

**Before the
Federal Communications Commission
Washington, D.C. 20554**

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| In the Matter of |) | |
| |) | |
| Space Exploration Holdings, LLC |) | IBFS File No. SAT-MOD-20181108-00083 |
| |) | |
| Request for Modification of the Authorization |) | Call Signs S2983 and S3018 |
| For the SpaceX NGSO Satellite System |) | |
| |) | |

MEMORANDUM OPINION AND ORDER

Adopted: June 4, 2020

Released: June 4, 2020

By the Chief, International Bureau:

I. INTRODUCTION

1. By this Memorandum Opinion and Order, we address the petitions to reconsider and petition to condition the International Bureau's April 2019 decision to grant Space Exploration Holdings, LLC's (SpaceX) request to modify its authorized non-geostationary satellite orbit (NGSO) fixed-satellite service (FSS) constellation.¹ Specifically, we grant in part and deny in part the Petition for Reconsideration and Petition to Condition filed by WorldVu Satellites Limited (OneWeb);² and dismiss the Petition for Reconsideration filed by Kepler Communications, Inc.³

II. BACKGROUND

2. On April 26, 2019, the International Bureau (the Bureau) granted SpaceX's request to modify its original authorization to, among other things, reduce the number of satellites in its constellation from 4,425 to 4,409 and to reduce the operating altitude of 1,584 of these satellites from 1,150 km to 550 km. On March 28, 2019, SpaceX filed applications for six Ku-band gateway earth stations intended for use with its NGSO FSS system.⁴ SpaceX subsequently filed amendments on April 8, 2019, to increase the

¹ See *Space Exploration Holdings, LLC, Request for Modification of the Authorization for the SpaceX NGSO Satellite System*, Order and Authorization, 34 FCC Rcd 2526 (IB 2019) (*First Modification Order*).

² See Petition for Reconsideration and Petition to Condition of WorldVu Satellites Limited, IBFS File Nos. SAT-MOD-20181108-00083, SES-LIC-20190402-00425 through -00427, SES-LIC-20190402-00450, -00451, and -0454 and SES-AMD-20190410-00520 through 00525 (filed May 28, 2019) (OneWeb Petition).

³ See Letter from Nickolas G. Spina, Counsel to Kepler Communications, Inc., to Marlene H. Dortch, Secretary, FCC, IBFS File Nos. SAT-MOD-20181108-00083, SAT-MOD-20190830-00087, and SAT-STA-20190924-00098, at 1-2, 5-13 (filed Oct. 15, 2019) (Kepler Petition). Kepler's Petition was filed several months late and Kepler requests a waiver of 47 CFR §1.106(f) to allow its filing to be considered late. Kepler Petition at 13.

⁴ See SpaceX Services, Inc., IBFS File No. SES-LIC-20190402-00425 through -00427 and SES-LIC-20190402-00450, -00451, and -00454, Application for Authority (filed March 28, 2019).

number of antennas at each gateway Earth station from one to four.⁵ These applications remain pending.⁶

III. DISCUSSION

A. OneWeb's Petition

3. OneWeb claims that the *First Modification Order* does not properly consider evidence that SpaceX's modified constellation will impact the interference environment for other systems.⁷ In particular, OneWeb claims that if the SpaceX system itself becomes more susceptible to uplink interference, there will be an increase in the number and duration of in-line interference events.⁸ Those events, if coordination is either ongoing or unsuccessful, will trigger the band-splitting mechanism described in section 25.261 of the Commission's rules.⁹ In addition, OneWeb contends that, contrary to the Bureau's analysis, SpaceX's use of Ku-band gateway earth stations will increase interference into other NGSO FSS systems.¹⁰ Finally, OneWeb claims the reduction in operating altitude of its satellites will make SpaceX's gateway earth stations more susceptible to interference.¹¹ OneWeb requests that the Bureau rescind the Modification Order or, alternatively, condition SpaceX's space station license, earth station licenses, or both, to mitigate OneWeb's concerns.¹² In response, SpaceX claims OneWeb's Petition is procedurally flawed and also opposes OneWeb's technical challenges.¹³

4. As discussed below, we decline to rescind the First Modification Order as OneWeb requests. Rather in the alternative, based on concerns raised by OneWeb, we adopt a new condition for the modified SpaceX system.

