMSS Application, SES-LIC-20120427-00404, Call Sign E120075, Exhibit A at 1 (filed April 27, 2012) ("ViaSat Application").

adoption of rules for Earth Stations Aboard Aircraft ("ESAA") in the Ku-band,[2] the initial processing approach adopted at Ku-band prior to the new rules, and the significant differences between the state of current development of the Ku- and Ka-bands. The Commission should not move forward with processing the ViaSat application until the applicant has addressed the deficiencies in its showing under the FCC's rules and policies, and until the FCC has considered carefully the stage of development of Ka-band services and evaluated the specific potential impact of the ViaSat technical proposal upon such development.

I. Statement of Interest

Row 44's interest in matters relating to AMSS use of FSS frequency bands is well-known. Row 44 is the holder of a Ku-band ESAA authorization permitting it to offer in-flight broadband service to commercial airline passengers and crew.[3] As demand for such services has continued to grow, and the number of airlines seeking to offer such services has increased, there has been greater interest in the potential for Ka-band satellite capacity to augment existing Ku-band services. Row 44 is currently exploring options for possible implementation of Ka-band service at some time in the future, and therefore is concerned that the initial mobile earth station deployments in this spectrum not compromise future use of the band for long-term, high-quality services. Introduction of a less than state-of-the-art aircraft-mounted antenna could have an

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[2] *See Revisions to Parts 2 and 25 of the Commission's Rules to Govern the Use of Earth Stations Aboard Aircraft Communicating with Fixed-Satellite Service Geostationary-Orbit Space Stations Operating in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz and 14.0-14.5 GHz Frequency Bands*, Notice of Proposed Rulemaking and Report and Order in IB Docket Nos. 12-276 and 05-20, FCC 12-161, *slip op.* (released December 28, 2012) ("*ESAA R&O and NPRM*"). Generally, in these Comments, Row 44 uses AMSS to refer to aircraft-mounted mobile-satellite services operating in FSS bands, and ESAA to refer exclusively to the newly adopted regulations that will soon apply to Ku-band mobile earth station operations on aircraft.

[3] *Row 44, Inc. Application for Authority to Operate Up to 1,000 Technically Identical Aeronautical Mobile Satellite Service Transmit/Receive Earth Stations Aboard Commercial and Private Aircraft,* 24 FCC Rcd 10223 (IB/OET 2009).

adverse impact on other service providers by placing undue constraints on the use of the band, by establishing the potential for grandfathering of an antenna that actually limits use of the band for other services, and/or by creating a negative impression in the marketplace of the Ka-band AMSS generally.

With these concerns in mind, Row 44 is generally supportive of introducing AMSS to the Ka-band as an application of the FSS. As the ViaSat Application is the first request for authority to provide such service, however, it warrants careful scrutiny. While the Commission has very recently adopted new technical and processing rules to govern Ku-band ESAA, no such service rules have even been proposed for similar operations in the Ka-band. Moreover, the introduction of this type of application into the Ka-band raises distinct regulatory and policy questions because Ka-band satellite service generally, and non-FSS applications in particular, are at a much earlier stage of development than at Ku-band, and the same regulatory approaches cannot be assumed to apply automatically in the same way that they have been applied to the Ku-band.

II. The ViaSat Application Does Not Comply with the Commission's Rules.

A. The ViaSat Application Relies on a Faulty Premise.

In the original ViaSat Application, ViaSat asserts that its proposal "is consistent with the existing regulatory framework for the Ka band," including "the PFD levels referenced in 25.138," as well as the off-axis-EIRP levels "except with respect to a few exceedances that can be coordinated with potentially affected satellite systems."[4] These assertions are misleading, and ultimately amount to nothing more than an acknowledgment that ViaSat's proposed operations are superficially consistent with some elements of the Commission's Rules but in very material respects are not compliant with them. ViaSat's specific reliance on Section 25.138 of the

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[4] ViaSat Application, Exhibit A at 1.

Commission's Rules, for example, is unavailing. The extant Ka-band rules apply on their face only to *FSS* applications, whether on an individually-licensed or blanket-licensed basis.[5] ViaSat, however, is not proposing to operate FSS earth stations in the Ka-band. It is instead proposing to operate MSS earth terminals in this band, a use for which there is no current licensing framework.

ViaSat is not simply seeking to use a non-conforming FSS antenna to provide otherwise permissible service in the band, it is seeking to use a fundamentally non-compliant antenna for a non-conforming purpose. There is no basis for ViaSat's implicit assertion that the licensing framework created for FSS implementations in the Ka-band is equally applicable to its *sui generis* AMSS application. ViaSat is not an applicant seeking to offer an allocated primary service, but one requesting authority to operate solely on a non-interference-protected, non-harmful-interference basis outside the scope of the Commission's Rules.[6] There is therefore no basis for it to be granted spectrum access on the very same terms as a *bona fide* primary service applicant. Instead, ViaSat has an affirmative obligation to demonstrate that it will not cause harmful interference to other spectrum users.

This obligation is amplified by the fact that the ViaSat Application is the very first such request that seeks to use Ka-band spectrum for an MSS-type network. ViaSat therefore must be

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[5] *See, e.g.*, 47 C.F.R. § 25.138 ("Blanket Licensing provisions of GSO FSS Earth Stations in the 18.3 to 18.8 GHz (space-to-Earth), 19.7-20.2 GHz (space-to-Earth), 28.35-28.6 GHz (Earth-to-space), and 29.25-30.0 GHz (Earth-to-space) bands"). Throughout this rule, the services covered are referred to as "GSO FSS."

[6] *See Ex Parte* Letter from John P. Janka and Elizabeth R. Park, Counsel to ViaSat, to Marlene H. Dortch, Secretary, FCC, File Nos. SES-LIC-20120427-00404 and SES-STA-20120815-00751, at 1 (filed December 10, 2012) ("ViaSat 12/10 *Ex Parte* Letter") ("As there is currently no designation for aeronautical mobile use of the Ka-band in the Commission's rules, ViaSat has sought a waiver of the Commission's rules to allow the proposed operations. Thus, ViaSat respectfully requests that the Commission grant authority for the proposed operations on a non-conforming, non-interference basis").

required to provide complete technical detail in order to allow all parties concerned about AMSS development in the Ka-band to evaluate its proposal fully. ViaSat must establish a clear foundation for grant of its proposal, and it has failed to make such a showing in the documentation it has filed to date.

