

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

In the matter of	)	
	)	
	)	
Space Exploration Holdings, LLC	)	File No. SAT-MOD-20200417-00037
	)	Call Signs: S2983/3018
Application for Modification of	)	
Authorization for the SpaceX	)	
NGSO Satellite System	)	

**REPLY OF ONEWEB**

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**REPLY OF ONEWEB**

WorldVu Satellites Limited, Debtor-in-Possession (“OneWeb”), by its attorneys and pursuant to Section 25.154(d) of the Commission’s rules,<sup>1</sup> hereby submits its reply (“Reply”) to the Consolidated Opposition and Response filed by Space Exploration Holdings, LLC (“SpaceX”) in the above-referenced proceeding.<sup>2</sup>

**INTRODUCTION AND SUMMARY**

In its comments, OneWeb demonstrated that grant of the Third SpaceX Modification would increase the potential for harmful interference into other non-geostationary orbit, fixed-satellite service (“NGSO FSS”) systems and heighten risks to the orbital environment.<sup>3</sup> Notably, no commenter in this proceeding supports an unconditional grant of the Third SpaceX Modification

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<sup>1</sup> 47 C.F.R. § 25.154(d).

<sup>2</sup> See Consolidated Opposition to Petitions and Response to Comments of SpaceX, IBFS File No. SAT-MOD-20200417-00037 (filed July 27, 2020) (the “SpaceX Opposition”); *see also* Application for Modification of Authorization for the SpaceX NGSO Satellite System, IBFS File No. SAT-MOD-20200417-00037 (filed April 17, 2020) (the “Third SpaceX Modification”).

<sup>3</sup> See generally Comments of WorldVu Satellites Limited, IBFS File No. SAT-MOD-20200417-00037 (filed July 13, 2020) (“OneWeb Comments”).

and many NGSO operators point out the significant issues presented by this application—involving fundamental space safety issues and negative impacts to the NGSO interference environment—are best addressed within the context of the Commission’s recently initiated processing round for NGSO FSS systems in the Ku- and Ka-bands.<sup>4</sup>

In the SpaceX Opposition, SpaceX fails to comprehensively address, much less successfully rebut, many of the significant concerns expressed in the record. OneWeb acknowledges that it supports SpaceX with respect to certain issues raised in the record of this proceeding and addressed in the SpaceX Opposition. For example, OneWeb agrees with SpaceX that its operations will not impact Multichannel Video Distribution and Data Service (“MVDDS”) operators in the 12.2-12.7 GHz band (“12 GHz Band”) and appreciates SpaceX’s agreement to license conditions requiring that it accepts additional interference into its Ka-band and Ku-band operations. However, many critical issues raised by the Third SpaceX Modification remain outstanding and OneWeb respectfully restates its request that the Commission refrain from any grant of the Third SpaceX Modification until SpaceX successfully resolves such issues. In addition, any Commission grant of the Third SpaceX Modification should include license conditions that appropriately safeguard the NGSO FSS operating environment.

**I. ONEWEB AGREES THAT NGSO FSS OPERATIONS WILL HAVE NO EFFECT ON MVDDS SYSTEMS NOW, OR IN THE FUTURE**

In response to the Third SpaceX Modification, CCIA/INCOMPAS argues that “[i]f the Commission grants the modifications requested in the SpaceX application, the potential 5G uses

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<sup>4</sup> See Satellite Policy Branch Information, *Cut-Off Established for Additional NGSO FSS Applications 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 17.5-30 GHz Bands*, Public Notice, DA 20-325 (IB Mar. 24, 2020) (“2020 NGSO Processing Round PN”).

for the 12 GHz band may never occur.”<sup>5</sup> OneWeb agrees with SpaceX that there is “no plausible explanation for CCIA/INCOMPAS’s assertion.”<sup>6</sup> As SpaceX correctly points out, these criticisms allege no actual harm to licensed MVDDS operations and CCIA/INCOMPAS tellingly do not describe the actual extent of current MVDDS deployments in the 12 GHz Band, even though the MVDDS has been authorized for more than twenty years.<sup>7</sup> Moreover, the CCIA/INCOMPAS Ex Parte misleadingly suggests that the 12 GHz Band constitutes only “3.6 percent of SpaceX’s total spectrum authorization.”<sup>8</sup> To the contrary, the 12 GHz Band comprises 26% to 29% of the spectrum available to NGSO FSS operators in the Ku-band for core user link connectivity.<sup>9</sup> CCIA/INCOMPAS simply fails to show how the Third SpaceX Modification would impact *current* MVDDS operations in the 12 GHz Band and as such, the Commission should disregard these “disjointed and illogical claims.”<sup>10</sup>

On a more fundamental level, OneWeb respectfully submits that the CCIA/INCOMPAS Ex Parte constitutes yet another attempt (on behalf of MVDDS interests) to stymie the utilization of the 12 GHz Band by NGSO FSS operators as part of a campaign to revive interest in the otherwise long dormant petition for rulemaking to convert the 12 GHz Band to a terrestrial 5G band—at the expense of NGSO FSS operators actually building networks and deploying

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<sup>5</sup> Letter from Vann Bentley and Angie Kronenberg to Marlene H. Dortch, Secretary, FCC, IBFS File No. SAT-MOD-20200417-00037, at 2 (filed July 13, 2020) (“CCIA/INCOMPAS Ex Parte”).

<sup>6</sup> SpaceX Opposition at 34.

<sup>7</sup> *Id.*; *Amendment of Parts 2 and 25 of the Commission’s Rules to Permit Operation of NGSO FSS Systems Co Frequency with GSO and Terrestrial Systems in the Ku-Band, First Report and Order and Further Notice of Proposed Rule Making*, First Report and Order and Further Notice of Proposed Rulemaking, 16 FCC Rcd 4096 (2000).

<sup>8</sup> CCIA/INCOMPAS Ex Parte at 2.