5. *Procedural Issue.* As an initial matter, SpaceX contends that OneWeb is barred from raising new interference claims under section 1.106(c) of the Commission's rules, which states that "a petition for reconsideration which relies on facts or arguments not previously presented to the Commission or to the designated authority" may only be granted when "the facts or arguments fall under one or more of the categories as set forth in section 1.106(b)(2)," or when "the Commission or designated authority determines that consideration of the facts or arguments relied on is required in the public interest."¹⁴ We acknowledge that OneWeb does in fact raise new interference claims in its petition,¹⁵ but we find, for the reasons set forth below, that these new claims satisfy the requirements of section 1.106(c) and that we

⁵ See SpaceX Services, Inc., IBFS File No. SES-AMD-20190410-00520 through -00525 (filed Apr 8, 2019).

⁶ OneWeb petitions for conditions to be placed, as appropriate, on these pending earth station applications. OneWeb Petition at 1, 9.

⁷ *Id.* at 1.

⁸ *Id.* at 1-5.

⁹ *Id.*; see also 47 CFR § 25.261.

¹⁰ See OneWeb Petition at 6-9.

¹¹ *Id.*

¹² *Id.* at 9-10.

¹³ See Opposition of Space Exploration Holdings, LLC and SpaceX Services, Inc., IBFS File Nos. SAT-MOD-20181108-00083, SES-LIC-20190402-00425, SES-AMD-20190410-00520, et al., (filed June 10, 2019) (SpaceX Opposition).

¹⁴ 47 CFR § 1.106(c); SpaceX Opposition at 1. SpaceX also argues that even if OneWeb's petition is not procedurally barred, the interference claims raised by OneWeb are meritless, both with respect to the claims related to SpaceX's system's decreased orbital altitude and the claims related to interference to and from Ku-band gateway earth stations. *Id.* at 2, 5-10.

¹⁵ *Id.* at 1.

may consider them.¹⁶

6. OneWeb's claims pertaining to SpaceX's Ku-band gateway earth stations are based on applications placed on public notice on May 1, 2019, several days after the *First Modification Order* was released on April 26, 2019.¹⁷ OneWeb also raises concerns regarding perceived errors in the Bureau's technical analysis of the impact of SpaceX's proposed modifications on the interference environment,¹⁸ and such concerns, as OneWeb noted in its reply, could not be raised prior to the release of the *First Modification Order*, which contained the Bureau's analysis in question.¹⁹ SpaceX argues that OneWeb did have sufficient time to consider the information contained in the SpaceX earth station applications since the applications were filed "more than three weeks" prior to the release of the *First Modification Order*.²⁰ SpaceX further argues that if OneWeb needed more time to prepare a response, it could have requested sufficient time to file instead of "wait[ing] until after SpaceX had actually launched the initial satellites of its system."²¹

7. We find that OneWeb's claims satisfy both the requirements of section 1.106(b)(2)(i), having relied on facts or arguments related to "events which have occurred or circumstances which have changed since the last opportunity to present such matters to the Commission,"²² in the case of the Ku-band gateway earth stations, and additionally satisfy the requirements of section 1.106(b)(2)(ii), having relied on facts or arguments unknown to the petitioner,²³ in the case of the Bureau's analysis of the interference environment presented in the *First Modification Order*. Having met the requirements of section 1.106(c)(1), we need not determine whether consideration of the facts or arguments relied on is required in the public interest as stated in section 1.106(c)(2).²⁴

8. *SpaceX's Space Station Susceptibility to Interference at Lower Orbital Altitude.* OneWeb claims that a reduction in SpaceX's operating altitude from 1,150 km to 550 km would make SpaceX's space stations more susceptible to interference.²⁵ Sharing and coordination procedures are established for NGSO FSS space stations in section 25.261 of the Commission's rules.²⁶ Good-faith coordination efforts are required in the use of commonly authorized frequencies.²⁷ If coordination does not occur between two or more NGSO FSS systems, an increase in system noise temperature of more than 6% $\Delta T/T$ for either an earth station receiver or space station receiver with on-board processing will trigger a band-splitting mechanism: the frequency band is divided among the systems in question until interference no

¹⁶ See 47 CFR § 1.106(c).

¹⁷ See Reply of WorldVu Satellites Limited, IBFS File Nos. SAT-MOD-20181108-00083, SES-LIC-20190402-00425, SES-AMD-20190410-00520, et al., at 4 (filed June 24, 2019) (OneWeb Reply).

¹⁸ See OneWeb Petition at 1; OneWeb Reply at 3.

¹⁹ See OneWeb Reply at 3.