Just prior to the placement of the ViaSat Application on Public Notice, the applicant filed a letter with the Bureau conceding that "there is currently no designation for aeronautical mobile use of the Ka band in the Commission's rules," and that it is not seeking authority to operate under the rules, but instead requires "a waiver" permitting it to operate "on a non-conforming, non-interference basis."[7] Accordingly, ViaSat must amend its application to make it consistent with a request for waiver to permit non-conforming use. It must provide a technical and coordination showing sufficient to demonstrate that it can operate successfully without causing harmful interference.

B. The ViaSat Application is Incomplete Even under Standards Established for Ku-band ESAA Applications.

Leaving aside the absence of any service rules – particularly any technical rules – to govern AMSS operations in the Ka-band, among the other potential issues is the fact that ViaSat has not filed any actual evidence of completion of coordination with any of the affected GSO or NGSO satellite networks. In the application as originally filed, ViaSat stated that its proposal "can be coordinated with" all affected parties and that it expected "to complete the formal coordination arrangements shortly."[8] In its subsequently-filed request for special temporary authority, ViaSat asserted that it "has completed coordination with … all operating Ka-band GSO satellite networks within six degrees" of each of the three satellites requested as points of

[7] ViaSat 12/10 *Ex Parte* Letter at 1.

[8] ViaSat Application, Exhibit A at 5.

communication, as well as "potentially affected Ka-band GSO satellite networks outside of the six-degree range," one potentially affected non-geostationary ("NGSO") network, and the recently launched EchoStar XVII satellite at 107.1° W.L.[9] Despite these sweeping representations, ViaSat has yet to submit any actual documentation to the FCC that memorializes or otherwise corroborates the completion of these coordination discussions. Moreover, and as further discussed in Section III, below, it is not clear that ViaSat has identified all "potentially affected Ka-band GSO satellite networks outside of the six-degree range" with which it would need to coordinate. This is so due to the fundamentally non-compliant nature of its proposed Ka-band antenna, which has the clear potential to cause harmful interference at orbital locations well beyond the standard twelve-degree coordination range (six degrees in each direction).

It bears noting that in the recently adopted rules governing Ku-band ESAA, the Commission has required that applicants that do not conform fully with both the antenna performance standards of Section 25.209 and the applicable values for off-axis EIRP must include as part of their application statements from all target satellite operators certifying that "the proposed operation of the ESAA has the potential to receive harmful from adjacent satellite networks that may be unacceptable"; "that the power density levels that the ESAA applicant provided to [each] target satellite operator are consistent with the existing coordination agreements … [with] adjacent satellite systems within 6° of orbital separation"; and that each "will include the power-density levels of the ESAA applicant in all future coordination

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[9] ViaSat Ka-band STA Request, File No. SES-STA-20120815-00751, at 1. *See also Ex Parte* Letter from John P. Janka and Elizabeth R. Park, Counsel to ViaSat, to Marlene H. Dortch, Secretary, FCC, File Nos. SES-LIC-20120427-00404 and SES-STA-20120815-00751, at 1 (filed December 17, 2012).

agreements."[10] ViaSat has not provided such documentation, which must reasonably considered a minimum threshold requirement given the Ku-band ESAA precedent and newly-adopted regulations. Indeed, in the early stages of Ku-band licensing of mobile antennas, applicants were required to submit counter-signed coordination letters evidencing the agreement of each of the affected operators.[11]

C. Ka-Band AMSS Applications Present Distinct Regulatory and Policy Issues That Ku-band ESAA Networks Do Not Implicate.

At a policy level, it is not clear, even if ViaSat is able to document coordination with each of the current licensed operators within six degrees of its requested points of communication in each direction, as well as those currently within the identified zone of concern created by the outlying grating lobes (which are discussed in Section III and the attached Technical Appendix), that ViaSat should be permitted to proceed based solely on these coordination agreements with the relatively few current Ka-band satellite operators. The presentation of completed coordination arrangements with all adjacent satellite operators within six degrees of any AMSS point of communication has been for several years an accepted means to secure licensing for this service in the Ku-band, and has been adopted as a specific provision of the rules governing Ku-band ESAA.[12] But it is not clear that this same approach is

[10] *See ESAA R&O and NPRM*, FCC 12-161, *slip op.*, Appendix C, Final Rules, at 81 (New Rule 47 C.F.R. § 25.227(b)(2)).

[11] *See, e.g.*, *ViaSat, Inc.*, 22 FCC Rcd 19964, 19969 (¶ 15) & n.31 (IB/OET 2007) (discussing Ku-band "coordination letter" signed by SES Americom, Inc. and "endorsed by" PanAmSat Corporation), *citing* Letter dated April 19, 2006 from Krish Jonnalagadda, Manager of Satellite Marketing and Development for SES Americom, and Darryl T. Hunter, Systems Engineer, ViaSat, endorsed by Mohammed Marashi, VP of Customer Support Engineering for PanAmSat Corporation.

[12] *See, e.g.*, *Row 44, Inc.*, 24 FCC Rcd 3042 (Sat. Div. 2009) ("*Row 44*"); *see also* 47 C.F.R. § 25.227(b)(2) (*Federal Register* publication pending).

appropriate for new Ka-band mobile operations at this time. Unlike the Ku-band GSO FSS, which is a mature service where most orbital locations over the continental U.S. have an established operator/licensee motivated to protect its interests, these same characteristics do not apply to Ka-band, which has only recently begun to be developed for provision of both GSO and NGSO satellite services. Because of the relatively early stage of development of Ka-band satellite services, many potentially usable orbital locations in these frequency bands are not yet licensed to any service provider. As a result, any rushed effort to implement non-conforming services in these bands, based solely on coordination agreements with existing FSS operators, could have unintended long term consequences for the development of service in this band, including the delivery of broadband satellite services to remote and underserved areas. These considerations must be carefully evaluated before the FCC moves down the road toward ubiquitous deployment of AMSS-like services in these bands. Indeed, the International Telecommunication Union remains engaged in examining issues related to what it refers to as Ka-band Earth Stations on Mobile Platforms ("ESOMPs"), including aircraft, to ensure that no greater interference will occur in the band than results from existing FSS applications.