<sup>9</sup> This assumes that certain spectrum near the 10.7 GHz band edge remains unused to protect radio astronomy services.

<sup>10</sup> SpaceX Opposition at iv.

innovative services.<sup>11</sup> OneWeb agrees with SpaceX that CCIA/INCOMPAS's misguided attempt to insert itself in a satellite license proceeding in service of its long sought "spectrum grab" is not only substantively flawed, but procedurally defective. In 2016, the Commission sought comment on the significant issues presented by the MVDDS Petition.<sup>12</sup> Despite the tireless efforts of MVDDS licensees and certain stakeholders, the MVDDS Petition has attracted "vanishingly little support" in the last four and a half years and the Commission has wisely refrained from initiating a rulemaking proceeding.<sup>13</sup> CCIA/INCOMPAS's attempt to sidestep the unfavorable record in that proceeding and instead focus on disrupting the deployment plans of NGSO FSS operators should be rejected.<sup>14</sup>

## **II. THE RECORD DEMONSTRATES THE COMMISSION SHOULD NOT GRANT THE THIRD SPACEX MODIFICATION WITHOUT ADDITIONAL SCRUTINY OF SPACEX'S HIGH IN-ORBIT FAILURE RATE AND HEIGHTENED COLLISION RISK PROFILE**

In the OneWeb Comments, OneWeb explained how grant of the Third SpaceX Modification could increase risk to the orbital environment.<sup>15</sup> Other commenters echo these

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<sup>11</sup> MVDDS 5G Coalition Petition for Rulemaking to Permit MVDDS Use of the 12.2-12.7 GHz Band for Two-Way Mobile Broadband Service, RM-11768 (filed Apr. 26, 2016) ("MVDDS Petition").

<sup>12</sup> *Consumer & Governmental Affairs Bureau Reference Information Center Petition for Rulemakings Filed*, Public Notice, Rep. No. 3042, RM-11768 (rel. May 9, 2016).

<sup>13</sup> Letter from David Goldman, Director of Satellite Policy, SpaceX, to Marlene H. Dortch, Secretary, FCC, RM-11768, at 5 (filed July 22, 2020).

<sup>14</sup> For example, almost *four years ago*, the MVDDS Coalition made similar arguments about OneWeb interfering with its efforts to monetize the 12 GHz Band by reallocating the band for terrestrial 5G, which the Commission rejected. *See* Petition to Deny of MVDDS 5G Coalition, IBFS File No. SAT-LOI-20160428-00041, at 3 (filed Aug. 15, 2016) (arguing that OneWeb's operations in the 12 GHz Band "would also prevent any future 5G mobile broadband services from operating in the band notwithstanding a petition for rulemaking to provide 5G service pending before the Commission.").

<sup>15</sup> OneWeb Comments at 3-8.

concerns and the current record demonstrates widespread discomfort with the space safety issues presented by the Third SpaceX Modification.<sup>16</sup> In the SpaceX Opposition, SpaceX largely dismisses these concerns as anticompetitive “fear mongering,” instead emphasizing its ability to physically coordinate its operations and touting the amount of orbital debris information provided to the Commission.<sup>17</sup> Nowhere in the SpaceX Opposition does SpaceX allege that the troubling failure rate calculated by OneWeb and other commenters is incorrect, nor does SpaceX deny that its collision risk is exponentially higher than the threshold the Commission is considering applying to large NGSO constellations.<sup>18</sup> As SES/O3b correctly notes, currently “open questions remain regarding how SpaceX will meet space safety standards”<sup>19</sup> and thus OneWeb agrees with Viasat that grant of the Third SpaceX Modification in its current form “would significantly heighten the risks to safe space” and the Commission should “condition any grant of authority that the

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<sup>16</sup> See, e.g., Petition to Deny or Defer of Viasat, Inc., IBFS File No. SAT-MOD-20200417-00037, at 6-35 (filed July 13, 2020) (“Viasat Petition”); Petition to Deny and Comments of Kuiper Systems LLC, IBFS File No. SAT-MOD-20200417-00037, at 2-4 (filed July 13, 2020) (“Kuiper Petition”); Petition to Deny of Kepler Communications Inc., IBFS File No. SAT-MOD-20200417-00037, at 12-16 (filed July 13, 2020) (“Kepler Petition”).

<sup>17</sup> SpaceX Opposition at 5-6.

<sup>18</sup> See OneWeb Comments at 6 (explaining that “the current failure rate for the SpaceX constellation stands at 3.14 percent as of last month, assuming none of the recently launched and yet-to-be tested 58 satellites will fail.”); Viasat Petition at 21-22 (discussing the increasing failure rates of Starlink satellites); Kuiper Petition at 3 (“[U]p to 14 of the 478 v1.0 satellites SpaceX launched in the year-long period included in the 2020 Annual Report, approximately 3%, either failed or were in the process of failing.”). See also *Mitigation of Orbital Debris in the New Space Age, Report and Order and Further Notice of Proposed Rulemaking*, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 4156, 4228 ¶ 159 (2020) (“2020 Orbital Debris Order and FNPRM”).

<sup>19</sup> Petition to Deny or Defer of SES Americom, Inc. and O3b Limited, IBFS File No. SAT-MOD-20200417-00037, at 17 (filed July 13, 2020) (“SES/O3b Petition”).

