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

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| In the Matter of | ) | |
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| Revising Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems | ) | IB Docket No. 21-456 |
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# SECOND REPORT AND ORDER AND ORDER ON RECONSIDERATION

**Adopted: November 5, 2024** **Released: November 15, 2024**

By the Commission:

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## I. INTRODUCTION

1. In this Second Report and Order, we continue to refine the Commission's rules governing spectrum sharing among a new generation of broadband satellite constellations to promote market entry, regulatory certainty, and spectrum efficiency through good-faith coordination. Specifically, we clarify certain details of the degraded throughput methodology that, in the absence of a coordination agreement, must be used in compatibility analyses by non-geostationary satellite orbit, fixed-satellite service (NGSO FSS) system licensees authorized through later processing rounds to show they can operate compatibly with, and protect, NGSO FSS systems authorized through earlier processing rounds. We adopt a 3% time-weighted average throughput degradation as a long-term interference protection criterion, a 0.4% absolute increase in link unavailability as a short-term interference protection criterion, and decline to adopt additional protection metrics or to adopt an aggregate limit on interference from later-round NGSO FSS systems into earlier-round NGSO FSS systems. In an accompanying Order on Reconsideration, we deny a petition for reconsideration of the Report and Order in this proceeding.[1] These actions continue the Commission's efforts to promote development and competition in broadband NGSO satellite services.[2]

## II. BACKGROUND

2. This proceeding advances the Commission's commitment to updating and refining its rules governing NGSO FSS systems,[3] at a time when these systems are being deployed at unprecedented scale.[4] NGSO FSS satellites traveling in low- and medium-Earth orbit provide broadband services to industry, enterprise, and residential customers with lower latency and wider coverage than previously available by satellite.[5]

3. *Processing Round Procedure Overview*. Applications for NGSO FSS system licenses and petitions for declaratory ruling seeking U.S. market access for non-U.S.-licensed NGSO FSS systems are considered in groups based on filing date, under a processing round procedure.[6] Pursuant to the Commission's rules, a license application for "NGSO-like"[7] satellite operation, including operation of an

[1] Petition of WorldVu Satellites Limited (OneWeb) for Partial Reconsideration (filed July 20, 2023) (OneWeb Petition); *Revising Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems*, Report and Order and Further Notice of Proposed Rulemaking, 38 FCC Rcd 3699 (2023) (*Report and Order* or *Further Notice*). WorldVu Satellites Limited is referred to as OneWeb throughout this Second Report and Order and Order on Reconsideration.

[2] *See generally* Executive Order No. 14036, Promoting Competition in the American Economy, 86 Fed. Reg. 36987, 36991 (July 9, 2021) ("The heads of all agencies shall consider using their authorities to further the policies set forth in section 1 of this order, with particular attention to: (i) the influence of their respective regulations, particularly any licensing regulations, on concentration and competition in the industries under their jurisdiction").

[3] *See generally Report and Order*; *Revising Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems*, *Revision of Section 25.261 of the Commission's Rules to Increase Certainty in Spectrum Sharing Obligations Among Non-Geostationary Orbit Fixed-Satellite Service Systems*, Order and Notice of Proposed Rulemaking, 36 FCC Rcd 17871 (2021) (*NPRM*); *see also Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, Report and Order, 32 FCC Rcd 7809 (2017) (*NGSO FSS Report and Order*), *pets. for recon. pending*.

[4] *Report and Order*, 38 FCC Rcd at 3699-70, para. 2.

[5] *See, e.g.*, *Communications Marketplace Report*, 37 FCC Rcd 15514, 15517-18, para. 6 (2022) (approximately 98% of all satellite launches in 2021 were deployed into low-Earth orbit to provide internet connectivity).

[6] *See generally* 47 CFR § 25.157.

[7] The term "NGSO-like satellite operation" is defined as: (1) operation of any NGSO satellite system; and (2) operation of a geostationary satellite orbit, mobile-satellite service satellite to communicate with earth stations with non-directional antennas. 47 CFR § 25.157(a).

NGSO FSS system, that satisfies the acceptability for filing requirements[8] is reviewed to determine whether it is a "competing application" or a "lead application."[9] A competing application is one filed in response to a public notice initiating a processing round.[10] Any other application is a lead application.[11] The public notice for a lead application initiates a processing round and establishes a cut-off date for competing NGSO-like satellite system applications.[12] After the close of the processing round, the Commission grants all the applications for which the Commission finds that the applicant is legally, technically, and otherwise qualified, that the proposed facilities and operations comply with all applicable rules, regulations, and policies, and that grant of the application will serve the public interest, convenience and necessity.[13]

4. *NGSO FSS System Spectrum Sharing Overview*. The Commission has adopted rules for spectrum sharing among NGSO FSS systems.[14] NGSO FSS space station license applications granted with a condition to abide by these sharing rules are exempt from frequency band segmentation procedures that otherwise apply to applications for NGSO-like satellite operation.[15] Instead, NGSO FSS operators must coordinate with one another in good faith the use of commonly authorized frequencies.[16] If two or more NGSO FSS satellite systems fail to complete coordination, a default spectrum-splitting procedure using a ΔT/T of 6% threshold applies, pursuant to section 25.261(c) of the Commission's rules.[17] In the *NGSO FSS Report and Order*, the Commission stated that it would "initially limit" sharing under the

[8] 47 CFR § 25.112.