III. ViaSat's Proposed Antenna Appears Ill-Suited to Provide Ubiquitously-Deployed Mobile-Satellite Service.

The technical information submitted in the ViaSat Application raises many technical questions, but at the same time leaves no question that its proposed antenna would not comply fully with any current FCC technical rule. As ViaSat concedes, its proposed antenna – the Mantarray M40 – does not comply with Section 25.138 of the FCC's rules in the elevation plane.[13] Of greatest concern in this regard is the fact that the spacing (pitch) of the feed horns utilized in the antenna design is fundamentally inconsistent with typical engineering practice for

[13] *See* ViaSat Application, Exhibit A at 4.

the reduction of grating side lobes. The optimal approach to avoid harmful impact from grating side lobes is to employ a maximum horn pitch of one wavelength (λ). The ViaSat antenna exceeds this benchmark spacing by a factor of two. For both right and left circular polarization senses, the antenna pattern for operation at all of the measured frequencies ranging from 28.1 to 30 GHz exhibits side lobes and grating lobes that greatly exceed the co-polarization elevation mask in Section 25.138.[14] *See* Technical Appendix, Attached hereto, at 2-3.

ViaSat itself states that its antenna patterns show four grating lobes which are "present for a limited range of skew angles centered around approximately 25° of skew" and notes that the EIRP "is as much as 22 dB above the 25.138 off-axis EIRP density mask."[15] ViaSat then provides plots of its EIRP exceedances applicable only to a limited range of skew values instead of the full range of skew values over which the Section 25.138 limits are exceeded. The rudimentary plot that ViaSat has supplied to indicate the scope of the grating lobe issue shows that the EIRP exceeds the Section 25.138 benchmark for skew values well-beyond a region centered at 25 degrees. However, no scale is provided on this plot to quantify the extent to which the EIRP spectral density exceeds the Section 25.138 mask for all applicable skew values.[16] In the attached Technical Appendix, the limited information provided in the ViaSat application is overlaid on a map of North America to demonstrate the potentially broad geographic impact of these grating lobes across the middle of the continental U.S. *See* Technical Appendix at 3-4. This graphic represents only the arc for one half of the skew region (the 2nd and 4th quadrants); however, the same effect exists in the 1st and 3rd quadrants as well.

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[14] *See* ViaSat Application, Exhibit C.

[15] ViaSat Application, Attachment 1, Technical Description at 7-8.

[16] ViaSat Application, Attachment 1, Technical Description at 8, Figure 3.

Accordingly, ViaSat's claim that only the AMC-16 satellite at 85° W.L. would be affected by these grating lobes[17] is both undemonstrated and inherently questionable. Indeed, as noted in the attached Technical Appendix, it can be inferred from the ViaSat Application itself that the skew angle range for which grating lobes point to the geostationary arc ranges from at least 22 degrees to 31 degrees, given the fact that ordinary skew angles are exacerbated by typical aircraft pitch and roll.[18] Within a large geographical area of the U.S., these grating lobes point to the GSO arc, with an affected orbital range extending from 76° W.L. to 90° W.L., at a minimum. If geometrical considerations are included, this range of impact is likely extended from at least 70° W.L. to 95° W.L, and potentially over an even wider area, resulting in at least the potential for harmful interference throughout the continental U.S. *See* Technical Appendix at 4.

ViaSat also states that its positioner tracking accuracy has a one sigma (RMS) value of 0.09 degrees in azimuth and 0.45 degrees in elevation. *See* ViaSat Application, Attachment 1 at 6. A reasonable estimate of the accuracy along the geostationary arc can be computed in terms of the skew angle alpha. For example, the accuracy along the geostationary arc for a skew angle equal to 30 degrees is estimated to be 0.3 degrees, resulting in a three sigma error of 0.9 degrees. If the skew angle is 50 degrees, the one sigma and three sigma errors are 0.4 and 1.2 degrees, respectively. ViaSat, however, assumes away these variations, treating azimuth error alone as defining the predicted extent of antenna mispointing. Accordingly, the Viasat tracking error substantially exceeds 0.2 degrees for skew values of 20 degrees and above, and is unacceptable

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[17] *See* ViaSat Application, Exhibit A at 8.

[18] *See* ViaSat Application, Attachment 1, Technical Description at 8 (Fig. 3).

under current standards for MSS antennas operating in FSS bands.[19] Similar results are seen with respect to maximum pointing error. *See* Technical Appendix at 5-7 and 11.

Added to these concerns is the fact that ViaSat cannot reasonably represent that all of the Mantarray M40 antennas it manufactures will be uniform, such that the actual grating lobes produced will be repeatable. There is no large-scale production experience with a machined horn array that causes grating lobes. For this reason, it is highly unlikely that the specific lobe patterns envisioned by ViaSat will be produced consistently in the manufacturing process. Instead, it is virtually certain that fabrication tolerances will lead to variations that produce substantially different antenna patterns from different production units. This varying performance among antennas would preempt any means of mitigating detrimental grating lobe effects across a network of up to 4,000 antennas. In short, repeatability in the manufacturing process cannot be assured where the existence of grating lobes is accepted as a characteristic of the antenna. *See* Technical Appendix at 8-10. It may therefore be impossible for ViaSat to ensure that its antennas will be truly technically identical, which is a critical requirement for blanket licensing of widely-deployed antennas.

Finally, it is specifically stated in the ViaSat Application that the proposed network would comply with Section 25.138(a)(6) of the Commission's Rules, which provides that "power flux-density at the earth's surface produced by emissions from a space station for all conditions, including clear sky, and for all methods of modulation shall not exceed a level of -118 dBW/m2/MHz." However, ViaSat provides no supporting documentation to justify this assertion. *See* ViaSat Application, Narrative at 4. *See* Technical Annex at 11.

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[19] *See, e.g.*, 47 C.F.R. § 25.221(a)(1)(ii) & (iii); *Panasonic Avionics Corporation*, 26 FCC Rcd 12557, 12570 (¶ 26(k)) (IB/OET 2011).

IV. **Conclusion**

For all of the foregoing reasons, Row 44 respectfully urges the Bureau to consider the ViaSat Application carefully, including an evaluation of the current stage of development of Ka-band services and the potential impact of the ViaSat technical proposal upon such development, and to require ViaSat to supplement its initial showing with additional information addressing the deficiencies outlined herein before taking any further action on the application.

Respectfully submitted,

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Technical Appendix

The Range over which ViaSat's Grating Lobes will Interfere

Figure 1, below, extracted from ViaSat's Exhibit C,[1] illustrates the predicted grating lobes that exceed the 25.138 limits. Because ViaSat provided plots for only a few specific skew values (25 degrees here), a complete quantification of ViaSat's likelihood to interfere with other satellites has not yet been provided. The analysis provided below seeks to remedy this omission.