Commission ultimately may issue on the achievement and verification of appropriate reliability and collision probability metrics.”<sup>20</sup>

**A. The Record Reflects That SpaceX’s Troubling Failure Rate Must Be Addressed Prior to Any Grant of the Third SpaceX Modification**

At its core, the Third SpaceX Modification raises three potentially troubling space safety issues: (i) the ongoing in-orbit failure rate of the Starlink satellites, (ii) the heightened collision risk profile presented by the deployment of SpaceX’s constellation, and (iii) the inherent relationship between uncontrollable, failed satellites and increased collision risk.<sup>21</sup> Nothing in the SpaceX Opposition provides sufficient comfort that these three issues are being adequately addressed. *First*, with respect to collision risk, SpaceX implicitly acknowledges the approximately 3% failure rate pointed out by Viasat, Kuiper, and OneWeb—nowhere in the SpaceX Opposition is that figure successfully challenged or rebutted, nor does it address the fact that this failure rate is far in excess of the one percent failure rate SpaceX deemed “unlikely” and approaching the five percent failure it characterized as “unacceptable.”<sup>22</sup> However, instead of committing to expeditiously address its persistently high rate of in-orbit failures, SpaceX instead argues that only a “small number of SpaceX satellites . . . have lost maneuverability” and deflects criticism by pointing to in-orbit anomalies experienced by some geostationary satellite operators (“GSO”).<sup>23</sup> As an initial matter, more than a dozen satellites failing in-orbit during an operator’s first year of operation is not remotely comparable to one-time in-orbit anomalies experienced by GSO

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<sup>20</sup> Viasat Petition at 5.

<sup>21</sup> OneWeb Comments at 4-7.

<sup>22</sup> Letter from William M. Wiltshire, Counsel to SpaceX, to Jose P. Albuquerque, Chief, Satellite Division, International Bureau, FCC, IBFS File No. SAT-LOA-20161115-00118, at 4 (filed Apr. 20, 2017).

<sup>23</sup> SpaceX Opposition at 16 (citing issues related to the AMC-9 and Viasat-2 satellites).



operators. Unlike SpaceX, those operators retained or regained control over those spacecraft and are not continuing to populate low-earth orbit—an already dense orbital environment—with satellites that pose a risk to the in-orbit assets of other operators.

As Viasat points out, SpaceX is essentially putting other operators on notice that “without substantial improvements in the reliability of its satellites, a significant number of additional satellites in the approximately 10,000 still-to-be-launched can be expected to become uncontrollable objects (and possibly more of those already launched).”<sup>24</sup> Given SpaceX’s prior assurances with respect to its failure rate have proved to be excessively optimistic, and OneWeb’s prescient concerns regarding the space safety issues associated with SpaceX’s deployments, SpaceX’s discussion of planned improvements to its safety profile are cold comfort for those operators (including OneWeb) whose assets must operate in or traverse orbits in close proximity to SpaceX.<sup>25</sup> SpaceX’s satellite failure rates merit increased scrutiny and the Commission should refrain from any grant of the Third SpaceX Modification until SpaceX’s ongoing orbital safety issues are more thoroughly investigated and addressed.<sup>26</sup>

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<sup>24</sup> Viasat Petition at 24.

<sup>25</sup> Contrary to SpaceX’s assertions, OneWeb has no conceptual objections to an “iterative design” approach. SpaceX Opposition at 16. OneWeb’s caution was based on its belief that the application of SpaceX’s frequently touted willingness to accept failure in the interest of faster deployments may be uniquely unsuited to deploying large numbers of satellites into the LEO environment. Viasat made a similar observation, noting that SpaceX appears to be “relying on an approach based more on disposability than reliability.” Viasat Petition at 30.

<sup>26</sup> The Commission has stated that it “specifically addressed concerns with failed satellites in the First Modification Order, and [found] that the conditions placed on SpaceX’s operations in that decision are sufficient to protect Kepler and other NGSO systems operating at or near the 550 km orbital altitude. *Space Exploration Holdings, LLC*, Memorandum Opinion and Order, 35 FCC Rcd 5649 (2020) (“Recon Order”). However, the Recon Order was released before both (i) SpaceX filed the Third SpaceX Modification and (ii) the submission of SpaceX’s annual report, noting the significant number of failed satellites.

**B. SpaceX's Collision Risk Profile and Autonomous Conjunction Capabilities Warrant Further Oversight by the Commission**

Several interested parties expressed concerns that grant of the Third SpaceX Modification could raise the potential for in-orbit collisions.<sup>27</sup> In particular, OneWeb emphasizes that (i) the assessment of SpaceX's collision risk profile must be made in light of the recently ascertained failure rates for the Starlink constellation and (ii) more information is needed regarding SpaceX's "state-of-the-art autonomous conjunction avoidance system."<sup>28</sup>

In the SpaceX Opposition, SpaceX particularly bristles at Viasat and OneWeb's suggestion that SpaceX should demonstrate its compliance with the aggregate collision risk metric the Commission is considering adopting, instead relying on the Commission's determination that satellites which maintain onboard propulsion are assumed to have zero risk.<sup>29</sup> OneWeb notes that the Commission explicitly stated that this assumption will not be applied in cases where there is evidence that an operator has not been able to satisfy the Commission's .001 large object collision risk metric.<sup>30</sup> Here, OneWeb agrees with Viasat that SpaceX's failure rate to date "raise[s] questions about SpaceX's ability to maneuver effectively and meet the 0.001 large object collision risk metric, and . . . present[s] the type of circumstances in which the Commission no longer should

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<sup>27</sup> See, e.g., Kepler Petition at 14 ("Considering . . . the potential of a 260-kg satellite to produce many fragments upon breakup, and the rapidly increasing spatial density of this altitude region, we do not believe it unreasonable, nor alarmist, to worry about the potential to form a powder-keg orbit"); Viasat Petition at 22-23 ("The inability to conduct active collision avoidance maneuvers means that failed satellites become a collision risk in their own right within the Starlink constellation, with other constellations, and with existing orbital debris."); Kuiper Petition at 7 ("The collision risk posed by the addition of a constellation in the same orbital altitude region as another constellation can be significant, resulting in additional conjunction events.").

<sup>28</sup> SpaceX Opposition at 17.

<sup>29</sup> 2020 Orbital Debris Order and FNPRM, ¶¶ 35, 159.