[9] 47 CFR §§ 25.156(d)(1), 25.157(c). A non-U.S.-licensed NGSO-like satellite system seeking to serve the United States can be considered contemporaneously with other U.S. NGSO-like satellite systems pursuant to this procedure and considered before later-filed applications of other U.S. satellite system operators if the non-U.S.-licensed satellite system: (1) is in orbit and operating; (2) has a license from another administration; or (3) has been submitted for coordination to the International Telecommunication Union. 47 CFR § 25.137(c). This procedure does not apply to applications for authority to operate certain replacement space stations. 47 CFR § 25.157(b)(1).

[10] 47 CFR § 25.157(c).

[11] *Id.*

[12] 47 CFR § 25.157(c)(2).

[13] 47 CFR § 25.156(a).

[14] 47 CFR § 25.261. These sharing rules apply to NGSO FSS operation with earth stations with directional antennas anywhere in the world under a Commission license, or in the United States under a grant of U.S. market access. 47 CFR § 25.261(a).

[15] 47 CFR § 25.157(b)(2), (e), (f), (g).

[16] 47 CFR § 25.261(b).

[17] 47 CFR § 25.261(c). Under the default spectrum-splitting procedure, whenever the percentage increase in system noise temperature of an earth station receiver, or a space station receiver for a satellite with on-board processing, of either system, ΔT/T, exceeds 6% due to interference from emissions originating in the other system in a commonly authorized frequency band, such frequency band will be divided among the affected satellite networks (*i.e.*, individual links) in accordance with the following: (1) Each of n (number of) satellite networks involved must select 1/n of the assigned spectrum available in each of these frequency bands; (2) the affected station(s) of the respective satellite systems may operate in only the selected (1/n) spectrum associated with its satellite system while the ΔT/T of 6% threshold is exceeded; and (3) all affected station(s) may resume operations throughout the assigned frequency bands once the ΔT/T of 6% threshold is no longer exceeded. *Id.* The spectrum selection order for each satellite network is determined by the date that the first space station in each satellite system is launched and capable of operating in the frequency band under consideration. 47 CFR § 25.261(c)(1); *see also The Establishment of Policies and Service Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ku-Band*, Report and Order, 17 FCC Rcd 7841, 7857, para. 53 & n.77 (2002) ("A[n NGSO FSS] system is deemed operational when at least one of its satellites reaches its intended orbit and initiates transmission and reception of radio signals.").

ΔT/T of 6% threshold to qualified applicants in a processing round.[18] The Commission explained that treatment of applicants after a processing round would be on a case-by-case basis and would consider both the need to protect existing expectations and investments and the benefits of additional entry, as well as any comments filed by incumbent operators and reasoning presented by the new applicant.[19]

5. *NPRM*. The *NPRM* in this proceeding sought comment on potential rule changes to clarify the relative obligations between NGSO FSS systems approved in different processing rounds.[20] Specifically, the Commission proposed to limit the existing NGSO FSS spectrum-splitting procedure in section 25.261(c) to those systems approved in the same processing round, and to require systems approved in a later processing round to coordinate with, or demonstrate they will protect, earlier-round systems.[21] The Commission invited comment on how to quantify inter-round protection and whether it should sunset after a period of time.[22] The Commission also proposed to require all NGSO FSS grantees,[23] regardless of their processing round status, to coordinate with each other in good faith, and sought comment on specific information sharing obligations that could facilitate operator-to-operator coordination.[24]

6. *Report and Order*. In response to the record developed through the *NPRM*, the *Report and Order* adopted rule changes designed to promote market entry, regulatory certainty, and spectrum efficiency of NGSO FSS systems.[25] The Commission, for the first time, limited the default spectrum-splitting procedure in section 25.261(c) to NGSO FSS systems approved in the same processing round and required NGSO FSS systems approved in a later processing round to coordinate with, or demonstrate they will protect, earlier-round systems, subject to a sunsetting provision.[26] The Commission also required all NGSO FSS grantees to coordinate with each other in good faith.[27] Regarding the technical demonstrations of compatibility of later-round NGSO FSS systems with earlier-round systems, the Commission concluded that an interference analysis based on a degraded throughput methodology offered the most technically promising path for NGSO FSS inter-round sharing and required later-round systems to use such a methodology.[28] In adopting a sunsetting provision for the inter-round protection requirement, the Commission concluded that protection of earlier-round NGSO FSS systems must ensure a stable environment for continued service and investment but should not hinder later-round systems indefinitely.[29] The Commission decided that NGSO FSS systems will be entitled to protection from systems approved in a subsequent processing round until ten years after the first authorization or market access grant in that subsequent processing round.[30] After that date, all systems in both processing rounds

[18] *NGSO FSS Report and Order*, 32 FCC Rcd at 7829, para. 61.

[19] *Id.*

[20] *NPRM*, 36 FCC Rcd at 17875-80, paras. 12-26.

[21] *Id.* at 17876, para. 16.

[22] *Id.* at 17877-78, paras. 20-21, 17879, para. 25.

[23] In this Second Report and Order and Order on Reconsideration, the term "grantee" refers to U.S.-licensed satellite operators granted Commission space station licenses and non-U.S. licensed satellite operators granted U.S. market access.

[24] *Id.* at 17876, para. 16, 17878-79, para. 23.

[25] *Report and Order*, 38 FCC Rcd at 3702-14, paras. 9-31.

[26] *Id.* at 3703, para. 11, 3704-05, para. 14, 3712-13, para. 29.

