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

Application of **VIASAT, INC.** For Modification of the Viasat Non-Geostationary Orbit Satellite System Using Ka- and V-Band Frequencies	)))))))))	Call Sign: S2985 File No. SAT-MPL-20200526-00056

PETITION TO DENY OR DEFER OF SPACE EXPLORATION HOLDINGS, LLC

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

David Goldman
Director, Satellite Policy

SPACE EXPLORATION TECHNOLOGIES CORP.
1155 F Street, N.W.
Suite 475
Washington, DC 20004
202-649-2700 tel
202-649-2701 fax

August 31, 2020

SUMMARY

The Commission granted Viasat market access to provide service in the United States from its non-geostationary orbit ("NGSO") satellite system in April of this year. Just weeks later, Viasat filed a skeletal application for modification, proposing more than a fourteen-fold increase in the number of satellites in its constellation. In publicly announcing this about face, Viasat made no mention of any public interest benefit of the application such as improved space safety or providing enhanced service to customers, instead explaining the "main reason" for the modification is to better position itself to receive financial subsidies from the Commission.

While Viasat's hasty application is riddled with analytical holes, missing data, and contradictions, careful examination of the bare bones that Viasat did provide leads to two inevitable conclusions:

- This modification will dramatically increase interference for NGSO operators that were properly included in the first processing round; and
- Viasat's new proposed system poses a far greater orbital-debris risk than it has disclosed.

Dramatic Increase in Interference. As the Commission has recognized, an increase in satellites will lead to an increase in interference to other NGSO systems. Viasat's modification confirms the validity of this conclusion that even Viasat endorsed – prior to this application, of course. In Viasat's own words, a reduction in "the number of active satellites in Viasat's planned constellation . . . reduces the potential for in-line events with other NGSO systems." Viasat now attempts to obscure this commonsense point by providing an analysis that is inapposite, incomplete, and based on demonstrably incorrect assumptions. A more complete analysis confirms that the modified operations Viasat proposes would impose a significant increase in the number, duration, and impact of interference events, notwithstanding Viasat's critically flawed analysis.

The Commission has established that such an effect alone should result in denial of a modification application or at least deferral of consideration to a later processing round. But the harm caused by Viasat's modification would be further exacerbated by its repeated insistence that it will not cooperate with other operators by sharing beam-pointing information to help them avoid interference from Viasat's operations.

Given these facts, the only way Viasat's proposed modification would not substantially worsen other NGSO systems' ability to use shared spectrum is if Viasat were to take full responsibility for avoiding interference, which would be precisely the result of properly relegating Viasat's application to a new processing round. In fact, Viasat should easily be able to accommodate operating in this later processing round, given the flexibility it envisions as a result of its new-found satellite diversity.

Significant Risk of Orbital Debris. For the majority of the Commission's recent orbital debris proceeding, Viasat relied primarily on a single argument – that non-U.S. licensed systems such as its own should be exempted from Commission oversight when it comes to orbital debris. Yet, in the past several months, Viasat has suddenly developed deep concerns with space safety. As a launch provider handling critical manned missions, SpaceX welcomes Viasat's awakening.

But despite Viasat's newfound interest in safety, it seems those concerns extend only to its competitors. When it comes to Viasat's own system, its proposed modification raises significant risk of new debris that would persist in orbit for hundreds to thousands of years. In fact, at the altitudes at which Viasat is proposing to operate, collisions with even small objects could create debris clouds that would persist for thousands of years, increasing the risk of more collisions or effectively precluding the use of certain orbits.

In an apparent effort to distract from the risks its system will create, Viasat makes a number of unsupported assertions about the hoped-for reliability of its notional spacecraft. But even assuming that Viasat can achieve the sort of performance it claims, its system would fail the very aggregate collision risk metric it has urged the Commission to impose on U.S.-licensed systems. Further, any of its satellites that fail in operational orbit would become space junk that will persist in a decaying orbit for over 750 years. This large debris will endanger other NGSO systems as well as manned space missions for centuries as it slowly and uncontrollably descends towards Earth. If the Commission were to adopt an aggregate metric as Viasat has urged, surely it should be designed to discourage the generation of such long-lived debris.

Despite these obvious dangers, Viasat attempts to justify its modification with flawed analysis, leading to conclusions that are wildly off base. Though Viasat works to obfuscate its analytical methodology – omitting data that it has said should be required for competitors – SpaceX was nonetheless able to confirm that the system-wide collision risk of Viasat's proposed system is likely over 170 times greater than what it claims. Moreover, even that level of risk is based on the assumption that Viasat can achieve the reliability standards it claims. Viasat routinely demands the Commission consider a litany of worst-case assumptions about its competitors, even as it only provides unrealistic best-case scenarios for itself. If the Commission were to make the sorts of assumptions about failure rates that Viasat has sought to impose on other NGSO systems, the picture of Viasat's operations would be dire – a collision risk many times the 0.001 standard per satellite, and an aggregate risk many orders of magnitude larger. In fact, Viasat's system is far riskier than other systems that Viasat has argued should preclude modification. The Commission must not allow Viasat to apply one standard to its own proposed operations while trying to hold others to a much more stringent one.

But possibly most troubling is Viasat's cavalier attitude about the safety of its operations. Unlike SpaceX's modifications to improve its safety profile to exceed accepted best-practices and Commission rules, Viasat shockingly asks to reserve its right to modify its system in the future to make it *less safe*. Despite Viasat's often over-heated rhetoric when critiquing competitors, this sort of request demonstrates that Viasat's commitment to safe operations may not be as firm as its posturing would suggest.

Finally, Viasat has adopted an unfortunate practice in Commission proceedings of lashing out at commenters – especially competitors – any time they point out valid weaknesses or failures in Viasat's applications. Rather than be diverted by these too-predictable tactics, the Commission should apply extra scrutiny to issues where Viasat resorts to *ad hominem* attacks or finger-pointing in lieu of substantive responses to legitimate concerns. The risks posed by Viasat's proposed modification are simply too serious for these types of unnecessary distractions.

TABLE OF CONTENTS

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

Application of	)	
VIASAT, INC.	)	Call Sign: S2985
For Modification of the Viasat Non-Geostationary Orbit Satellite System Using Ka- and V-Band Frequencies	)	File No. SAT-MPL-20200526-00056

PETITION TO DENY OR DEFER OF SPACE EXPLORATION HOLDINGS, LLC

Space Exploration Holdings, LLC ("SpaceX") hereby petitions to deny the application of Viasat, Inc. ("Viasat") for modification of its existing authorization to provide service in the U.S. market from a non-geostationary orbit ("NGSO") fixed-satellite service ("FSS") system using Ka- and V-band spectrum,[1] or at a minimum defer it to consideration in a later processing round.[2] Viasat proposes to deploy more than fourteen times as many satellites as currently authorized – a factor that the Commission has previously concluded can be expected to create the potential for more interference. Beyond just the sheer increase in the size of the proposed constellation, a confluence of harmful factors combine to ensure that the proposed modification would result in a significant increase in interference to other NGSO FSS systems, including the one licensed to SpaceX, notwithstanding the critically flawed analysis presented by Viasat. That alone warrants denial of the application.

[1] *See* Application, IBFS File No. SAT-MPL-20200526-00056 (filed May 26, 2020) ("Viasat Modification").

[2] For example, Viasat's application was filed in time to be considered in the Ka-band NGSO FSS processing round that closed on May 26, 2020. *See Cut-Off Established for Additional NGSO FSS Application or Petitions for Operations in the 10.7-12.7 GHz, 12.75-13.25 GHz, 13.8-14.5 GHz, 17.7-18.6 GHz, 18.8-20.2 GHz, and 27.5-30 GHz Bands,* Public Notice, 35 FCC Rcd. 2881 (IB 2020).

Yet increases in harmful interference are not the application's only significant shortcoming. Despite Viasat's effusive rhetoric about space safety when critiquing competitors' systems, Viasat fails to submit in its own application sufficient information on orbital debris mitigation to demonstrate its ability to operate safely in space – including information that it has insisted that the Commission must require of other applicants. Instead, Viasat chronicles its aspirations and uses them to assume away difficult issues. Such an approach does not satisfy the Commission's rigorous requirements for space safety and puts all others who operate satellite systems or transport humans in space at risk.