<sup>30</sup> *Id.* ¶ 35.

make simplifying assumptions about the risk of collisions with large objects.”<sup>31</sup> At a minimum, the Commission should recognize that SpaceX’s troubling failure rate calls into question the design reliability of the Starlink satellites and constitutes precisely the kind of scenario where rote application of a collision risk assumption is unwarranted.<sup>32</sup> Simply put, in the absence of further Commission oversight, SpaceX will have successfully leveraged the Commission’s orbital debris regime to effectuate the cost-free transfer of a substantial amount of in-orbit risk to other operators.

Similarly, the Commission should require SpaceX to provide additional information regarding its autonomous conjunction avoidance mechanisms. As Amazon points out, grant of the Third SpaceX Modification will result in “in an average of 509 daily conjunction events of close approach distance less than 1 km between the two constellations. This is more than an order of magnitude increase when compared to the Kuiper System’s “expected thirty-two daily conjunction events due to the existing orbit debris catalog.”<sup>33</sup> Similarly, SES/O3b highlight that SpaceX “provides no details on the workings of [its autonomous conjunction avoidance] system.”<sup>34</sup> Given that OneWeb’s own satellites must traverse SpaceX’s intended operational orbits, the Commission should require SpaceX to make the relevant details available as to how its “state-of-the-art autonomous conjunction avoidance system” is operating. Absent such information, it will be

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<sup>31</sup> Viasat Petition at 19.

<sup>32</sup> In addition, SpaceX’s assurances that it “has also demonstrated that its satellites will achieve 100% deorbit reliability at the lower altitudes proposed in the modification” is suspect. SpaceX Opposition at 14. As pointed out by Astroscale, “in effect, even if each Starlink satellite provided service in its operational orbit until it lost all maneuverability or otherwise unexpectedly failed, by the Commission’s current definition, a 100% PMD reliability rate would still be achieved.” Letter from Charity Weeden, Vice President, Global Space Policy, Astroscale U.S. Inc., to Marlene H. Dortch, Secretary, FCC, IBFS File No. SAT-MOD-20200417-00037, at 7 (filed Jun. 30, 2020).

<sup>33</sup> Kuiper Petition at 2.

<sup>34</sup> SES/O3b Petition at 17.

difficult for other satellite operators to accurately predict the position of the SpaceX satellites and react appropriately.

### **III. SPACEX HAS FAILED TO DEMONSTRATE THAT THE THIRD SPACEX MODIFICATION WILL NOT INCREASE THE POTENTIAL FOR SPECTRUM INTERFERENCE EVENTS WITH OTHER NGSO FSS OPERATORS**

The SpaceX Opposition fails to provide certain information necessary for OneWeb to fully evaluate the impact of the Third SpaceX Modification on the OneWeb System. In addition, the analyses provided in the SpaceX Opposition indicate grant of the Third SpaceX Modification Application would increase interference to other co-frequency NGSO FSS operators, including OneWeb. As explained below, SpaceX’s attempt to downplay the negative interference impacts of the Third SpaceX Modification on the earth stations of OneWeb and other NGSO FSS operators should be rejected. Similarly, SpaceX’s reliance on simplistic methodologies to support its arguments misguidedly focuses solely on the Commission’s coordination trigger—in lieu of thorough evaluation and analysis—and fails to account for more spectrally efficient coexistence solutions that can be achieved through coordination with other NGSO operators. Thus, SpaceX has not met its burden to demonstrate that the Third SpaceX Modification will not increase the potential for interference to other operators and the Commission should not take any action on the application until SpaceX successfully resolves these issues.<sup>35</sup>

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<sup>35</sup> See *Teledesic LLC, Minor Modification of License to Construct, Launch and Operate a Non-Geostationary Fixed Satellite Service System*, Order and Authorization, 14 FCC Rcd 2261 ¶ 5 (1999) (explaining that if a modification application “present[ed] significant interference problems” it would be treated “as a newly filed application and [the Commission] would consider the modification application in a subsequent satellite processing round.”).

**A. SpaceX has Failed to Demonstrate That the Third SpaceX Modification Will Not Increase the Potential for Uplink Interference to OneWeb's Ka-band Operations**

In the OneWeb Comments, OneWeb pointed out that SpaceX failed to provide information regarding changes in the operating power levels of its planned Ka-band gateway earth stations as a result of the Third SpaceX Modification, although it appeared that SpaceX planned to reduce the maximum uplink EIRP density of its gateway earth stations.<sup>36</sup> Although OneWeb notes SpaceX provided additional technical analyses as part of the SpaceX Opposition, SpaceX still has not provided even a simple assessment of the effect of its proposed modifications on the interference received by OneWeb's satellites in the Ka-band.

Considering that both the proposed reduction in the minimum elevation angle of the SpaceX gateway operations and the doubling of the number of satellites connecting to a single gateway increase the probability of high interference events between SpaceX and OneWeb's Ka-band operations, this analysis remains a key consideration in understanding how the Third SpaceX Modification affects the NGSO interference environment. OneWeb therefore restates its request that SpaceX provide an analysis of the change in the interference experienced by the OneWeb Ka-band satellite receivers as a result of the Third SpaceX Modification, along with information about the modification of the SpaceX gateway power levels resulting from the Third SpaceX Modification. Such information is critical to enable OneWeb to fully analyze the potential impacts of the Third SpaceX Modification on its gateway uplink operations in the Ka-band.

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<sup>36</sup> OneWeb Comments at 15.