[27] *Id.* at 3708, para. 21.

[28] *Id.* at 3706-07, para. 17.

[29] *Id.* at 3712-13, para. 29.

[30] *Id.* at 3713-14, para. 30.

will be treated on an equal basis with respect to spectrum sharing in the absence of a coordination agreement, and the default spectrum-splitting procedure in section 25.261(c) will also apply between systems in the two rounds.[31] In sum, prior to commencing operations, an NGSO FSS licensee or market access recipient must either certify it has completed a coordination agreement with any operational NGSO FSS system licensed or granted U.S. market access in an earlier processing round, or submit a showing for Commission approval that it will not cause harmful interference to any such system with which coordination has not been completed using a degraded throughput methodology.[32]

7. *Further Notice*. In conjunction with the decision in the *Report and Order* to adopt an inter-round protection requirement described above, the Commission adopted the *Further Notice* to finalize the details of the degraded throughput methodology.[33] The Commission invited specific comment on the appropriate values and assumptions to be used in this requirement, as well as on whether we should adopt a rule limiting aggregate interference from later-round NGSO FSS systems into earlier-round systems.[34] Ten comments, eight reply comments, and several *ex parte* presentations were filed in response to the *Further Notice*.[35]

8. *Petition.* On July 20, 2023, OneWeb filed a Petition for Partial Reconsideration of the Report and Order concerning the sunset period adopted with the new inter-round protection requirement.[36] Kuiper opposed the OneWeb Petition, SpaceX commented on it, and OneWeb replied to Kuiper's opposition.[37]

## III. DISCUSSION

### A. Second Report and Order

9. In this Second Report and Order, after review of the record, we clarify certain details of the degraded throughput methodology that, in the absence of a coordination agreement, must be used in compatibility analyses by NGSO FSS system grantees, authorized through later processing rounds, to show they can operate compatibly with, and protect, NGSO FSS systems, authorized through earlier processing rounds.[38] Specifically, we adopt a 3% time-weighted average throughput degradation as a

[31] *See id.*

[32] *Id.* at 3723, Appendix A (revisions to 47 CFR § 25.261).

[33] *Further Notice*, 38 FCC Rcd at 3717-19, paras. 38-43.

[34] *Id.* at 3717-18, para. 38.

[35] *See* Appendix C.

[36] *See* OneWeb Petition at 1-2. The OneWeb Petition was placed on public notice. *Petition for Reconsideration of Action in Proceeding*, Public Notice, Report No. 3200 (rel. Aug. 22, 2023); *Petition for Reconsideration of Action in Rulemaking Proceeding*, 88 FR 58540 (Aug. 28, 2023).

[37] *See* Response of Space Exploration Holdings, LLC to Petition for Partial Reconsideration of WorldVu Satellites Limited, IB Docket No. 21-456 (filed Sept. 12, 2023) (SpaceX Response to Petition); Opposition of Kuiper Systems LLC to Petition of WorldVu Satellites Limited for Partial Reconsideration, IB Docket No. 21-456 (filed Sept. 12, 2023) (Kuiper Opposition to Petition); Reply of WorldVu Satellites Limited, IB Docket No. 21-456 (filed Sept. 22, 2023) (OneWeb Reply to Opposition).

[38] TechFreedom argues generally that the Commission should have issued a notice of inquiry, rather than a further notice of proposed rulemaking, in this proceeding and that it should seek additional stakeholder input before adopting any rule changes, noting similar issues are currently being studied in the International Telecommunication Union Radiocommunication Sector. *See generally* TechFreedom Comments. TechFreedom did not submit reply comments in response to the actual record developed in the comments on the *Further Notice*, nor make any further filings on the record, in response to later technical studies or otherwise. Other commenters encourage the Commission to proceed with rule amendments. *See*, *e.g.*, Letter from Michal John Carlson, Senior Corporate Counsel, Kuiper Systems LLC, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456, at 1 (Kuiper July 24, 2024 *ex parte*) (urging the Commission to "move forward and settle the open questions regarding its spectrum-
(continued….)

long-term interference protection criterion and a 0.4% absolute increase in link unavailability as a short-term interference protection criterion.[39] We decline to adopt additional protection metrics or to adopt an aggregate limit on interference from later-round NGSO FSS systems into earlier-round NGSO FSS systems.[40] Our decisions in this Second Report and Order rely on our predictive judgment in the highly complex and dynamic area of spectrum sharing among a new generation of innovative NGSO FSS systems. Our decisions strive to balance our competing goals of providing regulatory certainty for, and adequate protection of, earlier round systems vis-a-via later entrants while encouraging new entry and coordination among NGSO FSS operators.[41]

### 1. Long-Term Interference Metric

10. *Further Notice*. In the *Further Notice*, the Commission outlined its expected steps in a degraded throughput analysis and sought comment on the proposed process.[42] Specifically, noting that

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sharing framework for [NGSO FSS] systems" raised in the *Further Notice*); Letter from Michael John Carlson, Senior Corporate Counsel, Kuiper Systems LLC, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456 at 5 (filed Oct. 18, 2024) (Kuiper October 18, 2024 *ex parte*); Letter from Jayson L. Cohen, Director, Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456 at 1 (filed Oct. 22, 2024) (SpaceX Oct. 22, 2024 *ex parte*). The degraded throughput methodology was already discussed in comments on the Notice of Proposed Rulemaking in this proceeding, that the *Further Notice* proposed to "finalize" the details of this methodology and also sought comment on other related issues, including protection of earlier-round systems from short-term interference. *Further Notice*, 38 FCC Rcd at 3717-19, paras. 38-43. In light of the robust record in response to the *Further Notice*, including the further technical studies that have been submitted, we see no reason to initiate a new consultation period before adopting any rule changes in response to the current record. *See also infra* para. 38. We further address the particular record developed on the issues raised in the *Further Notice* when coming to decisions on the proposals and comments on those issues.