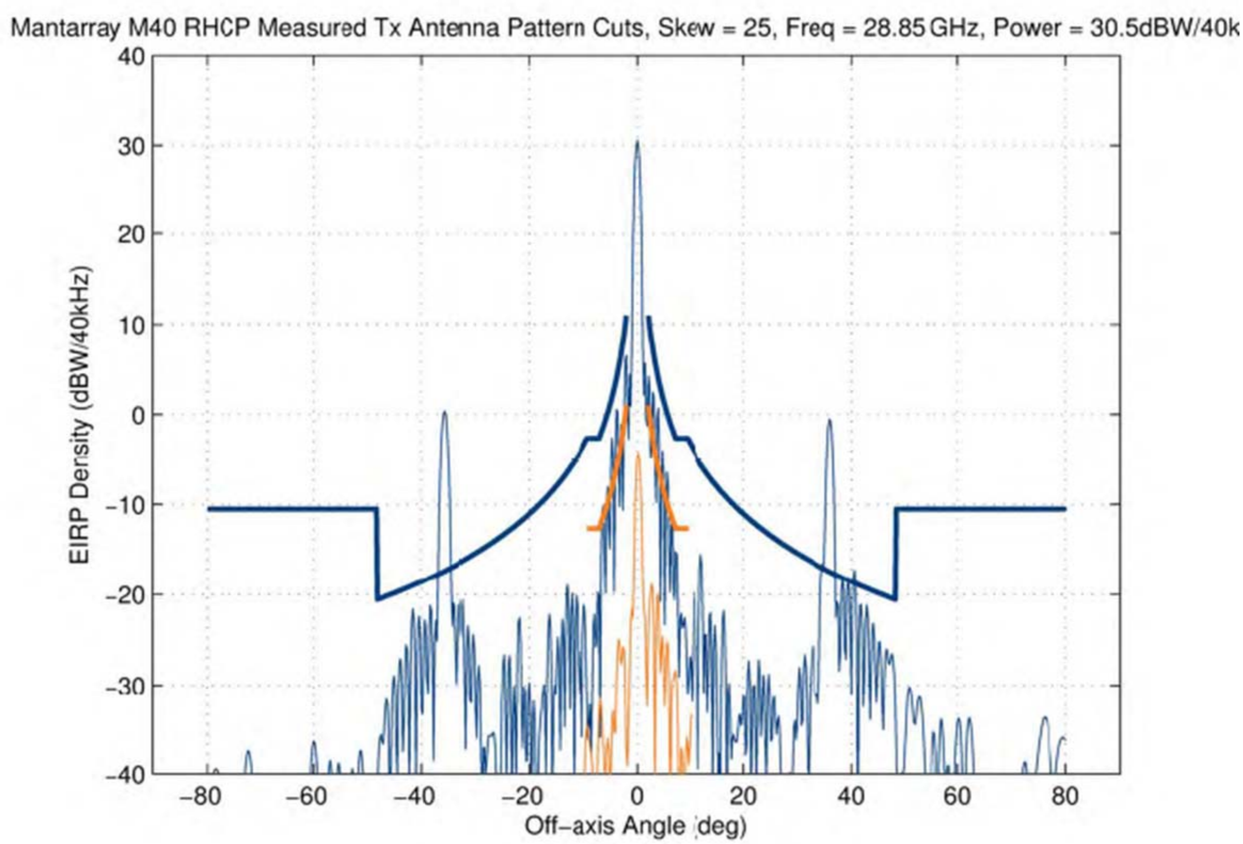


Figure 1: ViaSat's Plot of Grating Lobe EIRP Exceeding 25.138 for 25^0 skew

[1] *See* ViaSat Application, Exhibit C at 34.

Figure 2 on the next page, modified from 'Figure '3 of ViaSat's Technical Description,[2] illustrates the locations of the grating lobes that exceed the Section 25.138 criteria.

ViaSat's plots from their application (e.g., Figure 1 above) provide the off-axis EIRP values only for (operational) skew values of 0, 25, 60, 85 and 90 degrees. As is evident in Figure 2, a single plot in the 25 degree skew-range is insufficient to depict the actual skew range over which ViaSat's EIRP exceeds the 25.138 mask. Figure 2 provides no quantitative indication as to the amount of exceedance for any of the skew values in that range.

As an estimate of the skew-ranges over which the grating lobes will exceed the Section 25.138 benchmarks, solid lines are drawn tangent to the regions indicating the highest values of EIRP exceedance. In these narrow regions alone, it is evident that the Section 25.138 limits are significantly exceeded between skew values of 22^0 and 31^0 for positive skew values, as well as a similar region from -22^0 to -31^0 for negative values of skew.

(Note also that the left-half of the plot even suggests that Section 25.138 exceedance occurs across the entire range of skew values between 0^0 and 31^0.)

[2] *See* ViaSat Application, Attachment 1 at 8.