**B. SpaceX Has Failed to Satisfy the Burden to Demonstrate That the Third SpaceX Modification Will Not Increase the Potential for Interference to OneWeb’s Ka-band Gateway Downlinks**

In the OneWeb Comments, OneWeb pointed out that “SpaceX’s proposed reduction in operational altitude necessarily requires associated changes to the minimum elevation angle of its gateway earth stations that will increase the potential for interference into the OneWeb System.”<sup>37</sup> SES/O3b, Kuiper, and Viasat’s analyses similarly conclude that this change in elevation angle would cause increased interference into co-frequency operators in the Ka-band.<sup>38</sup> In the SpaceX Opposition, SpaceX provides further analysis purporting to demonstrate that there is no “material increase in inference” to OneWeb’s ground stations from SpaceX’s proposed operations.<sup>39</sup> As explained below, SpaceX’s erroneous conclusion fails to adequately account for the downlink interference it will cause to OneWeb’s gateway operations.

As an initial matter, the SpaceX Opposition confirmed that SpaceX “proposed to reduce the PFD levels for its Ka-band downlinks by 7 dB.”<sup>40</sup> It appears that total PFD—which SpaceX claims is 3 dB higher than the PFD per polarization<sup>41</sup>—has indeed been reduced from -116.3 in

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<sup>37</sup> OneWeb Comments at 10.

<sup>38</sup> SES/O3b Petition at 9-11; Kuiper Petition at 23-28; Viasat Petition at 45-46.

<sup>39</sup> SpaceX Opposition at 24-25& A-1–A-3.

<sup>40</sup> *Id.* at 25 n.73. OneWeb had assumed a 10 dB reduction, which SpaceX noted “is the correct value for a single polarization” and consistent with information provided by SpaceX in the Schedule S submissions for both its original license application and the Third SpaceX Modification. *Id.*; see also *Space Exploration Holdings, LLC, Application for Approval for Orbital Deployment and Operating Authority for the SpaceX NGSO Satellite System*, IBFS File No. SAT-LOA-20161115-00118, Schedule S (filed Nov. 15, 2016) (“2016 SpaceX License Application”). OneWeb notes that both polarizations were referenced in the respective Schedule S submissions for these applications, and thus SpaceX’s assertions regarding its use of a single polarization is somewhat inconsistent with the information provided in these applications.

<sup>41</sup> Since both SpaceX and OneWeb use orthogonal polarizations for their Ka-band gateway links, it is unclear why SpaceX would use combined polarization (3 dB higher) when computing interference into OneWeb. For consequential interference events, *i.e.*, in-line interference events where Interfering-to-Noise Power Ratio (“I/N”) values are significantly higher than the -12.2 dB

the 2016 SpaceX License Application to  $-123.3 \text{ dBW/m}^2/\text{MHz}$  in the Third SpaceX Modification.<sup>42</sup> As a result, there appears to be a discrepancy in the information provided in the Schedule S of the 2016 SpaceX License Application, where the maximum PFD of the Ka-band beams (provided per polarization) should have been  $-119.3 \text{ dBW/m}^2/\text{MHz}$ , instead of  $-116.3 \text{ dBW/m}^2/\text{MHz}$ . Thus, the basis of interference calculations remains unclear as to whether SpaceX is using single polarization or 3 dB increased PFD values in its simulations. SpaceX should clarify this discrepancy to enable other NGSO operators to more comprehensively evaluate the impact of the Third SpaceX Modification.<sup>43</sup>

In the SpaceX Opposition, SpaceX included results of a study of the change in the interference received by a OneWeb gateway earth station resulting from the Third SpaceX Modification.<sup>44</sup> However, as shown in Figure 1 below, these results differ significantly from the results that OneWeb calculated using a 7dB PFD reduction:

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coordination trigger, the satellite and earth station antennas can discriminate between the two polarizations such that the LHC polarization of the OneWeb gateway antenna will only be affected by the SpaceX LHC signal, with the RHC signal adding only negligible interference.

<sup>42</sup> SpaceX Opposition at 25 n.73.

<sup>43</sup> See 2016 SpaceX License Application, Schedule S.

<sup>44</sup> SpaceX Opposition at A-3 (Figure I-B).

**Figure 1 – Interference Statistics (I/N) for SpaceX Downlink into OneWeb Receive Gateway Earth Station  
(Modified SX System PFD reduced by 7 dB)**