[39] The long-term protection criterion compares throughput under time-varying propagation conditions to throughput under time varying propagation conditions with interference. The calculation of spectral efficiency is focused on satellite systems utilizing adaptive coding and modulation (ACM) by calculating the throughput degradation as a function of C/N, which varies depending on the propagation and interference impacts on the satellite link over the long term. The short-term protection criterion compares link availability under time-varying propagation conditions to link availability under time varying propagation conditions with interference.

[40] In the revisions to 47 CFR § 25.261 in Appendix A, we also repeat text from section 25.261(d) and (e) adopted in the *Report and Order* for ease of incorporation.

[41] Our decisions in this Second Report and Order are also consistent with the Commission's policy regarding interference realities. *See Principles for Promoting Efficient Use of Spectrum and Opportunities for New Services, Promoting Efficient Use of Spectrum through Improved Receiver Interference Immunity Performance*, Policy Statement, 38 FCC Rcd 3682, 3683-84, para. 5 (2023) (*Commission Policy Statement*) ("Services should plan for the spectrum environment in which they intend to operate, the service they intend to provide, and the characteristics of spectrally and spatially proximate operations. Planning should be ongoing and account for changes in spectrum operating environments."). At the same time, our decisions adopted here, including the evaluation of degraded throughput and acceptable levels of interference, are based on the technical record developed in this proceeding regarding modern NGSO FSS systems and should not be construed to be setting a precedent for other services.

[42] *Further Notice*, 38 FCC Rcd at 3718, para. 39. The Commission expected that the degraded throughput analysis should consist of three steps. The first step is to establish a baseline of performance. To do this, an operator models the earlier-round NGSO system's performance without any additional interference by computing the earlier-round NGSO system's probabilistic C/N level using its published system parameters and a rain-attenuation model. This provides the baseline in terms of: (1) the earlier-round system's time-weighted average throughput (derived by computing the spectral efficiency from the C/N results), and (2) the earlier-round system's link unavailability time percentage (i.e., the percentage of time when the earlier-round system's expected C/N will fall below its minimum usable level). The second step is to repeat the analysis above, adding in the effect of the later-round system's interference into the earlier-round system. This produces a second measurement of time-weighted average throughput and link unavailability time-percentage. The third step is to compare these two sets of figures to measure
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3% had been suggested as an appropriate value for several aspects of the degraded throughput analysis, including a long-term interference limit based on reduction in time-weighted average throughput, the Commission invited comment on the appropriate values for such a limit, including technical justification.[43]

11. *Comments*. Four out of the five commenters proposing a specific threshold value for degraded throughput support using the 3% value noted in the Further Notice.[44] Kuiper, for example, observes that a 3% throughput-degradation threshold has been adopted internationally to protect V-band GSO networks from NGSO FSS systems and argues that it provides a conservative measure of protection for incumbent systems due, in part, to conservatism in the methodology a new entrant must use to estimate interference.[45] Viasat agrees that use of the 3% threshold should adequately safeguard systems from adverse performance degradation experienced over an extended period of time.[46] Telesat, while initially arguing that "[t]he long-term criterion is sufficiently stable and there is a sufficient record, including through recent ITU studies, to support adopting a 3% degradation limit,"[47] more recently concludes that specific degraded throughput criteria should be left to coordination discussions among satellite operators to determine.[48] Telesat now believes that the record is sufficiently complete to allow the Commission to adopt rules, endorsing the 3% degraded throughput value for the long-term protection criterion proposed by SpaceX.[49] Intelsat initially indicated that further study would be required before concluding upon a degraded throughput value, but now supports the 3% value as well.[50] TechFreedom

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the effect of any additional interference. If the resulting performance impact exceeds the permissible limits, then the later-round system must adjust its operations to mitigate interference to a permissible level. *Id.*

[43] *Id.* at 3718-19, para. 40.

[44] Kuiper Comments at 5-9; Viasat Comments at 3; Letter from Jayson L. Cohen, Director, Satellite Policy, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, IB Docket 21-456, at 2, S-6 to S-9 (filed July 25, 2024) (SpaceX Spectrum Sharing Study); Letter from Suzanne Malloy, Vice President, O3b Limited, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456, Attachment at 1 (filed Aug. 22, 2024) (O3b Aug. 22, 2024 *ex parte*). Only OneWeb proposes an alternative value.

[45] Kuiper July 24, 2024 *ex parte* at 3-4 ("For example, a new entrant must complete its analysis before commencing commercial operations but must assume full deployment of their constellation under worst-case conditions—though full deployment is years away, if it occurs at all. Further, the 3% throughput-degradation threshold caps the interference permissible at any location, not the expected average of interference across all locations. This means that worst-case locations drive the discussion of mitigation measures and appropriate system parameters, making actual interference far less than 3% in the vast majority of circumstances.").

[46] Viasat Comments at 3.

[47] Telesat Comments at 3.