²⁰ Letter from William M. Wiltshire, Counsel to SpaceX, to Marlene H. Dortch, Secretary, FCC, IBFS File No. SAT-MOD-20181108-00083 (dated July 9, 2019) at 2 (Wiltshire Letter).

²¹ *Id.*

²² 47 CFR § 1.106(b)(2)(i).

²³ See 47 CFR § 1.106(b)(2)(ii).

²⁴ See 47 CFR §§ 1.106(c)(1), 1.106(c)(2).

²⁵ See OneWeb Petition at 2-5.

²⁶ See 47 CFR § 25.261.

²⁷ See 47 CFR § 25.261(b).

longer exceeds the 6% threshold.²⁸

9. OneWeb states that because the 6% $\Delta T/T$ threshold for use of band-splitting mechanisms is based on interference-to-noise (I/N), rather than carrier-to-interference ratio (C/I), it is independent of the SpaceX uplink's equivalent isotropically radiated power (EIRP) density level and will be reached more often and for longer durations as a result of the *First Modification Order*.²⁹

10. SpaceX disagrees with OneWeb's assessment. Instead of focusing on the 6% $\Delta T/T$ threshold and the use of I/N rather than C/I, SpaceX points out that the reduction in altitude will actually reduce the frequency and duration of in-line events and will improve the overall interference environment.³⁰

11. We agree with the general point made by OneWeb that I/N, and not C/I, is the trigger for a potential need to split bandwidth for NGSO networks. However, a dynamic analysis of the satellite systems, as conducted by SpaceX, provides a more realistic, meaningful indication of the likelihood of in-line events in both frequency and duration. Such analysis shows that the proposed modification reduces the duration of in-line events and the total percentage of time during which a given level of interference is exceeded.³¹ We therefore decline to place a condition on SpaceX's license requiring SpaceX to accept any increased interference to its space stations caused by the reduction in operating altitude. We also decline to condition SpaceX's license to state that increased interference to its space station will not result in band-splitting.

12. *Interference Generated by SpaceX's Ku-band Gateway Transmissions.* OneWeb's Petition next claims that transmissions from SpaceX's proposed Ku-band gateway earth stations will increase worst-case interference with other NGSO FSS systems because gateway transmissions have higher EIRP densities than those of user terminal transmissions.³² The Petition uses a hypothetical in-line event as an example, where the interference received by a satellite from another NGSO FSS system increases proportionately with the peak EIRP density of the gateway earth station, which is nearly 6 dB higher than for SpaceX user terminals.³³ The Petition requests that the gateway earth stations be conditioned to limit the maximum uplink EIRP density to no greater than that of the SpaceX user terminals.³⁴

13. SpaceX claims first that its proposed six Ku-band gateway earth stations are intended to be temporary until Ka-band capable satellites and associated gateway earth stations are incorporated into its systems, and that these earth stations will communicate with no more than 75 satellites during their operation.³⁵ SpaceX also contends that despite the nearly 6 dB higher peak EIRP density level, its Ku-band gateway earth stations will not result in a proportionally higher level of interference compared to user terminals.³⁶ Because SpaceX's system is designed to communicate with a large number of user terminals at once, any OneWeb satellite experiencing an in-line event with a narrow beam from one of

²⁸ See 47 CFR § 25.261(c)(1-3).

²⁹ *Id.*

³⁰ See SpaceX Opposition at 2-3, 5-6, 8, Table 2.

³¹ *Id.*

³² See OneWeb Petition at 6-7.

³³ *Id.*

³⁴ *Id.*; see also OneWeb Reply at 8-9.

³⁵ See SpaceX Opposition at 9.

³⁶ *Id.* at 9-10.

SpaceX's gateway earth stations would also likely be in-line with multiple SpaceX user terminals.³⁷ The interference from those user terminals could potentially combine to create as much or more interference than a gateway.³⁸

14. We disagree with OneWeb's claims regarding SpaceX's Ku-band gateway earth stations and decline to limit SpaceX's maximum EIRP density to that of SpaceX's user terminals as OneWeb requests. In addition to the fact that Ku-band gateways will be used to communicate with less than 2% of the satellites in the constellation, as pointed out by SpaceX, we note that the only limitation the initial SpaceX Authorization imposed on transmissions from its earth stations was compliance with the applicable EPFD_{up} limits. The Commission previously determined that it was not necessary to adopt any additional limits on earth station transmissions.³⁹

15. *SpaceX's Ku-Band Gateway Earth Stations Susceptibility to Interference.* OneWeb also claims that as a result of the increased gain of the gateway antennas over user terminals, SpaceX gateway earth stations will be nearly 6 dB more sensitive to interference. SpaceX acknowledges that in a downlink interference scenario, the higher gain of its gateway antennas could result in additional interference as compared to its user terminals.⁴⁰ We note that, although interference levels at the antenna output will be higher, interference events will be shorter due to the narrower antenna beam. In any case, SpaceX indicates willingness to "forgo a greater level of protection" for its gateway stations in the event of a space station transmitting to commercially-licensed earth stations operating in the United States.