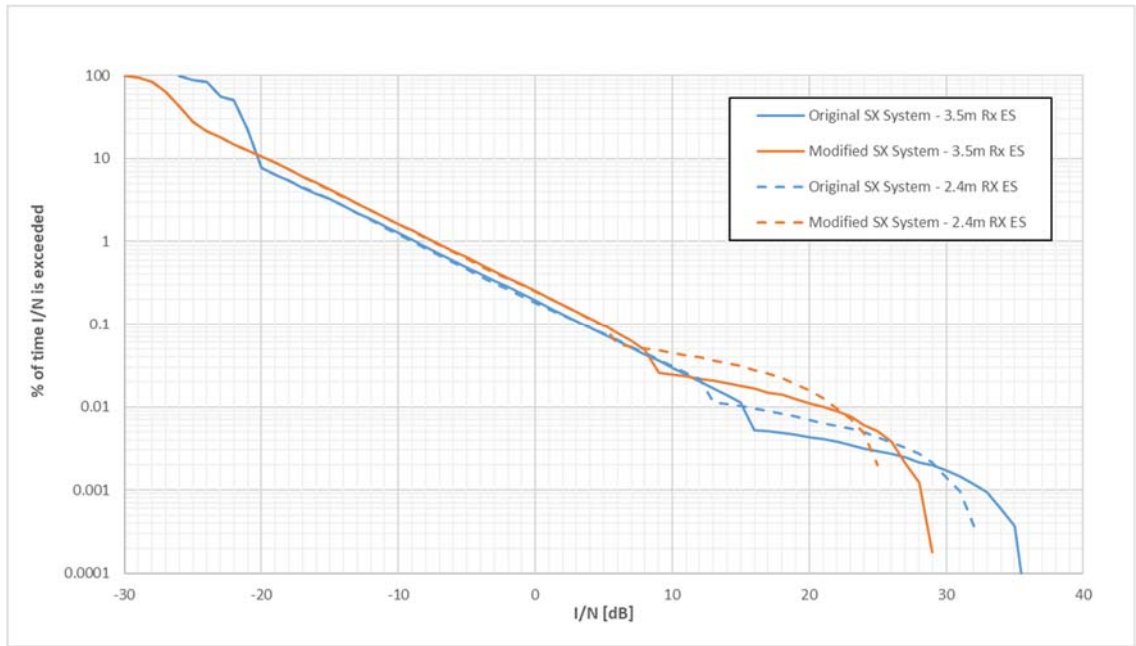


Figure 1 demonstrates that contrary to SpaceX’s assertions, the Third SpaceX Modification will increase the interference experienced by a OneWeb gateway earth station receiver in Ka-band for wide ranges of I/N values. This directly contradicts the results presented by SpaceX, which purports to show that the Third SpaceX Modification reduces the interference for a wide range of I/N values.<sup>45</sup>

OneWeb notes that SpaceX failed to include the assumptions used in its interference analysis of downlink interference to OneWeb in the Ka-band, such as the satellite selection strategy, which are critical to further understand the basis of these discrepancies. OneWeb therefore requests that SpaceX promptly make available the underlying assumptions used in its analysis, specifically with respect to SpaceX’s transmit power/satellite gain values and gateway/satellite selection strategy. Absent any such clarification from SpaceX, OneWeb’s

<sup>45</sup> *Id.*



analysis demonstrates that grant of the Third SpaceX Modification would cause negative impacts to the downlink operations of OneWeb's gateway earth stations in the Ka-band.

**C. SpaceX's Emphasis on the Increased Uplink Interference to the SpaceX NGSO FSS System Does Not Obviate the Need for a Comprehensive Review of the Interference Impacts to the NGSO Spectrum Sharing Environment and the Inter-Operator Coordination Process**

In the SpaceX Opposition, SpaceX argues that the negative impacts to the downlink operations of other NGSO FSS operators caused by the Third SpaceX Modification cannot be viewed "in isolation" and an "analysis must look at all four" interference scenarios.<sup>46</sup> While OneWeb agrees that interference analyses should account for the larger NGSO spectrum sharing framework, this analytical imperative does not absolve SpaceX of the need to demonstrate that the interference environment is not degraded in *any* of the four interference scenarios (uplink interference to and from SpaceX and downlink interference to and from SpaceX), regardless of the differences between the percentage of time associated to an I/N of -12.2 dB in each scenario (*i.e.*, in-line interference events).

In the good faith coordination process required by the Commission's rules, the technical solutions agreed to between two operators will often depend on the protection requirements of both systems, which could differ between the two systems and the different portions of a link.<sup>47</sup> For example, the interference tolerated by a SpaceX Ka-band satellite receiver could be different from the interference tolerated by the Ka-band receivers of the earth stations of other NGSO FSS systems. The fact that SpaceX calculates that the -12.2 dB coordination trigger will be exceeded

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<sup>46</sup> *Id.* at 28.

<sup>47</sup> *See* 47 C.F.R. § 25.261(b).

in the OneWeb downlinks less often than in SpaceX's satellite receivers, on its own, is a misleading characterization of the impact of SpaceX's downlink interference into OneWeb's operations.<sup>48</sup>

Moreover, SpaceX's narrow focus on the impact of the Third SpaceX Modification on the coordination trigger ignores the coordination process and the potential for SpaceX to accept higher levels of interference in lieu of band splitting every time the I/N into its satellites and gateway receivers exceeds -12.2 dB. While this metric is the threshold that the Commission uses to define an in-line event, SpaceX should demonstrate that the Third SpaceX Modification does not degrade the interference environment, including other parts of the I/N Cumulative Distribution Functions ("CDF") curve, which could be detrimental to the coordination process and mutual compatibility between two NGSO FSS systems. For example, modern satellite systems frequently can accept higher levels of interference (above -12.2 dB I/N) for limited amounts of time. The conditions agreed to during inter-operator coordination negotiations therefore depend on the levels and associated probability of interference experienced between the systems—not simply the percentage of time associated to -12.2 dB of I/N—and their associated protection requirements.<sup>49</sup> Put another way, SpaceX's assertion that "*existing interference from other NGSO systems into SpaceX uplinks even without the modification...will overwhelm any effect SpaceX's modified operations may have on their respective downlinks*" is simply not correct, as it is not indicative of an acceptable operating environment for both operators.<sup>50</sup>

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<sup>48</sup> SpaceX Opposition at 28.

<sup>49</sup> As an example, SpaceX's Ka-band interference study could lead to the erroneous conclusion that a 10 degree avoidance angle would be required so that I/N into the SpaceX satellites would always be below approximately -8.5 dB. *Id.* at A-2, Figure I-A. In reality, it is possible to coordinate two NGSO systems with higher, short-term levels of I/N depending on the robustness of the links.

<sup>50</sup> *Id.* (emphasis in original).

In addition, SpaceX's simplistic argument ignores one of the most effective mitigation techniques that can be employed between two NGSO FSS systems deploying co-frequency *gateway* earth stations: geographic separation. SpaceX quickly jumps to the conclusion that since avoidance measures may be required to avoid interference into SpaceX's uplinks—based on interference criteria defined by SpaceX—OneWeb's downlinks will consequently be protected since the predicted time percentage for an I/N level of 12.2 dB into OneWeb's downlinks is less than the percentage of time to achieve this same level into SpaceX's uplinks.<sup>51</sup>

However, this overly simplistic analysis fails to consider that SpaceX's simulations are based on collocated ground stations. If SpaceX were to instead deploy geographic separation for its gateway earth stations, additional factors (such as both SpaceX and OneWeb's antenna gain patterns) would be relevant to this interference analysis.<sup>52</sup> The additional isolation that can be obtained via geographic separation of the two systems' gateway earth stations will have a different impact on the uplink performance of one NGSO FSS system as compared to the downlink of the other NGSO FSS system. As a result, the Commission should reject SpaceX's attempt to downplay the increase in the interference into the earth stations of other NGSO FSS systems resulting from the Third SpaceX Modification based on its reliance on a narrow analytical framework that (i) assumes the necessity of spectrum splitting any time the interference level exceeds an I/N greater than -12.2 dB and the relative frequency of such events occurring on

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<sup>51</sup> *Id.* at 28-29.