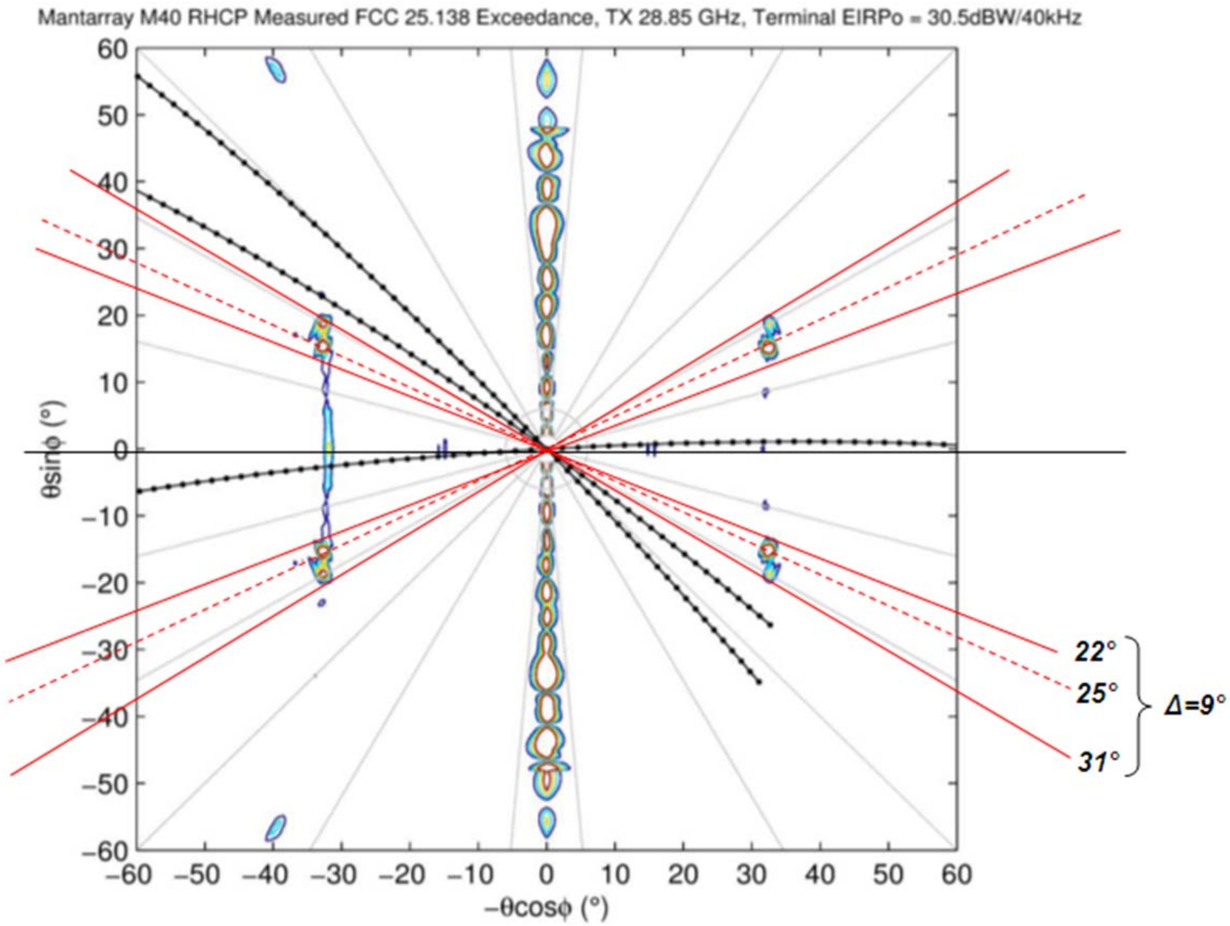


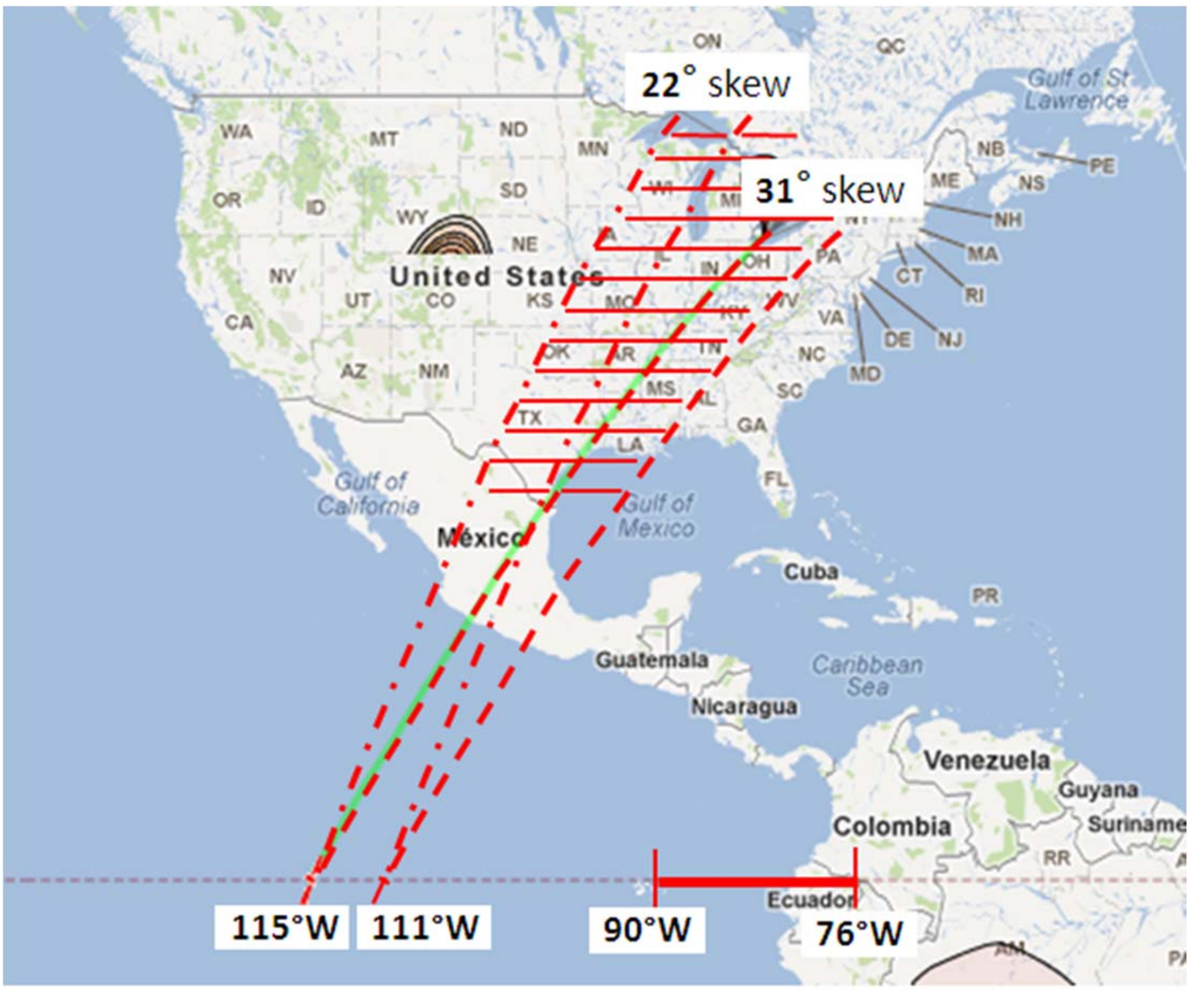
Figure 2: Estimated Skew Ranges where Grating Lobes Cause Interference

Figure 3, on the next page, illustrates the geographical impact of the exceedance boundaries of Figure 2 for a 'flat' aircraft. While pointing to either of ViaSat's satellites, there will be a geographical region within which an antenna pointing to either of ViaSat's satellites will invoke a skew value falling within the range of skew values over which ViaSat violates the Section 25.138 EIRP limits.