Accordingly, if the Commission does not deny the Viasat Modification based on increase interference or failure to comply with the orbital debris mitigation requirements, at a minimum it should defer consideration to a new set of processing rounds where more complete information on the impact to other NGSO systems can be more fully assessed and addressed.

BACKGROUND

In 2016 and 2017, Viasat filed applications in a series of NGSO processing rounds[3] seeking authority to provide service in the U.S. market from a Netherlands-authorized NGSO system using Ka-band and V-band spectrum. The Commission granted those applications in April 2020.[4] Just one month later, Viasat filed the current application to modify that authorization, seeking to increase the number of active satellites from 20 to 288 and convert its system from mid-Earth orbit

3 *See OneWeb Petition Accepted for Filing, Cut-Off Established for Additional NGSO-Like Satellite Applications or Petitions for Operations in the 10.7-12.7 GHz, 14.0-14.5 GHz, 17.8-18.6 GHz, 18.8-19.3 GHz, 27.5-28.35 GHz, 28.35-29.1 GHz, and 29.5-30.0 GHz Bands*, Public Notice, 31 FCC Rcd 7666 (IB 2016); *Cut-Off Established for Additional NGSO-Like Satellite Applications for Petitions for Operations in the 12.75-13.25 GHz, 13.85-14.0 GHz, 18.6-18.8 GHz, 19.3-20.2 GHz, 29.1-29.5 GHz Bands,* Public Notice, 32 FCC Rcd 4180 (IB 2017); *Boeing Application Accepted for Filing in Part, Cut-Off Established for Additional NGSO-like Satellite Applications or Petitions for Operations in the 37.5-40.0 GHz, 40.0-42.0 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz Bands*, Public Notice, 31 FCC Rcd 11957 (IB 2016). These are collectively referred to herein as the "2016 Round."

4 *See Viasat, Inc.*, 35 FCC Rcd. 4324 (2020) ("*Viasat Authorization*").

("MEO") to low-Earth orbit ("LEO"), changing the orbital altitude and inclination from 8,200 km and 87° to 1,300 km and 45°. Despite its proposed relocation into the heart of previously licensed LEO systems, Viasat continues to contemplate the future operation of Ka-band satellite-to-satellite links to communicate with geostationary orbit ("GSO") satellites.[5]

Critically, when announcing this modification, Viasat did not claim that the changes would serve the public interest. Rather, despite Viasat's extensive lobbying to prevent competitors from being eligible to participate in Commission funding programs, Viasat's CEO confessed, "We had a purpose in mind for the MEO, but the biggest factor in wanting to go over the altitude is really the amount of funding that the FCC is aiming at low specifications."[6] It appears that despite Viasat's many claims to the contrary when criticizing competitors, it does in fact understand that systems operating at lower altitudes can provide low-latency service.

Viasat's public interest discussion citing improved service for customers and space safety are transparent post hoc rationalizations. As Viasat's CEO himself made clear when asked to confirm whether Viasat would have even applied for the modification absent the possibility of increased subsidies, "The funding is certainly the most – that's the most obvious attraction to it."[7]

DISCUSSION

I. VIASAT'S PROPOSED MODIFICATION WOULD SIGNIFICANTLY INCREASE INTERFERENCE

Viasat asserts that, notwithstanding its proposal to multiply the number of satellites in its constellation many times over, other NGSO systems will not experience increased interference.

5 *See* Viasat Modification at 2.

6 "Viasat, Inc. (VSAT) Q4 2020 Earnings Call Transcript," THE MOTLEY FOOL (May 26, 2020) (response by Mark Dankberg, Chairman of the Board and Chief Executive Officer of Viasat), https://www.fool.com/earnings/call-transcripts/2020/05/26/viasat-inc-vsat-q4-2020-earnings-call-transcript.aspx.

7 *Id.*

In support of this assertion, Viasat presents an analysis that considers the dynamic, time-varying interference expressed as a cumulative distribution function ("CDF") of the interference-to-noise ratio ("I/N"), that compares the fraction of time the I/N value of the modified system would exceed the I/N value for the presently authorized system.[8] Although that analysis is modeled after those submitted in connection with other modification applications, in each of the past cases, the modification involved a *decrease* in the number of satellites to be deployed. As discussed below, that analysis is not valid where the proposal includes hundreds of *additional* satellites – and use of this misleading metric is just one of several flaws in Viasat's analysis. As just one example, Viasat presents no analysis whatsoever of the potential interference impact on its own system of operating at lower altitude.

As discussed below, the I/N analysis is intended to capture actual interference based on certain assumptions. However, those underlying assumptions are no longer valid when one party proposes to significantly increase the number of satellites in its system. In these circumstances, the analysis does not accurately capture the number and duration of geometric in-line events that result in spectrum splitting. The analysis is particularly inapposite when one party, such as Viasat, has repeatedly expressed an unwillingness to share beam pointing information that could be used to resolve or reduce the number of such events. In this case, Viasat's proposed modification would significantly increase such in-line events and therefore would significantly increase the potential interference impact on other NGSO systems. Moreover, even if Viasat could use the I/N analysis in this case, SpaceX has determined that Viasat's I/N analysis was seriously flawed, and that a proper analysis would further demonstrate the significant interference impact of the proposed

[8] *See* Viasat Modification, Technical Annex at 13-18.

modification. Either one of these conclusions would be sufficient to deny the modification application, or at minimum to defer it to a later processing round.

A. Substantially Increasing the Number of Satellites in Viasat's Constellation Will Correspondingly Substantially Increase the Number of Geometric In-Line Events, Necessitating More Spectrum Splitting

Viasat proposes to increase the number of satellites in its NGSO constellation by a factor of more than fourteen – from 20 to 288. The Commission has long recognized that increasing the number of satellites in an NGSO constellation will also increase the potential for interference.

> A system's orbital configuration can impact its ability to share with other systems and services by affecting the number of active satellites "visible" at a particular location. ***The magnitude of sharing difficulty increases with an increase in the number of active visible satellites in the modified system.*** Thus, a customer using another satellite system will have more difficulty operating with that system if the number of visible satellites in the modified system is increased.[9]

In evaluating the interference impact of the modification proposed in *Teledesic*, the Commission assessed a key metric: whether the proposed modification would affect the number of Teledesic satellites visible above the proposed minimum elevation angle at any particular time period throughout the United States.[10] If so, the modification would yield more potential interference to other NGSO systems. Conversely, the Commission has found that decreasing the number of satellites would tend to reduce the potential for interference.[11] Indeed, this reduction was critical to the Commission's decision to grant a SpaceX modification application in which the number of satellites would decrease slightly (from 4,425 to 4,409). The Commission found that

---

9 *Teledesic LLC*, 14 FCC Rcd. 2261, ¶ 13 (IB 1999) (emphasis added) ("*Teledisic*").

10 *See id.*

11 *See, e.g., O3b Limited*, 33 FCC Rcd. 5508, ¶ 39 (2018) (finding that, even though "a reduction in the number of satellites may give [an NGSO operator] less flexibility to use satellite diversity, the number of potential interference events vis-à-vis other constellations will be reduced and, if no coordination agreement is reached with any of these constellations, the number of times those constellations will be required to reduce spectrum use will be smaller").

> the number of spatial configurations that have the potential for generating interference between SpaceX and any other NGSO FSS system in the same processing round is expected to remain approximately unchanged. ***We consider this to be a fundamental element in assessing whether there would be significant interference problems as a result of granting the proposed modification.***[12]

Fewer satellites in view reduces the chances for in-line events, while more satellites in view increases those chances and therefore the likelihood of significant interference.

Until recently, Viasat embraced this commonsense principle. In fact, in support of the amendment that was granted just one month before it filed the current modification, Viasat argued that a reduction in constellation size would reduce the potential for interference.

> This amendment simply reduces the number of active satellites in Viasat's planned constellation and reflects corresponding adjustments to their configuration within the constellation. At bottom, this change reduces the potential for in-line events with other NGSO systems. Namely, ***as the number of active satellites is reduced from 24 to 20 – a 17% reduction – the potential for frequency conflicts with other NGSO systems is reduced***.[13]

Viasat submitted the following figure to confirm that fewer satellites would be in view at all latitudes.