<sup>52</sup> For example, SpaceX has proposed to locate gateway earth stations in close proximity to OneWeb's planned gateway facilities, which does not provide sufficient satellite beam isolation. *See, e.g.*, IB File No. SES-LIC-20180727-02076 (OneWeb's application for a gateway earth station in Southbury, CT that is 12 km from SpaceX's proposed site in Litchfield, CT); *see also* IB File No. SES-LIC-20200410-00399 (SpaceX's application for a gateway earth station in Litchfield, CT).

SpaceX's uplink and OneWeb's downlink operations and (ii) fails to account for any mitigation techniques, such as geographic separation.<sup>53</sup>

**D. SpaceX Must Accept Any Increased Downlink Interference Into its Ka-band Gateways Resulting from the Third SpaceX Modification**

In the OneWeb Comments, OneWeb demonstrated how grant of the Third SpaceX Modification would “result in higher levels of interference experienced by SpaceX’s earth station receivers in Ka-band.”<sup>54</sup> Therefore, OneWeb asked that the Commission “condition any grant of the Third SpaceX Modification such that SpaceX must not request additional protection for its Ka-band gateways as a result of the decrease in its Ka-band downlink PFD.”<sup>55</sup> OneWeb appreciates SpaceX’s concession that grant of the Third SpaceX Modification will “make these transmissions to gateways more susceptible to interference” and its “willing[ness] to accept a condition requiring that it accept any additional interference in its Ka-band downlinks from other NGSO systems authorized in the 2016 processing round resulting from this modification compared to its current authorization.”<sup>56</sup> However, SpaceX’s proposed license condition is insufficient to protect OneWeb’s operations in Ka-band.<sup>57</sup>

Specifically, OneWeb requests that this proposed license condition mirror the license condition the Commission imposed on the operation of SpaceX’s gateway operations in the Ku-band: namely, that SpaceX cannot claim additional interference protection for a gateway earth station location than it would have been afforded pursuant to the grant of the 2016 SpaceX License

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<sup>53</sup> SpaceX Opposition at 30.

<sup>54</sup> OneWeb Comments at 16-20.

<sup>55</sup> *Id.* at 20.

<sup>56</sup> SpaceX Opposition at 25.

<sup>57</sup> *Id.* at 24.

Application.<sup>58</sup> Such a license condition would properly recognize the interference environment resulting from the cumulative effect of all three SpaceX modification applications in less than 18 months. Other NGSO FSS operators have also taken issue with SpaceX’s “death by a thousand cuts” approach to making material changes to its network architecture that fundamentally alter the NGSO sharing environment and argued that the Third SpaceX Modification should therefore be considered in the 2020 NGSO Processing Round.<sup>59</sup> This reality is also reflected in SpaceX’s interference analyses presented in the Third SpaceX Modification, which are compared against the 2016 SpaceX License Application.<sup>60</sup> Simply put, it would not serve the public interest to allow SpaceX to continually chip away at the interference framework which other licensees and market access grantees were authorized under.<sup>61</sup> Accordingly, OneWeb respectfully requests that any

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<sup>58</sup> See *Space Exploration Holdings, LLC Request for Modification of the Authorization For the SpaceX NGSO Satellite System*, Memorandum Opinion & Order, DA 20-588, IBFS File No. SAT-MOD-20181108-00083, ¶ 16 (rel. June 4, 2020) (“Specifically, when conducting coordination with other NGSO FSS systems, taking into account section 25.261, SpaceX cannot claim more protection to any of its Ku-band gateway earth stations than the protection to which a SpaceX user terminal at the same location would be entitled.”).

<sup>59</sup> See, e.g., Kuiper Petition at 30 (concluding that the Third SpaceX Modification belongs in the 2020 NGSO FSS processing round because “SpaceX’s prior modification requests collectively, with this Third Modification, adversely impact the operating environment”); SES/O3b Petition at 15 (“This approach reflects the fact that the system SpaceX now proposes to deploy is fundamentally and materially different than the one for which it originally applied and is necessary to protect the expectations of O3b and other operators that received authority as part of the Ku/Ka-band processing round that closed in November of 2016.”). See also 2020 NGSO Processing Round PN.

<sup>60</sup> See, e.g., SpaceX Opposition at A-2. Figure I-A of the SpaceX Opposition, where the maximum I/N experienced by the Ka-band satellite receivers of the two SpaceX systems compared (labeled as “Proposed” and “Approved”) differs significantly. This difference is due to the lower orbits used by the SpaceX “Proposed” system, i.e., the parameters reflected in the Third SpaceX Modification. Should the “Approved” system modeled in the simulation include the 550 km orbits in the currently authorized SpaceX NGSO FSS system, there would be no meaningful difference in the maximum I/N level experienced by the two modeled systems.

<sup>61</sup> See *Kuiper Systems, LLC, Application for Authority to Deploy and Operate a Ka-band Non-Geostationary Satellite Orbit System*, Order and Authorization, FCC 20-102 (rel July 30, 2020) (“Not all the authorized systems are at the same level of progress, but some have made substantial

Commission grant of the Third SpaceX Modification reflect that SpaceX cannot claim additional interference protection for a gateway earth station location than it would have been afforded pursuant to the grant of the 2016 SpaceX License Application.