As can be seen (again, for a 'flat' aircraft), the geographical span over which pointing to either of ViaSat's satellites involves skew values between 22 to 31 degrees extends over a broad portion of the continental US, thereby demonstrating that the region over which interference created by the Mantarray antenna grating lobes will occur is far broader and of greater concern than ViaSat acknowledges in its application.

As mentioned, Figure 3 indicates the region for a 'flat' aircraft. However, for a 4-degree pitched aircraft, the region is expanded approximately 2.9 degrees east, and 4.1 degrees west in longitude. That is, for an aircraft flying due east at a 4 degree pitch, the 31 degree skew contour (to ViaSat's satellite at 111.1 West) will occur at longitudes approximately 2.9 degrees farther-east than that shown in Figure 3. As well, for an aircraft flying due-west at a 4 degree pitch, the 22 degree contour (to ViaSat's satellite at 115.1 West) will occur at approximately 4.1 degrees farther-west than Figure 3. In view of the fact that all cruising aircraft fly at 'pitch', this indicates that the effective geographical regions for interference will actually extend well-beyond those indicated in Figure 3 when long-term, real-world operating conditions are considered.

(Note also that skew values in the 22 to 31 degree range can be achieved even well-beyond the above-mentioned areas for aircraft engaged in banking maneuvers.)



approx. 22° skew boundary for Viasat-1 and WildBlue-1, respectively
approx. 31° skew boundary for Viasat-1 and WildBlue-1, respectively

Figure 3: US Regions Where Interference from ViaSat's Grating Lobes is Likely

ViaSat's Pointing Error Projections are Improper

ViaSat refers to an "azimuth" and an "elevation" positioning error in their Application. Below is a reproduction of Table 3 in their Attachment 1, where ViaSat lists the antenna's azimuth and elevation error values associated with values of standard deviation (sigma).[3] In addition, ViaSat indicates the limits at which operation will be disabled.

1-sigma		**3-sigma**		**Limit**	
Azimuth Error	Elevation Error	Azimuth Error	Elevation Error	Azimuth Error	Elevation Error
+/- .09 deg.	**+/- .45 deg.**	**+/- .27 deg.**	**+/- 1.35 deg.**	**+/- .5 deg.**	**+/- 1.35 deg.**

When establishing the 0.5 degree 'limit', ViaSat treats the azimuth error as if that alone depicted the extent of antenna 'mispointing'. Actually, when considering the extent an antenna points towards an unauthorized satellite, the extent of 'mispointing' along the GSO arc is the appropriate consideration. Contrary to ViaSat's implications, azimuth pointing error values alone do not correspond to the true pointing error along the GSO arc. If ViaSat assumed them to be, the actual pointing error may substantially exceed the 0.5 degree limit.

ViaSat's referenced values apply only under limited circumstances. For a perfectly-flat aircraft at a geographic location of the same longitude as the satellite, the pointing error projected along the GSO arc does simply correspond to the azimuth pointing error. (Likewise, for the same circumstance, the elevation error corresponds to the pointing error perpendicular to the GSO arc.) However, if the aircraft is not oriented in a 'flat' manner, or is not located at the same longitude as the satellite, these numbers inaccurately portray the GSO arc pointing error.

The actual pointing error along the GSO arc is comprised of components from both the azimuth and elevation pointing errors, whose respective contributions vary with skew angle. The actual pointing error projected across the GSO arc closely follows the following equation:

PointErrorAlongGSO = AzPointError*Cos(SkewAngle)+ElPointError*Sin(SkewAngle)

The following table provides calculated values of GSO arc pointing error for the three groups of variations in error referenced by ViaSat:

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[3] *See* ViaSat Application, Attachment 1 at 6.

Error Scenario	Skew Angle (deg)	Azimuth Error (deg)	Elevation Error (deg)	Max Pointing Error Across GSO (deg)
1-sigma	10	+/- .09	+/- .45	.17
1-sigma	20	+/- .09	+/- .45	.24
1-sigma	30	+/- .09	+/- .45	.30
1-sigma	40	+/- .09	+/- .45	.36
1-sigma	50	+/- .09	+/- .45	.40
1-sigma	60	+/- .09	+/- .45	.43
3-sigma	10	+/- .27	+/- 1.35	.50
3-sigma	20	+/- .27	+/- 1.35	.72
3-sigma	30	+/- .27	+/- 1.35	.91
3-sigma	40	+/- .27	+/- 1.35	1.1
3-sigma	50	+/- .27	+/- 1.35	1.2
3-sigma	60	+/- .27	+/- 1.35	1.3
limit	10	+/- .50	+/- 1.35	.73
limit	20	+/- .50	+/- 1.35	.93
limit	30	+/- .50	+/- 1.35	1.1
limit	40	+/- .50	+/- 1.35	1.3
limit	50	+/- .50	+/- 1.35	1.4
limit	60	+/- .50	+/- 1.35	1.4

The table clearly indicates that the GSO arc pointing error under the '1-sigma' category may exceed the 0.2 degree threshold for skew values 20 degrees and above. For the 3-sigma category, the 0.5 degree limit may as well be exceeded for skew values of 20 degrees and above. ViaSat's assumptions would not recognize these deviations.

Per the table, if ViaSat (as stated in their Application) were to simply assume 0.5 degree azimuth error as the 'limit' at which to disable transmissions, the actual pointing error across the GSO arc may be as high as 1.4 degrees before such disabling would occur. This constitutes a significant deficiency in ViaSat's approach, and will result in excessive radiated interference towards an adjacent satellite for a situation where ViaSat should have otherwise disabled its transmitter.

Figure 4, on the next page, presents a visualization of the range of skew values where the positioning error exceeds the threshold of 0.2 degrees and the limit of 0.5 degrees.