---

[12] *Space Exploration Holdings, LLC*, 34 FCC Rcd. 2526, ¶ 11 (IB 2019) (emphasis added) ("*SpaceX Modification Order*").

[13] Application, IBFS File No. SAT-APL-20180927-00076, Exhibit A: Description of Amendment at 16 (Sep. 27, 2018) (emphasis added) ("Viasat Amendment").

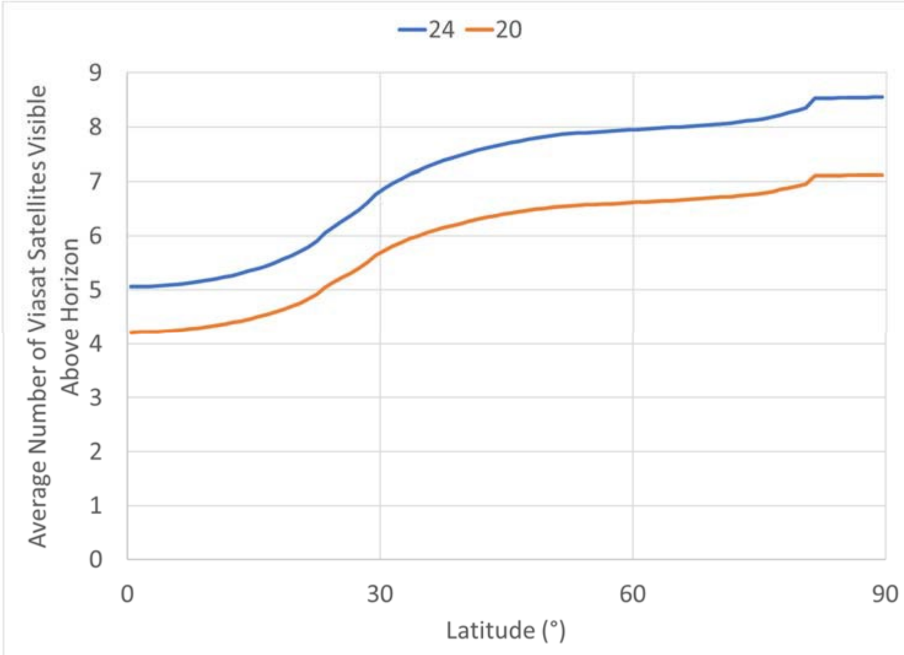

Figure 17 from Viasat Amendment: Average Number of Potentially Active VIASAT-NGSO Satellites Above the Horizon (In bands with EPFD limits)[14]

In granting Viasat's application, the Commission endorsed this analysis.

> [T]he fact that the number of satellites proposed is reduced, the altitude of the proposed orbits remains the same, and the frequencies requested are unchanged mean that the number of potential interference events between ViaSat's proposed satellites and other satellites being proposed in the same processing rounds is likely to be decreased and the number of times constellations will be required to reduce spectrum will also likely be smaller. ***As both ViaSat and SpaceX assert, and we agree, these changes decrease the potential for interference***, rather than increase it.[15]

Yet in its current application, Viasat takes precisely the opposite view. Indeed, it proudly proclaims that its proposed modification would dramatically *increase* the number of satellites in view from any point within the continental United States, as illustrated by the figure below taken from the application.[16]

---

14 *Id.*

15 *Viasat Authorization* ¶ 12 (emphasis added).

16 *See* Viasat Modification, Technical Annex at 5.

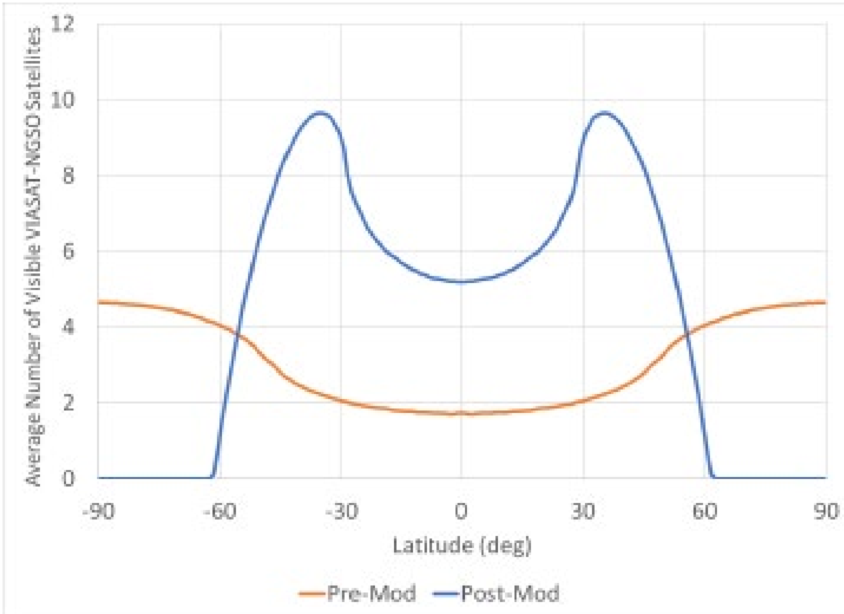

Figure 1 from Viasat Modification Technical Annex

Nonetheless, Viasat now claims that these additional satellites will not create the potential for additional interference because they provide "increased flexibility to employ satellite diversity as a mitigation technique more often than otherwise would have been possible with its previous design."[17]

Whether or not additional satellites *could* allow Viasat to ameliorate the impact of in-line events through increased satellite diversity in theory, the impact of in-line events *in reality* depends on other operational practices.[18] But when it comes to actual practice, Viasat provides scant detail. Not only has Viasat offered no explanation of how its operational practices will take advantage of this flexibility to reduce interference, it has made no commitment to do so. On the contrary, Viasat's continued opposition to sharing beam-pointing information[19] means that other operators

---

17 *Id.*

18 *Compare Orbital Communications Corp.*, 15 FCC Rcd. 1340, ¶¶ 7-8 (IB 1999) (finding that public interest would be served by approving modification because, although total number of satellites would increase, number in use would not, so there would be no change in overall spectrum utilization characteristics).

19 *See, e.g.,* Comments of Viasat, Inc., RM-11855, at 3 (June 15, 2020) (opposing SpaceX proposal for sharing beam pointing information).

could not account for these interference-mitigation practices, even if Viasat were to adopt them. Viasat's adamant insistence that it will not share this sort of information casts doubt on its vague claims that it will limit interference to other operators. Thus, without these other operational changes and willingness to communicate the necessary information to other operators, simple geometry makes clear that Viasat's order-of-magnitude increase in the number of satellites in its system will translate into a corresponding increase in the number of in-line events that can cause interference.

Consider a case of two NGSO systems (victim A and interferer B) with characteristics such that System B causes 6% ΔT/T to System A whenever their satellites are separated by less than 10 degrees as seen from a point on the ground where both systems have earth stations. If both systems typically have only one satellite apiece in view that is eligible for communications (i.e., above the system's minimum elevation angle and outside its GSO exclusion zone), then the two systems only have to split spectrum when those two satellites are within a 10-degree angle of each other. If instead System B increases the number of satellites in its system so that there are now ten eligible satellites in view at a time, there are now ten satellites that present potential geometric in-line events with System A. Although it is likely that System B would not communicate with this particular earth station site from all ten satellites, in the absence of coordination or information on System B's beam pointing, System A must assume that it will have to split spectrum whenever its satellite is within a 10 degree angle of any of those ten System B satellites.

To illustrate this principle, Figure 1 below shows the effect of Viasat's proposed modification on the number of eligible satellites in view for the Viasat and SpaceX NGSO systems from the location used by Viasat in its I/N analysis, assuming a 10-degree separation angle. As the figure shows, the introduction of hundreds of additional Viasat satellites reduces the average number of eligible SpaceX satellites from 20.63 to 17.13. In other words, the average number of SpaceX satellites experiencing a geometric in-line event with a Viasat satellite is *more than three times higher*, jumping from 1.36 to 4.86.