[48] *See* Letter from Elisabeth Neasmith, Senior Director, Telesat, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456, at 3 (Telesat July 5 *ex parte*) (arguing that not only is there no single degraded throughput (or increase in unavailability) value that works for all coordinations, but even within a single coordination there is no one single value that is appropriate in all scenarios when considering uplinks and downlinks from user terminals and gateways).

[49] Letter from Elisabeth Neasmith, Senior Director, Telesat, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456, at 2 (Telesat Oct. 22, 2024 *ex parte*).

[50] *See* Intelsat Comments at 4, n.6 (noting Intelsat is not necessarily opposed to using a 3% value for long-term spectral efficiency degradation, but suggesting the value should be further assessed); ITIF Comments at 3 ("A three percent threshold is a reasonable starting place for this analysis since it is already used in other satellite contexts."); Mangata Reply at 3 (stating the 3% for degraded throughput threshold "warrants serious considerations" but noting Mangata has not yet come to a conclusion whether it is the correct figure). *See also* Intelsat Oct. 18, 2024 *ex parte*, Attachment B at 2.

argues it is premature to adopt protection criteria.[51] Public Knowledge and New America Open Technology Institute also support adopting a 3% degraded throughput threshold.[52]

12. SpaceX, which initially commented that a 3% degraded throughput value required further study,[53] subsequently submitted its own spectrum sharing study evaluating the 3% limit.[54] Using publicly available information and reference standard antenna patterns, SpaceX performed 123 dynamic (Monte Carlo) simulations of interference from various 2020 processing-round NGSO systems into various 2016 processing-round NGSO systems.[55] In 112 of the 123 studied cases, degradation was below 3.12%, which SpaceX argues empirically supports the Commission adopting a 3.0% degradation of average spectral efficiency as a single-entry long-term interference criterion for compatibility determinations.[56]

13. Only OneWeb proposes a long-term interference metric other than 3%, arguing that a 3% time-weighted average degraded throughput limit will substantially harm NGSO FSS operators and disincentivize coordination.[57] OneWeb asserts that an aggregate interference and rain fade criterion of no more than 10% degradation in average throughput is appropriate for an NGSO FSS system, that apportionment of this allowed percentage of interference to other NGSO systems should be no more than 2.5 to 3.85%, and that when accounting for the existence of multiple co-frequency NGSO systems, the single-entry average degraded throughput should be less than 1% for each individual NGSO system.[58] OneWeb further claims that if a 3% limit were adopted per system and six NGSO FSS systems were operating co-frequency, then a 15% degradation in average throughput would occur from the 5 interfering systems to the victim system.[59] No other commenter supports OneWeb's proposal; SpaceX,[60] Kuiper,[61]

[51] TechFreedom Comments at 7. TechFreedom made these comments prior to the submission of technical studies assessing long-term and short-term interference protection criteria by Telesat and SpaceX.

[52] *See* Letter from John Bergmayer, Public Knowledge, and Michael Calabrese and Jessica Dine, Wireless Future Project, New America's Open Technology Institute, to Marlene H. Dortch, Secretary, FCC, WT Docket Nos. 24-186, 20-443, IB Docket No. 21-456, ET Docket Nos. 24-40, 18-295, 20-443 (filed Oct. 31, 2024), citing Public Interest Organizations Comments at 10.

[53] *See* SpaceX Reply at 10.

[54] SpaceX Spectrum Sharing Study at S-6-S-9.

[55] *Id.* at 1-2, S-1.

[56] *Id*. at S-7 ("Long-term interference in SpaceX's large study falls into two discernible buckets: (1) degradation below 3.12%, and (2) degradation between 4.325% and 16.6%. Only eleven cases, outliers in the study, fall into the second bucket between 4.325% and 16.6%. They are all uplink cases. Given the variety of systems and the number of cases in the SpaceX study, these results suggest that interference to most links generally should fall into the first bucket with approximately 3% or lower degradation of average spectral efficiency, indicating empirically that 3% is a good backstop value. Taking a closer look at the outlier cases also supports using 3% as a backstop, as that backstop creates incentives for efficient spectrum sharing through good-faith coordination.").

[57] OneWeb Comments at 12-13, Tech. Annex 1; *see also* OneWeb Reply at 7-9; Letter from Kimberly M. Baum, Vice President, WorldVu Satellites Limited, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456 at 7-8, 11-15 (filed Oct. 3, 2024) (OneWeb Oct. 3, 2024 *ex parte*).

[58] OneWeb Comments at 11-13.

[59] *Id.*

[60] SpaceX Reply at 11 ("[OneWeb's] back-of-the-envelope calculations for its values rely on a series of incorrect assumptions. First, OneWeb's calculations rely on a patently incorrect treatment of atmospheric attenuation by using a static rain-fade value. …. Second, OneWeb presumes that half of the interference that earlier-round NGSO systems tolerate will be from GSO operations. …. Third, OneWeb arbitrarily assumes that 'three to five' NGSO systems share a frequency band when calculating its single-entry value proposals.").