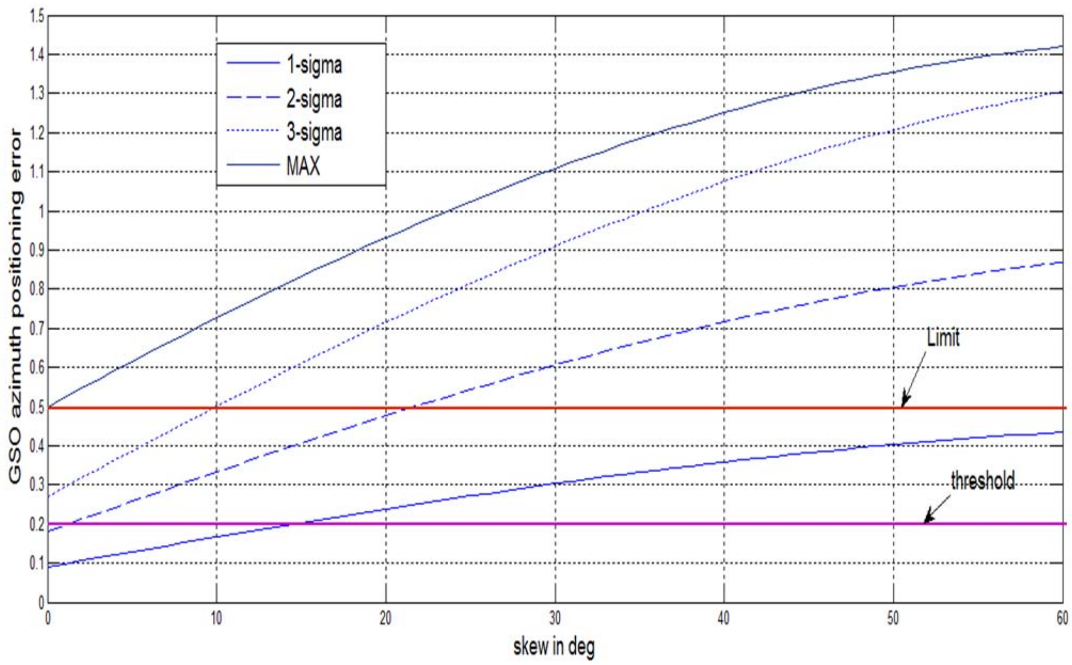


Figure 4 Skew Values for GSO Positioning Error Exceedance

From even a 'minimal-error' perspective, the above plot, which provides more detailed data, it is seen that the threshold value of 0.2 degrees can even be exceeded by 'one-sigma' values over the skew angle range of approximately -15 to -50 degrees (and 15 to 50 degrees). Geographically this range involves aircraft within a region from the US East Coast, from Maine to Florida, up to a line approximately from Minnesota to Texas.

From a 'maximal-error' perspective, (i.e., considering three sigma values), the limit value of 0.5 degrees can be exceeded for skew angles from 10 to 60 degrees. As already discussed, within this realm, ViaSat's misinterpretation of pointing error would not disable the transmitter for a wide range of skew and azimuth/elevation pointing error combinations. The associated potential for interference will occur over a broad portion of the United States.

In conclusion, considering grating lobes and mispointing , ViaSat has not identified all scenarios capable of producing interference, and should both (1) provide measured antenna pattern data for a range of skew angles, and (2) identify a proper method of mitigating pointing error.

The Mantarray Antenna's Deficiencies

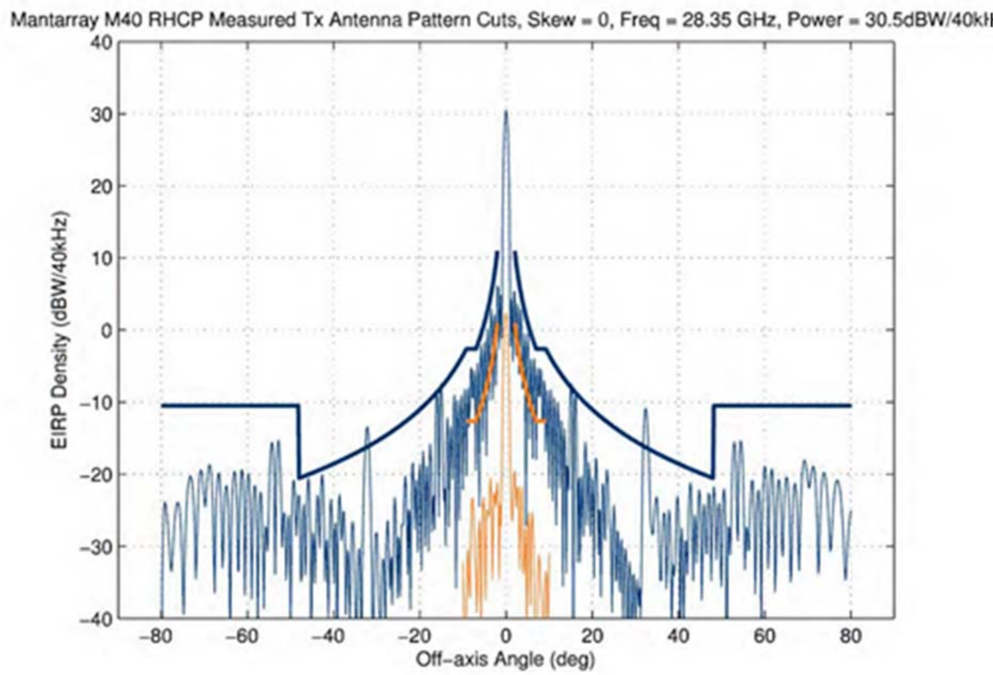
The size of the Mantarray horns can be expected to produce an abundance of antenna pattern grating lobes. For a horn-array consisting of oversized horns (i.e., horns larger than λ_c, where λ_c is the wavelength of the transmit frequency), grating lobes levels are known to be problematic. This is indeed the case of the ViaSat antenna, where the horns, which measure approximately 1.95 centimeters, are nearly two times λ_c (at 30 GHz λ_c = 1cm).[4] This ratio of ~2 λ_c implies that (1) Grating lobes will occur at frequencies > 15 GHz, and (2) Parasitic 'higher-order' modes will exist as well.[5]

In general, uncontrolled grating lobes may be of substantial levels. Analysis has suggested that grating lobes may even rival the level of the antenna's main lobe itself.

In an attempt to suppress the grating lobes at 0 degree skew, the Mantarray antenna uses an established technique of shifting the antenna horns in the second row of the array by the width of one-half-horn. If manufactured perfectly, this design would result in the absence of grating lobes in the 0 degree skew pattern. However, even the smallest of imperfections prohibits the existence of this perfect array. These imperfections are evident in ViaSat's 0 degree skew plot below, where 1st order grating lobes are clearly present (at approximately each of +/- 17 deg., +/- 32 deg., and +/- 54 deg.). As is obvious, even though the Mantarray design attempts to eliminate them, the lobes are indeed present, and even at ~+/- 32 degrees violate the FCC EIRP mask significantly.

[4] *Cf.* ViaSat Application, Attachment 1 at 5.