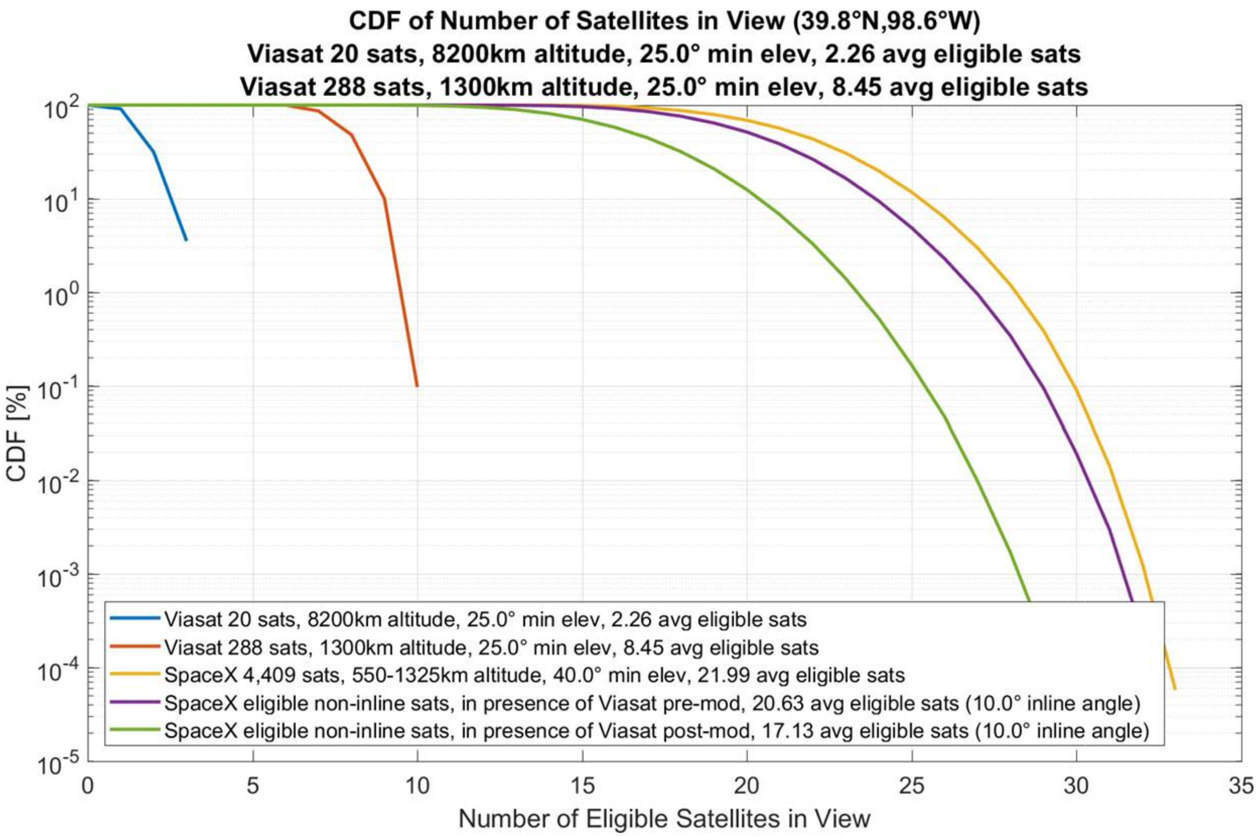

Figure 1. Geometric In-Line Events Before and After Proposed Viasat Modification

As noted above, Viasat argues that the additional satellites in view will provide the flexibility to choose satellites that are not in-line with other NGSO systems and thereby avoid interference. But the only way to ensure that Viasat's proposed modification would not substantially reduce the ability of other NGSO FSS systems to use shared spectrum would be if Viasat were to take full responsibility for avoiding interference by, for example, using beam pointing information from the victim system(s) to avoid interference events. If Viasat's application were considered in a new processing round, the rights of existing NGSO FSS licensees would presumptively be protected in this way – a requirement that Viasat could use its new-found satellite diversity to satisfy. Accordingly, the Commission should defer consideration of this modification to a later processing round.

B. Proper Analysis of Viasat's Proposal Demonstrates That the Modification Would Substantially Increase Interference from and to Viasat's System

As demonstrated above, the addition of eligible satellites by Viasat would pose a significant increase in the number and duration of geometric in-line events with other NGSO systems. Instead of acknowledging and dealing with its prior recognition of the correlation between the number of satellites in an NGSO system and its potential for interference, Viasat submits an analysis that purports to show that its system as modified would actually decrease the potential for interference into other NGSO systems. Yet putting aside the insufficiency of such an I/N analysis in this context, Viasat's analysis does not even support its position using its chosen I/N metric.

Viasat's analysis is both incomplete and based on demonstrably incorrect assumptions. In assessing previous NGSO modification applications, the Commission has examined the potential for interference in four scenarios: uplink interference to and from the modified system and downlink interference to and from the modified system.[20] Viasat has not provided any analysis with respect to two of these scenarios – i.e., the susceptibility of its modified system to additional uplink or downlink interference. Moreover, even in the two scenarios Viasat purported to address – i.e., interference Viasat would cause to the uplink and downlink of other NGSO FSS systems, including SpaceX – Viasat did not provide complete information on the assumptions that went into its analysis, and SpaceX has been unable to replicate it. Indeed, it would appear that some of those assumptions were clearly erroneous, such as the fact that Viasat purports to have evaluated Ka-

[20] *See, e.g., Space Modification Order* ¶¶ 12-15.

band interference for SpaceX's "Typical User Terminal Antennas"[21] – even though SpaceX only uses Ka-band frequencies for communications with *gateway* antennas.

Nonetheless, below we discuss each of the four scenarios of interest. Where appropriate, SpaceX has attempted to reproduce Viasat's I/N analysis based on the actual authorized space station and earth station parameters of SpaceX's system and publicly available information filed by Viasat with the Commission or the International Telecommunication Union ("ITU"). As demonstrated below, contrary to Viasat's assertions, the proposed modification would significantly increase interference in some cases.

1. Uplink Interference to Viasat

As noted above, Viasat did not consider the effect of its proposed modification on its own susceptibility to interference. Because other NGSO FSS operators will be required to split spectrum with Viasat's modified system at a specified interference level, their systems could be adversely affected by Viasat's own susceptibility to interference. This is particularly troublesome on the uplink, where reducing operating altitude by 6,900 km reduces the path loss and effectively increases the EIRP of competing uplink signals of other systems into Viasat's satellite receive antenna by approximately 16 dB. By comparison, the satellite G/T in the Viasat Modification has been reduced by just 3.6 dB or 7.9 dB for high gain and low gain antennas, respectively. Figures 2 and 3 below show the dramatic effect of these changes on the interference experienced by Viasat's modified system in the Ka-band and V-band, respectively.

[21] Viasat Modification, Technical Annex at 14.