[61] Kuiper Reply at 7 ("OneWeb bases this recommendation on a note in Recommendation ITU-R S.2131[.] One obvious problem with OneWeb's conclusion is that the ITU recommendation did not recommend, nor purport to even consider, an interference threshold (or an aggregate interference threshold). "); *id.* at 8 ("OneWeb attacks the (continued….)

and Telesat[62] raise numerous technical concerns with it; and commenters suggest alternative explanations for the results of OneWeb's analysis.[63]

14. OneWeb also argues that SpaceX's study purporting to affirm the 3% metric relies on flawed assumptions that undermine its conclusions.[64] Specifically, OneWeb contends that the study fails to accurately model system-specific details that could impact whether a previous-round system may experience harmful interference.[65] OneWeb's analysis incorporating its revised assumptions argues that the 3% metric results in substantially higher levels of interference than projected by both SpaceX and Kuiper, which could exceed 5% when taking into account a small deployment of Kuiper customer terminals without adding any contribution from the Viasat system.[66] Thus, OneWeb concludes that SpaceX's study fails to adequately predict the interference levels prior-round NGSO systems would receive. OneWeb further highlighted its support for a 1% or less average degraded throughput as the long-term criterion that should be adopted.[67]

15. *Decision*. We adopt a 3% time-weighted average degraded throughput threshold as the long-term interference metric that must be complied with in any inter-round compatibility showing submitted by a later-round NGSO FSS grantee. The 3% time-weighted average degraded throughput is calculated on a per link basis. We conclude that adopting this value best furthers our goals of providing regulatory certainty for, and adequate protection of, earlier-round NGSO FSS systems while allowing for new entry and coordination among NGSO FSS operators. First, this value has been developed and adopted internationally as sufficient for the protection of GSO satellite networks using adaptive coding and modulation techniques, which are also used by NGSO FSS systems.[68] Second, the 3% throughput-degradation threshold limits the interference allowed at any location, not the expected average of interference across all locations. Since the worst-case locations will likely drive the discussion of appropriate system parameters and any mitigation measures, actual interference should be less than 3% in many circumstances.[69] Third, our technical review of the SpaceX study on the record indicates that the study reliably supports the conclusion that a 3% threshold is achievable by later-round systems, and therefore encourages competitive new entry, by demonstrating that the simulated degradation was near or below 3% in 112 of the 123 studied cases of later-round systems protecting earlier-round systems.

16. We disagree with OneWeb that a 3% degraded throughput threshold would disincentivize coordination, for three reasons. First, not all links considered in the SpaceX study meet this degraded throughput threshold. Additional links or different assumed parameters might also not meet the

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3% throughput degradation interference threshold by arguing that if 5 new entrants each caused 3% interference then the cumulative interference to an incumbent would be 15%. However, it provides no study to demonstrate such cumulative interference[.]").

[62] *See* Telesat Reply, Tech. Annex.

[63] Kuiper Reply at 8 ("These contortions make plain OneWeb's goal: to come up with some argument—any argument—to counter the 3% single-entry interference threshold[.]"); *see also* SpaceX Spectrum Sharing Study at S-10.

[64] OneWeb Oct. 3, 2024 *ex parte* at 13-14.

[65] *Id*. (listing victim power levels, tracking strategy, antenna patterns, power control method, interference from multiple interferers, or a carrier-to-noise threshold as determining factors on modeling for interference).

[66] *Id*. at Annex C, Eutelsat Group's Analysis, Replicating SpaceX Analysis Using Corrected Assumptions.

[67] *Id*. at 11.

[68] *See* ITU Radio Regulations No. 22.5L.

[69] *See, e.g.*, Kuiper July 24, 2024 *ex parte* at 4. To the extent OneWeb contends that the SpaceX study fails to accurately model OneWeb's system-specific details, *see* OneWeb Oct. 3, 2024 *ex parte* at 13-14, we note that individualized parameters will be considered in individual compatibility analyses. *See infra* para. 30.

threshold, and therefore the 3% degraded throughput threshold would incentivize coordination or require mitigation.[70] Second, this protection requirement is unilateral, and later-round systems will have an incentive to coordinate to receive some accommodation, or protection from interference, from earlier-round systems. And third, the 10-year sunset period ensures that earlier-round systems and later-round systems will be treated on an equal basis after the sunset, and any compatibility analyses will no longer permit the later-round system to operate in cases where it would exceed the default spectrum-splitting mechanism in section 25.261(c).[71]

17. In contrast, a criterion of 1% or lower has not been demonstrated to allow for competitive new entry by any study. We also find the technical basis for this criterion to be flawed. We agree with Telesat that OneWeb is incorrect in claiming that Note 3 of Recommendation ITU-R S. 2131-1 provides a 10% limit on time-weighted average degraded throughput for an FSS link employing adaptive coding and modulation (ACM).[72] In addition, the single-entry interference criterion proposed by OneWeb is based on an isolated scenario that does not represent the broad variation of throughput degradation that can occur due to rain fade.[73] Further, the single-entry throughput degradation values suggested by OneWeb are based on arbitrary assumptions.[74] And the idea conveyed by OneWeb that the allowable degradation from one interference source should simply be computed by considering the degradation allowance from all interference sources and then dividing by the number of interference sources is simply incorrect, because it does not take into account the manner in which ACM is implemented in modern satellite links.[75]

18. On the other hand, declining to adopt any specific long-term interference protection criterion could invite unnecessary and lengthy debates among later-round operators submitting compatibility analyses and earlier-round operators subject to those analyses with whom a coordination agreement has not yet been reached. Instead, we conclude that establishing a specific long-term interference protection metric, as technically supported on the record, will provide a clear benchmark for new entrants, around which parties may tailor any alternative long-term protections mutually agreed in coordination.[76]

[70] Indeed, OneWeb itself notes that the use of "system-specific details" in a compatibility analysis, rather than certain assumed parameters as in the SpaceX study, could show a greater impact on the incumbent system and therefore require coordination or mitigation in cases where a more generalized analysis would show compliance with the 3% metric. *See* OneWeb Oct. 3, 2024 *ex parte* at 13.