[5] Grating lobes may be described in terms of 'orders'. A given 'order' refers to a group of lobes predicted to occur by mathematical analysis of a given antenna design.



The Mantarray technique of shifting the row of horns does not actually eliminate the grating lobes, but rather shifts them to a pattern of a different skew angle. For the Mantarray horn spacing of 2 λ_c and a shift of λ_c, that skew angle can be approximated by sin(alpha) = 2 H /L, where H is the array-height and L the array-width. (Here sin(alpha) = 0.4, or alpha = 23.6 degrees. Because of the shaped edges and the amplitude tapering this value is slightly shifted to about 25 degrees.)

'Higher order' modes are also readily excited by minute imperfections in the antenna waveguides, power dividers, and 'horn feedings' (which affect the electric field distribution), and will produce an antenna pattern significantly-altered from that of a (fundamental) TEM-mode horn. The more deficient an oversized-horn antenna's design, the more higher-order lobes are instigated. This fact is supported by the measured patterns.

Even the best-achievable manufacturing tolerances will cause the Mantarray grating lobes to violate design specifications. Beyond this, any effort to predict the grating lobe deviations for assumed tolerance values will virtually never compare to the values achieved with actual, production antennas. The Mantarray design invokes a complex mechanical 'tolerance chain', where grating lobe amplitude variations of 10 dB or more will occur. This varying antenna-to-antenna performance will preempt any means attempting to predictably-mitigate detrimental grating lobe effects. Another concern involves the effect of reflections off the inner surface of the radome.[6] A typical Ka-band radome operating at 30 GHz causes a significant portion of the

[6] *Cf.* ViaSat Application, Attachment 1 at 5.

transmit signal to be scattered back to the aperture, thereby further-disturbing the radiation pattern. In advanced antenna arrays which, unlike ViaSat, utilize horn spacings less than λ_c, the lobe levels will change less than 0.1 dB.

In addition to the unit-to-unit repeatability, the effects of aging and varying environmental conditions on such an array is unknown. For the same, aforementioned reasons relating to structural tolerances, this is also a concern. (For example, low frequency vibration is suspected to influence the amplitude of the grating lobes.)

Beyond this, the operation of an antenna such as the Mantarray (i.e., having been intentionally constructed in a manner permitting high-level grating lobes) is without precedent. The rules for both FCC and ITU coordination were not established to facilitate the use of antennas with mask-exceeding lobes. The FCC has never licensed such antennas. As well, the ITU framework was not established to permit them.[7]

The detriment of this 'lack of precedence' extends even beyond the FCC and ITU regulatory framework. Existing satellite service providers will likely be unfamiliar with such designs and the associated detriment, and may be unable to gauge the resulting interference to their operations, thereby exposing their networks to interference risk.

ViaSat's reference to Report ITU-R S.2223 is also misleading (see ViaSat Application, Exhibit A, Sec. III.A. at 6). ITU-R S.2223 states that the off-axis e.i.r.p. levels shall be in conformance with Recommendation ITU-R S.524-9, "or with any other *limits coordinated with neighboring* satellite networks." Rep. ITU-R S.2223, Sec.3.1 at 2. The use of the term "neighboring satellite networks" indicates that this report assumes regular antenna patterns as defined, for example, in Recommendation ITU-R S.580-6.

Required Information Omitted from ViaSat's Application

There is additional information that remains missing from the ViaSat Application relating to:

1. Antenna Control Unit (ACU) tracking performance
2. Compliance with Power Flux Density at the Earth's surface

[7] In the ITU framework the EIRP spectral density has to be reduced such that the grating lobes are below the mask. *Cf*. Rec. ITU-R S.524-9. In the case of Viasat this means that the max EIRP spectral density had to be reduced by approximately 15 dB (i.e from about 30 dBW/40kHz to about 15 dBW/40kHz).

Antenna Control Unit tracking performance

ViaSat has neglected to demonstrate that its proposed system could operate with the significant pitch, yaw and roll of flight without causing harmful interference into adjacent satellite operations. It has also not offered any data that demonstrates the ability to comply with peak antenna pointing accuracy of 0.2 degrees and to cease transmission within 100 msec once its antenna is mispointed by more than 0.5 degrees.[8] Compliance requires measured data be obtained under a variety of conditions. For example with a stationary aircraft, the antenna shall begin its pointing with 0 degrees elevation, 0 degrees azimuth and instructed to 'point' to a satellite with a specified velocity and acceleration. Satellite tracking should be ascertained for cases that include: 1) tracking a satellite of a constant elevation angle, and a varying azimuth angle, 2) tracking a satellite of a constant azimuth angle, and a varying elevation angle, 3) tracking a satellite of a varying elevation and a varying azimuth angle, 4) tracking a satellite during routine aircraft flight, 5) tracking a satellite during aircraft banking and 6) tracking a satellite during aircraft taxiing. Data obtained under these conditions would be important to demonstrate ACU tracking performance with the Mantarray antenna.

Compliance with Power Flux Density at the Earth's surface

FCC requirements in Section 25.138(a)(6), which are the only established parameters for operation of Ka-band GSO satellite networks, state that the power flux-density at the earth's surface produced by emissions from a space station for all conditions, including clear sky, and for all methods of modulation shall not exceed a level of -118 dBW/m2/MHz. Verification of this requirement ordinarily requires measurements of the fuselage attenuation. When the ViaSat antenna is pointed toward at its intended satellite, the combination of fuselage attenuation and attenuation from the aircraft antenna sidelobes are introduced in the computation. ViaSat has neglected to provide any supporting documentation that it complies with this requirement.[9]

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[8] *Cf.* ViaSat Application, Attachment 1 at 5-6.

[9] *Cf.* ViaSat Application, Exhibit A at 4.

TECHNICAL CERTIFICATE

I, James B. Costello, hereby certify that I am the technically qualified person responsible for the preparation of the technical discussion contained in the foregoing "Comments of Row 44, Inc." that I am familiar with Part 25 of the Commission's Rules (47 C.F.R., Part 25), and that I have either prepared or reviewed the technical information and supporting facts contained herein and found them to be complete and accurate to the best of my knowledge and belief.

January 11, 2013

By: James B. Costello

James B. Costello
Vice President - Engineering
Row 44, Inc.

CERTIFICATE OF SERVICE

I, Sharon A. Krantzman, do hereby certify that on this 11th day of January 2013, I sent a copy of the foregoing "Comments of Row 44, Inc" via first-class mail to:

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