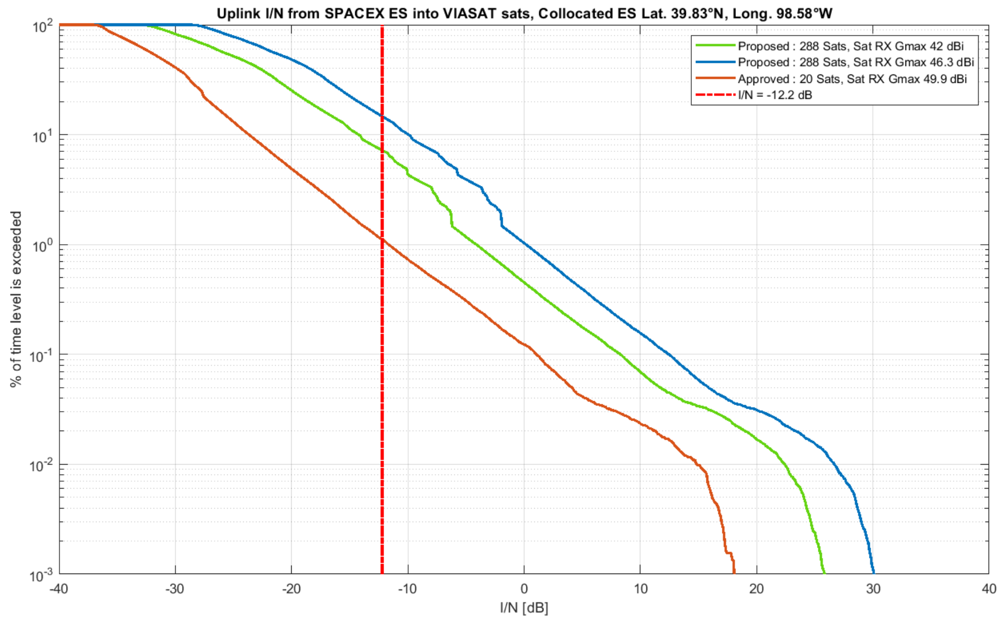

Figure 2. Ka-Band Uplink Interference to Viasat's NGSO System

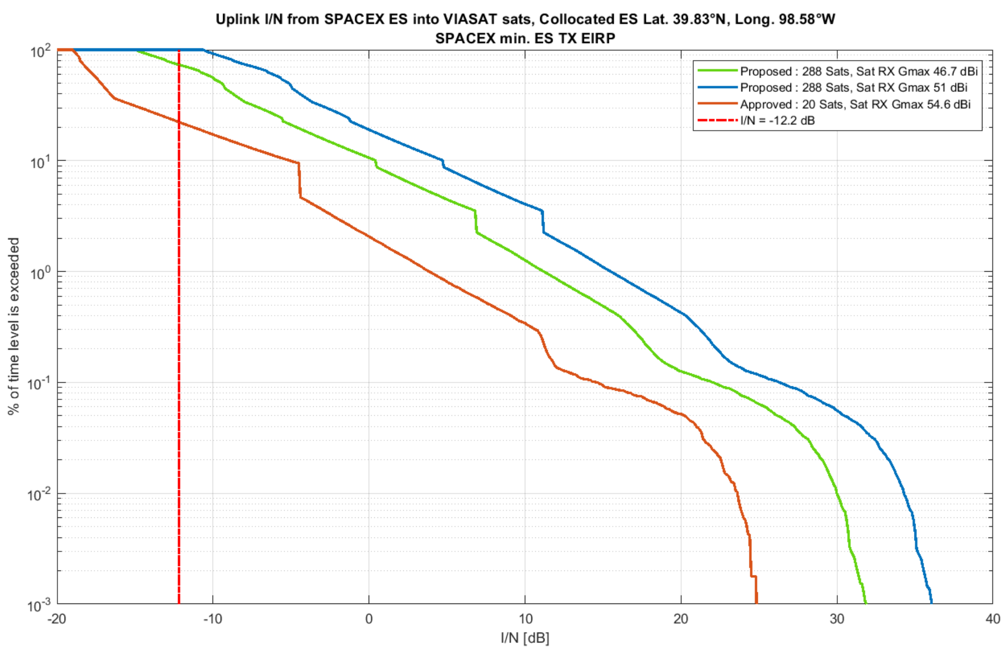

Figure 3. V-Band Uplink Interference to Viasat's NGSO System

Accordingly, if the Commission grants the modification in any form, it must impose a condition requiring Viasat to accept any additional interference to its uplinks from other NGSO systems authorized in the 2016 Round resulting from this modification compared to its current authorization.

2. Uplink Interference from Viasat to SpaceX

To date, Viasat has yet to apply to the Commission for any earth station authorization to communicate with its NGSO system. Thus, the only information available about the operational parameters of Viasat earth stations is that which can be gleaned from its ITU filings (DREBBELSAT-2 and -3 for its existing Ka- and V-band MEO systems, respectively, and DREBBELSAT-4 for its proposed Ka/V-band LEO system). Those filings indicate that earth station EIRP for the modified LEO system will be approximately 18 dB lower in Ka-band and 13 dB lower in V-band than for the current MEO system, which makes sense given the significantly decreased distance between Viasat's satellites and the Earth. Assuming that Viasat will actually operate in this manner, the uplink transmissions to its modified NGSO system should not impose significant additional interference onto SpaceX's NGSO system. In order to ensure this outcome, the Commission should condition any grant of this application on a requirement that earth station EIRP not exceed the levels stated in Viasat's current ITU filings.

3. Downlink Interference to Viasat

Viasat states in its application that its proposed LEO system will operate with the same PFD levels as its currently authorized MEO system.[22] If this is true, there would be no reason to anticipate that its modified downlinks would be more susceptible to interference from other NGSO systems.

4. Downlink Interference from Viasat to SpaceX

To determine the effect of the proposed modification on the downlinks of SpaceX's authorized system, SpaceX performed an I/N CDF analysis like the one provided by Viasat. In Viasat's analysis, "[o]perational EPFD spectral densities have been used to model the VIASAT-

---

22 Viasat Modification at 1.

NGSO transmitters based on the current grant and on the proposed modification."[23] Accordingly, for its simulation, SpaceX incorporated information from the EPFD data files submitted by Viasat to the ITU for its current and proposed systems. Among other things, the DREBBELSAT filings indicate a 2 dB decrease in Ka-band PFD (from -131.3 dBW/m^2/40kHz for the current MEO system to -133.4 dBW/m^2/40kHz for the proposed LEO system) and a 4 dB increase in V-band PFD (from -131.3 dBW/m^2/40kHz for the current MEO system to -127.2 dBW/m^2/40kHz for the proposed LEO system). In addition, these ITU filings indicate that the number of co-frequency beams per spot (the "Nco" value) in both the Ka- and V-bands would increase from 2 in the current MEO system to 8 in the proposed LEO system. SpaceX also used the assumptions stated in Viasat's analysis.[24] The results are presented in Figures 4 and 5 below for Ka-band and V-band, respectively.

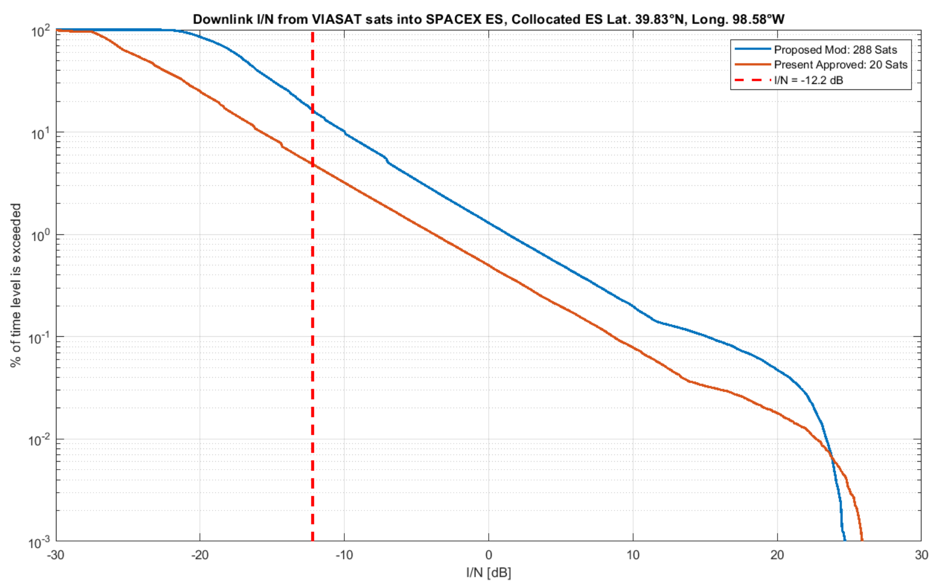

Figure 4. Viasat Ka-Band Downlink Interference to SpaceX

---

[23] Viasat Modification, Technical Annex at 13.

[24] *See id.* ("The VIASAT-NGSO earth station and the victim earth station are collocated near the center of the CONUS;" "The VIASAT-NGSO earth station and the victim earth station can each communicate with any satellite in its respective system following the rules applicable for that system (e.g. GSO avoidance angle and minimum elevation angle). Within those constraints, the satellites are chosen randomly;" and Viasat "chose 39°50' North and 98°35' West as a representative location").