[71] 47 CFR § 25.261(c). We address below the claim that the interference metrics we adopt here provide less protection than the level at which operators in the same processing round must protect each other. *See infra* para. 37; OneWeb Oct. 3, 2024 *ex parte*, OneWeb Apr. 3, 2024 *ex parte*, Attachment B at 5.

[72] *See* OneWeb Comments, Tech. Annex at 3; *see* Telesat Reply, Tech. Annex at 1.

[73] Telesat Reply, Tech. Annex.

[74] *Id.*

[75] Telesat Reply, Tech. Annex ("Recommendation ITU-R S.2131-1, however, does not address a specific limit on the allowable time-weighted average degraded throughput (i.e., long term) for an FSS link employing ACM. Rather, the 10% reduction mentioned in Note 3 of that Recommendation addresses the reduction in throughput corresponding to a one dB reduction in C/N, during a one-second interval. (That is, the reduction in C/N of one dB forces a MODCOD change only after one second and during that one second the link would suffer from a reduction in throughput of about 10%, none of which has to do with long term degradation). This was a key assumption used when developing the equations contained in Recommendation ITU-R S.2131-1. The above-described misinterpretation alone negates OneWeb's conclusions.").

[76] We address the issue of aggregate interference in Section III.A.4.c. *infra*.

### 2. Short-Term Interference Metric

#### a. Relative vs. Absolute Increase in Unavailability

19. *Further Notice*. In addition to seeking comment on defining a long-term interference metric in the degraded throughput analysis, the *Further Notice* sought comment on setting a short-term interference metric expressed as a change in the earlier-round system's link unavailability time percentage.[77] The Commission invited comment on the appropriate value for this limit, including technical justification.[78]

20. *Comments*. On the issue of defining a short-term interference metric, commenters differed on whether to use a relative change in link unavailability, an absolute change in link unavailability, or both.[79] Ultimately, commenters on this issue support the use of an absolute metric; no commenter opposes use of an absolute metric or only supports use of a relative metric.[80] SpaceX, for example, explains that because next-generation satellite systems are designed to be resilient to signal degradation, these systems frequently maintain a high degree of link availability—typically in excess of 99%—despite varying environmental effects and interference from other NGSO systems.[81] This equates to a typical baseline unavailability of less than 1%, but with such levels of unavailability as the baseline, SpaceX states that very small changes in link performance can trigger "wild swings" in a relative unavailability metric, even if the absolute level of link availability remains close to its baseline value.[82] O3b and Intelsat each propose a formula to determine an absolute allowed increase in unavailability that changes with the baseline availability, reflecting concerns that a single value for increase in unavailability may not adequately protect high availability links.[83] OneWeb supports an absolute increase in

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[77] *Further Notice*, 38 FCC Rcd at 3718, para. 39. *See id*. at para. 40 (seeking comment on means to protect earlier-round systems from "potentially high levels of short term interference").

[78] *Id.* at 3718-19, para. 40.

[79] A relative change in link unavailability considers the baseline availability, while an absolute change in unavailability does not – for example, a 0.1% absolute change in link unavailability for a link with a baseline availability of 99.5% is equivalent to a relative change in unavailability of 20%.

[80] *See, e.g.*, SpaceX Comments at 4 ("[T]he absolute change in link availability provides a more accurate and reasonable metric for assessing inter-system interference between NGSO systems because it avoids two notable flaws of a relative unavailability metric. First, the absolute availability metric reframes short-term performance in terms of the time when highly efficient NGSO links are available, rather than the infrequent instances when such a link is unavailable. This framing is more representative of actual harm to NGSO system links that are resilient to interference. Second, the absolute availability metric expresses the actual numerical reduction in time when a system can maintain a link, rather than calculating relative percentage changes from an NGSO system's small unavailability baseline number."); SpaceX Comments at 4-5; SpaceX Reply at 3-5; Telesat Comments at 6-8; O3b Comments at 7; Intelsat Comments at 4; OneWeb Reply at 9-10; Kuiper July 24, 2024 *ex parte* at 7.

[81] SpaceX Comments at 2.

[82] SpaceX Comments at 2-3. Similarly, Intelsat states it "would be impractical due to the nature of NGSO operations" to use a relative unavailability metric that "could appear quite high while not significantly affecting the actual link availability." Intelsat Comments at 4. In the same vein, O3b states that "a comparatively large relative increase in unavailability may have only a negligible effect" on link performance, while an absolute metric "will provide more flexibility for new NGSO entry while still allowing operating NGSO systems to maintain acceptable service availability." O3b Comments at 7.