16. We therefore add a condition to the *First Modification Order* to address any potential increase in interference to SpaceX's Ku-band gateway earth stations. 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.

B. Kepler's Petition

17. Kepler bases its Petition for Reconsideration largely on its concerns about an increase in orbital debris potentially caused by SpaceX's modifications to its constellation and the performance of SpaceX's satellites.⁴¹ SpaceX argues that the Kepler Petition is untimely filed and that, with the exception of its claims about the satellite failures, Kepler's interference and orbital debris concerns could have, and should have, been raised within the filing window for reconsideration petitions.⁴² We agree with SpaceX. Under the Commission's rules, petitions for reconsideration of an order must be filed within thirty days of the release of that order.⁴³ Kepler does request a waiver of section 1.106(f) as part of its petition.⁴⁴ However, the D.C. Circuit has held that the Commission cannot consider untimely

³⁷ *Id.*

³⁸ *Id.*

³⁹ See *NGSO FSS Report and Order*, 32 FCC Rcd at 7827, para. 55 (stating that "given the variety of NGSO FSS system proposals and their potential to offer broadband services directly to consumers, we believe it is premature to adopt any additional technical limitations to promote sharing among NGSO FSS systems").

⁴⁰ See SpaceX Opposition at 10.

⁴¹ Kepler Petition at 1-2, 5-13.

⁴² See Consolidated Opposition to Petitions of SpaceX, IBFS File No. SAT-MOD-20190830-00087, at 9-10 (filed Oct. 30, 2019) (SpaceX Consolidated Opposition).

⁴³ See 47 U.S.C. § 405(a); 47 CFR § 1.106(f).

⁴⁴ See Kepler Petition at 13.

reconsideration petitions absent extraordinary circumstances.⁴⁵

18. We find that Kepler's stated reasons for its delayed filing do not rise to the level of extraordinary circumstances. Kepler's complaint that the Bureau did not address commenters' orbital debris concerns could have been submitted during the thirty-day window for filing petitions for reconsideration. Furthermore, Kepler does not provide any justification for its delay in filing its petition on this basis. Kepler further argues that the failure rate of SpaceX's first tranche of satellites has raised significant orbital debris concerns since the first modification was granted.⁴⁶ Kepler cites the fact that three of SpaceX's satellites lost all communications ability shortly after launch, and as of the filing of Kepler's Petition, four more satellites were still a significant distance from their operational location.⁴⁷ Kepler takes this continued orbit-raising as indication of the satellites' failure and calculates that this failure rate would result in 184 defunct Starlink satellites at the 550 km altitude.⁴⁸ SpaceX states, however, that while three satellites have not functioned as planned, this failure rate is within the bounds anticipated by the *First Modification Order*, and the additional four satellites Kepler references have not reached their operational altitude due to a phased orbit-raising approach rather than the critical failure Kepler supposes.⁴⁹ While the health of SpaceX's satellites may not have been ascertainable until after the close of the thirty-day window, Kepler's assessment of SpaceX's on-orbit failure rate is based on the unsupported presumption that continued orbit-raising of several satellites is equivalent to critical failure of those satellites, a presumption which SpaceX has refuted.⁵⁰ We also agree with SpaceX that the potential failure of some SpaceX's satellites was contemplated and accounted for in the order granting SpaceX's modification.⁵¹ We therefore find that Kepler's arguments do not constitute an extraordinary circumstance and do not justify Kepler's delay in filing of nearly six months from the release of the *First Modification Order*.