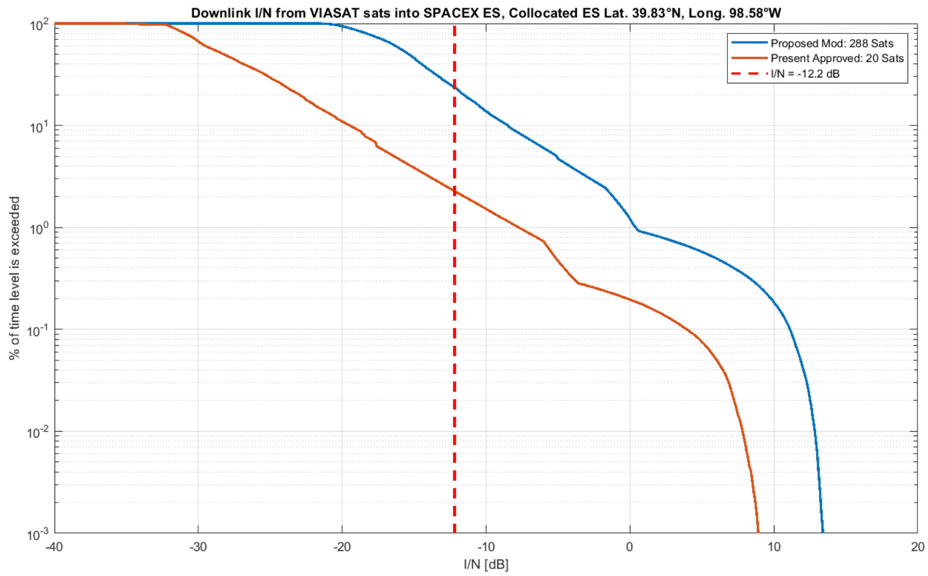

Figure 5. Viasat V-Band Downlink Interference to SpaceX

As this analysis clearly shows, contrary to Viasat's assertions, its modified system would create significantly more potential interference to SpaceX's system than the system Viasat is currently authorized to deploy – even assuming a decrease in Ka-band PFD for the proposed LEO system. It would increase minimum I/N levels and increase the probability of I/N levels requiring band splitting in Ka-band by 240%. Accordingly, the Commission can only consider this application as part of a later processing round.[25] In this case, Viasat filed its application within the window for participation in the Ku/Ka-band NGSO processing round that was recently initiated. Its requests with respect to V-band spectrum, however, should initiate a new processing round in that band.

C. The Commission Must Impose Additional Conditions on Viasat's Notional Inter-Satellite Links to GSO Systems

In the 2016 Round, Viasat sought authority for satellite-to-satellite communications between its NGSO constellation and GSO satellites using Ka-band spectrum. The Commission

---

[25] *See Teledesic* ¶ 5 ("if the modification application were to present significant interference problems, we would treat the modification as a newly filed application and would consider the modification application in a subsequent satellite processing round").

found that transmissions from Viasat's MEO satellites presented a potential interference hazard to operations along the GSO arc and imposed the following condition:

> If satellite-to-satellite transmissions in the 27.5-28.6 GHz and 29.5-30.0 GHz bands are authorized by another administration, this market access grant is subject to ViaSat submitting a modification to its Petition showing that off-axis power flux density levels at the GSO are no greater than those that would be produced by an earth-based antenna operating in compliance with the off-axis EIRP density limits contained in section 25.218(i)(1)-(4).[26]

Viasat commits to comply with this condition if its modification is granted.[27]

However, by relocating Viasat's constellation from MEO to LEO, the modification presents a very different interference threat. Whereas before Viasat would have been transmitting from 8,200 km to satellites at higher altitude, it now proposes to transmit from 1,300 km. SpaceX's satellites currently authorized to operate in the same band at 1,325 km would not have been affected by Viasat's MEO-GSO transmissions. However, if the modification were granted, they would now potentially be caught directly in the path of its LEO-GSO transmissions with very little separation form the origin of those transmissions. Moreover, even Ka-band satellites operating slightly below Viasat's altitude, including SpaceX satellites at 1,275 km and Telesat satellites at 1,248 km, could be affected by these transmissions. Thus, any grant of the modification application must include a revised condition requiring Viasat to demonstrate that its operations will protect not only GSO satellites but NGSO satellites operating at altitudes between 1,200 km and the GSO arc in the relevant portion of the Ka-band.[28]

---

26 *Viasat Authorization* ¶ 52(f).

27 *See* Viasat Modification at 2.

28 SpaceX is currently seeking modification of its authorization to relocate its satellites from 1,275 km and 1,325 km to lower altitude. *See* Application, IBFS File No. SAT-MOD-20200417-00037 (filed Apr. 17, 2020). Grant of that modification would obviate the need for Viasat to make the proposed showing with respect to SpaceX.

II. VIASAT HAS FAILED TO PROVIDE CRITICAL INFORMATION ON THE ORBITAL DEBRIS IMPLICATIONS OF ITS PROPOSED SYSTEM

Viasat boldly asserts that "the design of the [modified] constellation allows the highest standards of space safety to be met for this LEO constellation as a whole."[29] Indeed, Viasat cites the safety of its system as a public interest reason for granting its application.[30] Yet Viasat also "reserves the right modify this orbital debris mitigation plan to incorporate any less-stringent requirements" adopted by the Commission.[31] Apparently, Viasat's commitment to safe space extends only as far as meeting the bare minimum regulatory requirements.

The Modification Application also makes clear that Viasat is still in the process of developing its space station design. For example, Viasat states that it "is designing the VIASAT-NGSO satellites to comply with the current NASA debris standards,"[32] "is designing the satellites to limit the probability that they will become a source of debris by collision with small debris or meteoroids,"[33] and that "upon finalization of space station design" it will submit updated information on its orbital debris mitigation plans.[34] Despite the evidently nascent status of its satellite design efforts Viasat claims that its system will operate with a high degree of safety. For example, it confidently asserts that "[t]he expected maneuver capability reliability over the satellite lifetime will be designed to be greater than 99.5%."[35] Yet Viasat appears to have backed into this

---

[29] Viasat Modification, Technical Annex at 1.

[30] Viasat Modification at 4-5.

[31] Viasat Modification, Technical Annex at 6. Although Viasat's NGSO system is licensed by the Netherlands, it has not provided any information on the Netherlands' licensing process as required to avoid compliance with the Commission's orbital debris mitigation rules. *See* 47 C.F.R. § 25.114(a)(14)(v).

[32] Viasat Modification, Technical Annex at 6.

[33] *Id.* at 7.

[34] *Id.* at 11.

[35] *Id.* at 8.

reliability expectation only to support the otherwise unsubstantiated assertions that its system will comply with safety requirements for collision risk and probability of successful deorbit.[36]

As discussed below, even assuming that Viasat can achieve the sort of performance it claims for its notional spacecraft, its proposed system presents significant risks – including the likelihood that some of its satellites will fail in orbit and remain a danger to manned spacecraft and other NGSO systems for hundreds of years. Moreover, if the Commission were to make the sorts of assumptions about failure rates that Viasat has sought to impose on other NGSO systems, the picture would be far worse – and significantly worse than the risks posed by other systems that Viasat has argued should preclude modification. The Commission should not allow Viasat to apply one standard to its own proposed operations while trying to hold others to a much more stringent one.

Moreover, not only has Viasat refused to provide the types of information that it routinely demands of competitors, Viasat has even failed to provide orbital debris information that the Commission has required of other NGSO applicants. For example, Viasat did not supply an analysis of the demise time for a satellite that loses maneuverability while in its operational orbit, proffering instead only a chart showing demise times after the satellites have been successfully lowered to a disposal orbit for passive decay.[37] While that chart was at least described as portraying the passive de-orbit phase, Viasat also claims that the probability of a collision between one of its satellites and another large object (10 cm or larger in diameter) "during the total orbital lifetime of the satellite, including the deorbit phase" would be less than 0.00025.[38] However, the

36 *Id.* at 8-9.

37 *See id.* at 11 (Figure 3).

38 *Id.* at 7.

analysis presented below demonstrates that this value might apply to the passive de-orbit phase but clearly does not reflect the risk of failure at operational altitude.

A. Reverse Engineering Viasat's Omitted Orbital Debris Information Reveals that Viasat Has Greatly Understated its System's Potential to Generate Dangerous Debris.