**E. SpaceX Must Accept Any Increased Uplink Interference Into its Satellites Resulting from the Third SpaceX Modification**

The additional interference into SpaceX's uplink operations as a result of any grant of the Third SpaceX Modification mirrors the downlink interference issues. In the OneWeb Comments, OneWeb demonstrated how grant of the Third SpaceX Modification would result in higher levels of interference experienced by SpaceX's satellite receivers in both Ku and Ka-band.<sup>62</sup> Therefore, OneWeb asked that the Commission "condition grant of the Third SpaceX Modification such that SpaceX accept any additional interference caused by its orbit altitude modification."<sup>63</sup> OneWeb appreciates SpaceX's concession that "its satellites . . . will be somewhat more susceptible to uplink interference from earth stations communicating with other NGSO systems" and its "willing[ness] to accept a condition requiring that it accept any additional interference to its uplinks from other NGSO systems authorized in the 2016 processing round resulting from this modification compared to its current authorization."<sup>64</sup>

With regards to Ka-band, SpaceX proposes to remedy the increased susceptibility of its satellite receivers with a license condition in which SpaceX would accept an increased I/N as its coordination trigger for spectrum splitting with respect to OneWeb's uplinks. However, this proposed condition would not substantively safeguard OneWeb's uplink operations in Ka-band.

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progress and, presumably, *all are configuring their systems relying on an interference environment based upon the approved systems.*") (emphasis added).

<sup>62</sup> OneWeb Comments at 20-25.

<sup>63</sup> *Id* at 25.

<sup>64</sup> SpaceX Opposition at 23.

While OneWeb agrees with SpaceX that a revised coordination trigger is appropriate to maintain the percentage of time during which the trigger would be exceeded, the Commission should additionally impose a condition clarifying that when conducting coordination with other NGSO FSS systems, SpaceX cannot claim more protection for any of its Ka-band satellite receivers than the protection to which a SpaceX Ka-band satellite receiver would have been afforded pursuant to the grant of the 2016 SpaceX License Application. As discussed in Section III.D above, this would align with the Commission’s prior treatment of SpaceX modification applications that make SpaceX’s operations more susceptible to increased interference and allow SpaceX and OneWeb to comprehensively address this issue in inter-operator coordinator negotiations.

OneWeb highlights that in its Ka-band interference analysis, which demonstrates the increased susceptibility of the SpaceX Ka-band satellite receivers, SpaceX provides an example including a 10 degree avoidance angle<sup>65</sup>—the Commission’s former coordination trigger—which drastically reduces the interference into the SpaceX NGSO FSS system.<sup>66</sup> In this example, the interference to the SpaceX satellite receivers exceeds an I/N of -12.2 dB for about 7% of the time and never exceeds an I/N of -8.5 dB. However, SpaceX states that the resulting interference “remains at a more reasonable—but still not acceptable—level.”<sup>67</sup> As discussed in Section III.C above, this claim does not indicate sufficient willingness from SpaceX to explore spectrally efficient coexistence solutions through inter-operator coordination. For instance, OneWeb notes that GSO operators frequently agree to interference levels higher than -8.5 dB from neighboring

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<sup>65</sup> *Id.* at A-2.

<sup>66</sup> *Id.* at A-2, Figure I-A.

<sup>67</sup> *Id.* at A-2.

GSO satellites *for 100% of the time*. Even the interference that NGSO FSS systems—such as SpaceX’s—are allowed to generate into the receivers of GSO earth stations in the bands where EPFD limits apply results in higher interference levels (for short periods of time) than the -8.5 dB that SpaceX claims is not acceptable to its Ka-band satellite receivers, *for any period of time*.

With respect to the Ku-band, the analysis presented by OneWeb clearly demonstrated that the drastic reduction in the orbit altitude of SpaceX’s NGSO FSS system results in higher interference susceptibility of the SpaceX Ku-band satellite receivers.<sup>68</sup> As a result, the interference experienced by a SpaceX satellite receiver increases for all percentages of time in the CDF curve. As explained in the OneWeb Comments, if this potential interference susceptibility increase is not remediated by the Commission in any grant of the Third SpaceX Modification, then other NGSO operators will be unfairly burdened with resolving interference issues which have been created as a result of the Third SpaceX Modification.<sup>69</sup> Unsurprisingly, SpaceX does not dispute that this increased burden will largely be shouldered by other NGSO FSS operators—not SpaceX. Therefore, OneWeb respectfully requests that the Commission condition any grant of the Third SpaceX Modification such that SpaceX cannot claim more protection for any of its Ku-band satellite receivers than the protection to which a SpaceX Ku-band satellite receiver would have been afforded pursuant to the grant of the 2016 SpaceX License Application.

#### **IV. CONCLUSION**

As demonstrated above, the SpaceX Opposition fails to resolve substantial concerns detailed in the record addressing the negative impacts to the NGSO interference environment and the significant space safety issues presented by the Third SpaceX Modification. OneWeb

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<sup>68</sup> OneWeb Comments at 24-25.

<sup>69</sup> *Id.* at 25.



respectfully requests the Commission carefully evaluate the record in this proceeding and refrain from any action on the Third SpaceX Modification until these issues are successfully resolved. OneWeb also restates its request that any grant of the Third SpaceX Modification reflect appropriate license conditions necessary to preserve the stability of the NGSO orbital environment and spectrum sharing framework.

Respectfully Submitted,

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August 7, 2020

## CERTIFICATE OF SERVICE

I, Douglas Svor, certify that I have on this 7th day of August, 2020, caused a copy of the foregoing “Reply of OneWeb” to be served upon the persons identified below via First Class mail:

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**CERTIFICATION OF PERSON RESPONSIBLE FOR  
PREPARING ENGINEERING INFORMATION**

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this Reply of OneWeb, 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 Reply of OneWeb, and that it is complete and accurate to the best of my knowledge and belief.

Dated: August 7, 2020

/s/ Marc Dupuis

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