19. Even if we were to consider Kepler's Petition, Kepler's arguments are unpersuasive. Kepler claims the *First Modification Order* did not adequately address the concerns of commenters regarding the increase in interference and the new orbital debris risk posed by the SpaceX Modification.⁵² According to Kepler, basing SpaceX's collision risk of zero on its satellites' propulsive capabilities ignores the fact that relocating SpaceX's satellites to a lower orbital altitude will increase conjunctions with Kepler's satellites and will interrupt Kepler's service because of the need to make avoidance maneuvers, unless SpaceX assumes the responsibility of making all avoidance maneuvers because its systems use propulsion.⁵³ Kepler therefore requests that on reconsideration the Commission impose a condition on SpaceX's authorization requiring SpaceX to assume the burden of all avoidance maneuvers because of its propulsion capabilities.⁵⁴ Kepler further argues that the introduction of SpaceX's constellation into the 550 km LEO environment will triple the number of satellites orbiting at that altitude and "inevitably" increase orbital debris, especially given Kepler's calculation of an 11.6% on-orbit failure rate of

⁴⁵ See *Virgin Islands Telephone Corp. v. FCC*, 989 F.2d 1231, 1237 (D.C. Cir. 1993) (citing *Reuters LTD. V. FCC*, 781 F.2d 946, 951-52 (D.C. Cir. 1986)).

⁴⁶ See *Kepler Petition* at 7-11.

⁴⁷ *Id.* at 7-8.

⁴⁸ *Id.* at 8-9.

⁴⁹ See SpaceX Consolidated Opposition at 9-10, n.22.

⁵⁰ *Id.*

⁵¹ *Id.* at 9-10; *First Modification Order* at 2532-35, paras. 18-22.

⁵² See *Kepler Petition* at 1.

⁵³ *Id.* at 6-7.

⁵⁴ *Id.* at 6.

SpaceX's satellites.⁵⁵

20. While it is true that the reduction in operating altitude for the SpaceX satellites will increase the number of satellites operating at 550 km, contrary to Kepler's assertions, the Bureau considered these interference and orbital debris concerns in the *First Modification Order*, taking into account the propulsive capabilities of the Starlink satellites.⁵⁶ As we stated in the *First Modification Order*, "Our rules do not prohibit SpaceX's selection of an orbital regime that is also used by other satellite operators,"⁵⁷ and given that SpaceX is aware of its obligations as a satellite operator with propulsive capabilities and has voluntarily assumed responsibility for collision avoidance,⁵⁸ we decline to reconsider our analysis and to condition SpaceX's authorization as Kepler requests. Furthermore, it is the Commission's established licensing practice to consider satellites equipped with propulsion capability to have a collision risk of zero or near zero, absent specific information to the contrary.⁵⁹ Kepler has provided none. Finally, as discussed above, Kepler's assessment that the ongoing orbit-raising of SpaceX's first tranche of satellites indicates critical failure of satellite maneuverability is based on unsupported conjecture that SpaceX has refuted. While SpaceX admits that three of its satellites have not functioned as planned, we specifically addressed concerns with failed satellites in the *First Modification Order*,⁶⁰ and we find 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.

21. For all these reasons, we deny Kepler's request for a waiver of section 1.106(f) and dismiss Kepler's petition to reconsider the *First Modification Order* as untimely.

IV. ORDERING CLAUSES

22. Accordingly, IT IS ORDERED, pursuant to section 405(a) of the Communications Act of 1934, as amended, 47 U.S.C. § 405(a), and section 1.429(i) of the Commission's rules, 47 CFR § 1.429(i), that the Petition for Reconsideration and Petition to Condition filed by WorldVu Satellites Limited IS GRANTED IN PART and DENIED IN PART to the extent indicated above. The Petition for Reconsideration filed by Kepler Communications, Inc. is DISMISSED.

23. IT IS FURTHER ORDERED that the *First Modification Order*, DA 19-342, be conditioned as set forth in paragraph 16 as follows: 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.

⁵⁵ *Id.* at 7-11.

⁵⁶ See *First Modification Order*, at 2532-35, paras. 18-22.

⁵⁷ *Id.* at para. 22.

⁵⁸ *Id.*

⁵⁹ See *Mitigation of Orbital Debris in the New Space Age*, Report and Order and Further Notice of Proposed Rulemaking, FCC-20-54, para. 35 (Apr. 24, 2020).

⁶⁰ See *First Modification Order* at 2532-34, paras. 18-22.

24. This Memorandum Opinion and Order is issued on delegated authority pursuant to sections 0.241 and 0.261 of the Commission's rules, 47 CFR §§ 0.241 and 0.261, and is effective upon release. Applications for review under section 1.115 of the Commission's rules, 47 CFR § 1.115, may be filed within thirty days of public notice of this Order.

FEDERAL COMMUNICATIONS COMMISSION

Thomas P. Sullivan
Chief, International Bureau