Viasat did not submit all of the assumptions underlying its orbital debris analyses as part of its sparse application. However, in addition to statements of intention for its still-under-design system, Viasat did submit a few bits of information on those assumptions. SpaceX has attempted to use that bare information to reverse engineer the main assumptions that underlie its assertions. While this process introduces certain imperfections and parameter assumptions into the analysis, Viasat has left stakeholders and the Commission no other way to derive a fairly accurate estimate of the true risk probability for the modified Viasat system.

For example, Viasat states its intention to reserve 256 m/s of ΔV to perform an active disposal maneuver that would lower the orbital perigee of its satellites at end of life from 1,300 km to 300 km, at which point the satellite's orbit will passively decay until its demise in the atmosphere.[39] Viasat's fuel reserve figure is just sufficient for a single impulse burn to move perigee from 1,300 to 300 km, but leaves no additional fuel for other orbital parameter changes (to say nothing of collision avoidance or other maneuvers).[40] Thus, the passive decay orbit will have apogee of 1,300 km, perigee of 300 km, inclination of 45 degrees, and unknown argument of perigee.

---

39 *Id.* at 10.

40 The calculation is $\Delta V = \sqrt{\frac{\mu_E}{r_2}}\left(1 - \sqrt{\frac{2r_1}{r_1+r_2}}\right) = 255.5\ m/s$.

This information can be used with other data provided by Viasat to determine the area-to-mass ratio ("A:M") assumed for each Viasat satellite. Viasat used NASA's Debris Assessment Software ("DAS") to generate the following plot of passive decay time against mission end year[41]:

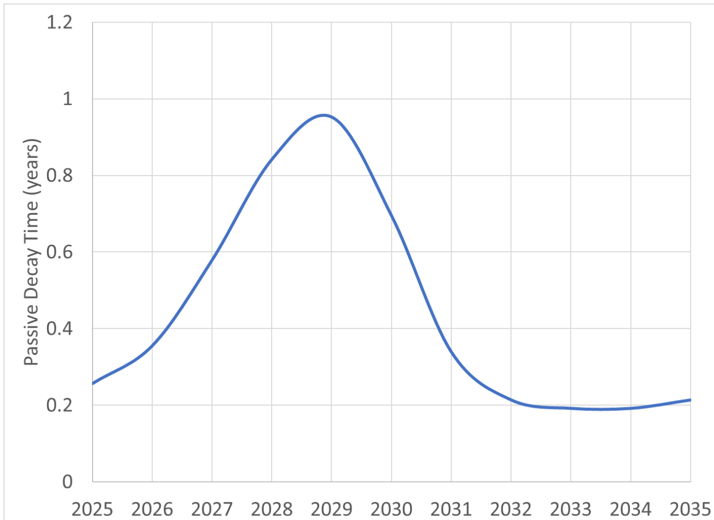

Figure 3 from Viasat Modification Technical Annex

With the information determined above about the characteristics of Viasat's intended passive decay orbit, DAS can be used to determine the A:M.[42] Figure 6 below shows the best fit, which uses A:M of 0.10 m^2/kg to achieve results virtually identical to those presented by Viasat.[43]

[41] Viasat Modification, Technical Annex at 11, Figure 3.

[42] For this purpose, RAAN is averaged over the constellation and argument of perigee is varied from 0 to 360 degrees to provide an error bound.

[43] Note that this value is very different from the A:M value of 0.0396 m^2/kg disclosed by Viasat in connection with its currently authorized NGSO system. *See* Letter from John P. Janka to Marlene H. Dortch, IBFS File No. SAT-PDR-20161115-00120, Attachment at 1 (Apr. 11, 2017).

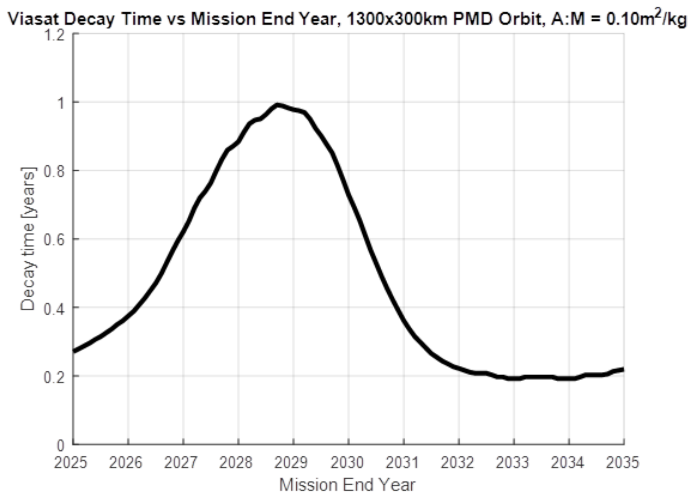

Figure 6. DAS-Generated Recreation of Viasat Passive Decay Curve

The A:M, in turn, can be used with another DAS plot provided by Viasat to determine mission duration. Below is the plot provided in the application of collision probability risk vs. launch year.[44]

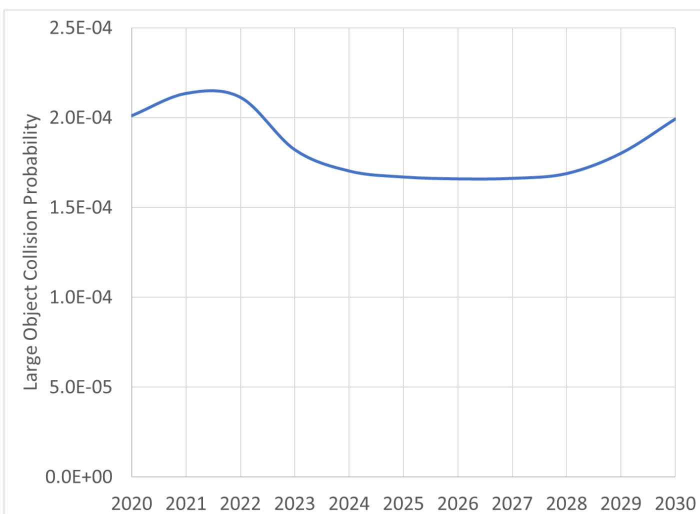

Figure 2 from Viasat Modification Technical Annex

Viasat states in the Schedule S accompanying its modification application that its spacecraft will have an estimated lifetime of fifteen years. However, as shown in Figure 7, using that value in the DAS analysis results in a curve that does not correspond to the shape of the one provided by Viasat.

44 Viasat Modification, Technical Annex at 8, Figure 2.

Using a value of five years does not result in a match either. Assuming a seven-year mission duration, however, results in a curve shape that very closely replicates the one submitted by Viasat. (Since we do not yet have a value for the mass of a Viasat spacecraft, we use several values in the 150-600 kg range to generate a curve for consideration.)

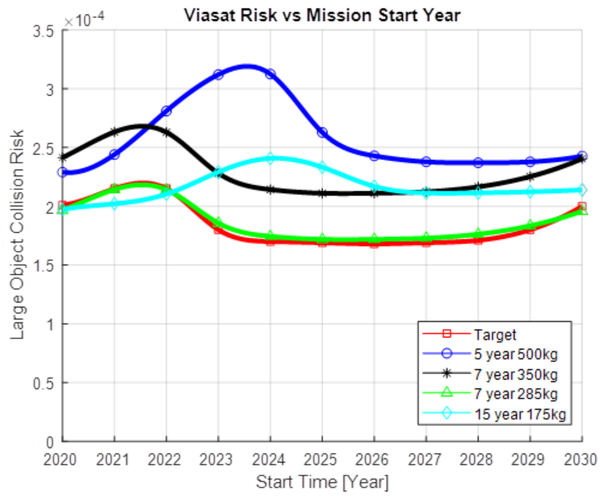

Figure 7. DAS-Generated Attempts to Recreate Viasat Collision Risk Curve

With the mission duration deduced, satellite mass is the only parameter left to tune the plot. As shown in Figure 8 below, using a mass of 285 kg with a mission duration of seven years results in a DAS output that is nearly identical to Figure 2 from Viasat's filing.

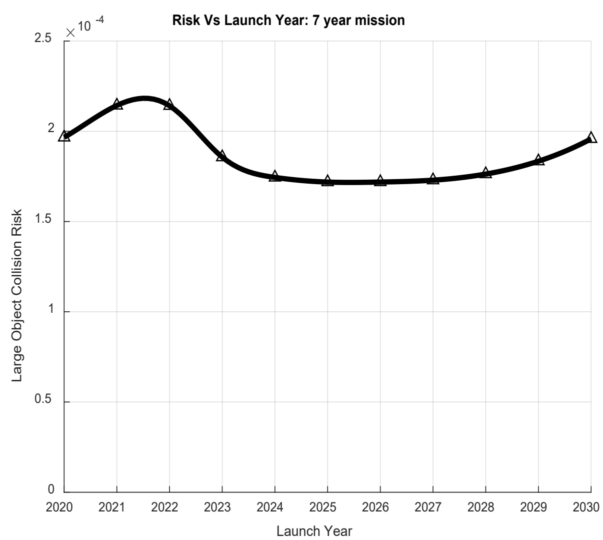

Figure 8. Fully Recreated DAS Collision Risk Plot

Having used DAS to deduce the values used by Viasat, we can now evaluate Viasat's orbital debris analysis. In order to do so, we first determine the characteristics of those Viasat satellites that fail in operational orbit at 1,300 km altitude – something Viasat obscured by providing only information on passive deorbit *assuming* active removal from operational orbit had already been accomplished. DAS will only report up to 100 years of decay time and will zero out any risk after 2130. However, this limitation can be overcome to reach a much more accurate assessment by recursively feeding the final altitude at the end of each 100-year analysis into a new DAS analysis until the satellite reenters the atmosphere. Table 1 below shows the decay time and risk of collision with a large object for a Viasat in-orbit failure under each of these approaches.

	Years to Decay to Reentry	Collision Risk
Limited DAS	100+	0.0033
Recursive DAS	760	0.0622

Table 1. Viasat In-Orbit Failure Characteristics

If we accept Viasat's claim that 99.5% of its satellites will retain full maneuver capability throughout their lifetime and therefore should be assumed to have zero collision risk, applying the recursive DAS collision risk to the proposed Viasat constellation yields an aggregate collision risk of 0.0896.[45] Moreover, if we assume (given a seven-year lifetime) that there will be at least two generations of Viasat satellites over the course of its fifteen-year license, the "total probability of collision for the system as a whole" would be 0.1792.[46]

[45] The calculation is (0.005)*(288 satellites)*(0.0622) + (0.995)*(288 satellites)*(0).

[46] Viasat defines this concept as "the sum of the probability of collision associated with each satellite space station, for the estimated number of stations to be deployed over a 15-year period, including replacement space stations." Viasat Modification, Technical Attachment at 8 n.9. SpaceX has not considered replacements in its calculations.

This is over 170 times the 0.001 system-wide collision risk claimed by Viasat. The most likely explanation for this discrepancy is the fact that unless instructed otherwise DAS calculates the probability of collision with large objects by assuming that all satellites are located in the post-mission disposal orbit at the end of their mission – i.e., a 100% maneuver reliability rate rather than the 99.5% rate to which Viasat aspires.[47] By assuming away the potential for failures at operational altitude, such an approach would significantly underestimate the potential for collisions. When correctly applied, DAS demonstrates that Viasat's proposed system would have a significantly higher collision risk than claimed in Viasat's application.

Moreover, applying a less favorable reliability rate – an approach that Viasat has endorsed for its U.S.-licensed competitors – would further exacerbate the risk presented by the modification. Where an NGSO operator will rely on maneuverability to reduce collision risk, Viasat would require a calculation of the total probability of collision with large objects taking into consideration an assumed 10% failure rate of the maneuver capability.[48] Applying Viasat's approach to its proposed modification yields a collision risk probability of 0.0062 per satellite (i.e., 10% times 0.062) and an aggregate risk for the total constellation of 1.786 (for a single generation) to 3.572 (for two generations). This level of risk is many times higher than 0.001 for a single satellite, and many orders of magnitude larger than that figure on an aggregate basis. In addition, the average time for orbital decay to demise would be 76.5 years – more than triple the 25-year standard for successful disposal of NGSO satellites recently adopted by the Commission.[49]

---

[47] This observation is consistent with the fact that presented the DAS output for demise time only for the passive deorbit phase of a satellite's life – i.e., assuming it had successfully maneuvered from its operational orbit to a disposal orbit with a perigee of 300 km. *See id.* at 11 (Figure 3).

[48] *See* Letter from John P. Janka to Marlene H. Dortch, IB Docket No. 18-313, at Exhibit 1 (Apr. 10, 2020) ("Viasat Apr. 10 Ex Parte") (proposing recommended line edits for draft rule).

[49] *See* 47 C.F.R. § 25.114(d)(14)(vii)(D)(i). The calculation is (0.1)*(760 years) + (0.9)*(0.6 years).

Viasat has also raised concerns about the effects of impacts from smaller orbital debris which "can prevent a satellite from maneuvering to avoid collisions and also can result in a satellite itself becoming uncontrollable orbital debris."[50] The 1,300 km altitude at which Viasat proposes to operate and the lower altitudes through which its satellites must deorbit are characterized by a relatively high concentration of small objects. In case of a collision, in addition to the danger from a debilitated satellite, the resulting debris clouds could last for thousands of years, increasing the risk of more collisions or effectively precluding the use of certain orbits. Indeed, this was one of the reasons SpaceX applied to relocate its system out of this region of space and down to lower altitudes where atmospheric drag removes both small debris and impaired satellites from orbit far more quickly. The increased risk of collision with these small objects further calls into question the legitimacy of Viasat's asserted 99.5% reliability rate and the resulting diminution of total collision risk for its modified system.

To be clear, SpaceX does not support Viasat's proposal for an aggregate collision risk limit of 0.001 for NGSO constellations. However, that is a metric that Viasat has claimed should be required for all applicants – and one that it patently does not meet, even with a favorable 99.5% reliability assumption. The Commission is currently considering whether there should be a system-wide metric for collision risk, and if so, what that metric should be.[51] SpaceX looks forward to participating in that discussion. But at a minimum, a system such as Viasat's should be closely evaluated under any such metric, as any satellite failures over a license term will create space junk that will persist in a decaying orbit for over 750 years. This large debris will endanger other NGSO systems as well as manned space stations for centuries to come as it slowly and uncontrollably

---

[50] *See* Viasat Apr. 10 Ex Parte at 6-7.

[51] *See Mitigation of Orbital Debris in the New Space Age*, 35 FCC Rcd. 4156, ¶¶ 155-63 (2020).

descends toward the atmosphere. If there is to be an aggregate metric, surely it should be designed to discourage the generation of such long-lived debris.

CONCLUSION

Viasat has acknowledged that the main reason for its modification is to better position itself for Federal subsidies. Despite these public statements, Viasat fails to mention its plans for seeking government funds in its application to the Commission, and instead makes an unrelated series of ambitious claims about the modifications it proposes for its NGSO system. When properly analyzed, however, Viasat's modified system poses both a significant risk of increased interference and a significant risk to space safety (to the extent its nascent design can be properly analyzed). Either of these flaws would be sufficient to warrant denial of its application. At a minimum, the Commission should defer consideration of this application to a later processing round to ensure that Viasat would bear the responsibility for ameliorating the interference it has caused and would have additional time to proceed with the development of its system to a point where the Commission and other interested parties can make a more complete evaluation of the risks it presents to other operators in space.

Respectfully submitted,

SPACE EXPLORATION HOLDINGS, LLC

By: _*/s/ David Goldman*________
David Goldman
Director, Satellite Policy

SPACE EXPLORATION TECHNOLOGIES CORP.
1155 F Street, NW
Suite 475
Washington, DC 20004
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

August 31, 2020

ENGINEERING CERTIFICATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this filing, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this filing, and that it is complete and accurate to the best of my knowledge and belief.

/s/ *Mihai Albulet*

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

August 31, 2020

Date

CERTIFICATE OF SERVICE

I hereby certify that, on this 31st day of August, 2020, a copy of the foregoing pleading was served via First Class mail upon:

John P. Janka
Amy R. Mehlman
Viasat, Inc.
901 K Street, N.W.
Suite 400
Washington, DC 20001

Christopher J. Murphy
Viasat, Inc.
6155 El Camino Real
Carlsbad, CA 92009

/s/ *Hailey Stewart*
Hailey Stewart