[83] O3b Aug. 22, 2024 *ex parte* at 2. SpaceX opposes O3b's formula as arbitrary and "designed solely and specifically to overprotect its 2016 processing round system." Letter from Jayson L. Cohen, Director, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456 at 1 (filed Sept. 30, 2024) (SpaceX Sept. 30, 2024 *ex parte*). SpaceX also notes that "O3b's submission makes no mention of its downlink operations whatsoever" and therefore O3b presents "no basis at all for its formula to apply to any links from space to Earth." *Id.* at 4. Telesat states that it "shares some of the concerns expressed by SpaceX" on O3b's formula and argues that "the granularity of the O3b proposal risks dragging the Commission into details that are

(continued….)

unavailability and supports O3b's proposal for a variable absolute increase in unavailability based on the service requirements of the link to cover a wider range of use cases.[84]

21. *Decision*. We agree with the general consensus among commenters on this issue. We conclude that the use of an absolute increase in link unavailability as the short-term interference metric provides a more reliable measure of short-term interference that is not as susceptible to significant fluctuations as a relative increase metric would be. We therefore adopt an absolute increase in link unavailability as the sole short-term interference metric required in an inter-round compatibility showing submitted by a later-round grantee. As discussed in greater detail below, we decline to adopt proposals for a formulaic approach for a variable absolute increase in unavailability in establishing a short-term interference metric.

**b. Value**

22. *Further Notice*. The *Further Notice* also invited specific comment on the appropriate value for the short-term interference metric, with accompanying technical justification.[85]

23. *Comments*. Commenters are divided on the appropriate value for the short-term protection criterion. OneWeb asserts that if the Commission adopts an absolute change in link unavailability as the short-term metric, the single-entry limit should be "substantially lower than" 0.01% to account for uses which may necessitate higher levels of availability, such as links designed to meet a 99.99% unavailability requirement.[86] Viasat claims that a 0.05% tolerable packet loss rate from all sources "is the minimum necessary requirement" and states that a smaller value, such as 0.01%, would provide a margin to allow for other sources of short-term packet loss.[87] Intelsat initially argued that further study would be required before determining protection criteria values,[88] although now supports an absolute metric based on a sliding-scale formula, similar to O3b's, for the short-term protection criterion.[89] Similarly, Telesat had also initially argued that no single short-term metric is appropriate for all links in all coordinations based on its own study,[90] but now agrees that the SpaceX proposal strikes the right balance in protecting incumbent NGSO systems while supporting the entry of new NGSO systems and supports the 0.4% metric.[91]

24. SpaceX argues that its study of several 2016 processing-round and 2020 processing-round systems using 123 dynamic (Monte Carlo) simulations establishes an "empirical zone of reasonableness" for the values of the absolute change in link availability.[92] The values in the SpaceX

(Continued from previous page)
more appropriately addressed in coordination." Telesat Oct. 2, 2024 *ex parte*. *See also* Letter from W. Ray Rutngamlug, Associate General Counsel, Intelsat US LLC, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456, Attachment B at 4 (filed Oct. 24, 2024) (Intelsat Oct. 24, 2024 *ex parte*) (proposing a modified version of O3b's formula, asserting that a sliding-scale approach will consider the availability requirements for different FSS links).

[84] OneWeb Oct. 3, 2024 *ex parte* at 9.

[85] *Further Notice*, 38 FCC Rcd at 3718-19, para. 40.

[86] OneWeb Reply at 9-10.

[87] Viasat Comments at 4. Kuiper retorts that OneWeb, O3b, and Viasat propose an "exceedingly low absolute threshold merely to protect incumbents" but that "absent in these proposals is any accounting for whether such a low threshold could actually allow new entry into the satellite arena." Kuiper July 24, 2024 *ex parte* at 9.

[88] Intelsat Reply at 4.

[89] Intelsat Oct. 24, 2024 *ex parte*, Attachment B at 2-4.

[90] Telesat July 5, 2024 *ex parte* at 3, Annex.

[91] Telesat Oct. 22, 2024 *ex parte*.

[92] SpaceX Spectrum Sharing Study at S-6.

study range from 0% to 0.382% at a carrier-to-noise (C/N) threshold of 0 dB, and SpaceX states that the upper end of this range is appropriate for both uplink and downlink.[93] SpaceX therefore contends that its study provides empirical support for short-term interference up to approximately 0.4% absolute change in link availability at a C/N threshold of 0 dB.[94] SpaceX further argues that its conservative use of a C/N threshold of 0 dB to assess changes in link availability further supports allowing short-term interference up to 0.4% absolute change.[95] SpaceX suggests that setting such a value will incentivize a later-round system to try to limit inline events to an earlier-round system toward achieving this level of short-term interference or if it cannot, to coordinate with the earlier-round system to more efficiently use the shared spectrum.[96] Telesat supports the proposed SpaceX approach, noting that it is the only approach that encourages coordination amongst operators by establishing a backstop value to protect incumbent operators while also supporting good faith coordination and promoting competition.[97]

25. Kuiper supports the proposed SpaceX 0.4% absolute increase in unavailability metric as well. Kuiper initially proposed the Commission adopt a 0.1% absolute increase in link unavailability as a threshold for short-term interference, which Kuiper argued would offer sufficient room for new entrants to bring their systems into operation, even in drier climates, while being highly protective to incumbents.[98] Kuiper now urges the Commission to adopt an absolute threshold in the range of 0.1% to 0.4% for short-term protection as proposed by Kuiper and SpaceX, respectively, arguing that this would incentivize both new entrants and incumbents to negotiate in good faith while minimizing impacts on vulnerable links and operations in both systems.[99] Kuiper also explains that arguments claiming that a short-term threshold in this range would discourage coordination between incumbents and new entrants ignore the realities of coordination, which occurs when both parties are incentivized to negotiate a more mutually beneficial outcome than an alternative compatibility showing scenario.[100] Kuiper notes that even with interference thresholds tilted in favor of new entrants, rather than with a more balanced approach as proposed by Kuiper and SpaceX, new entrants would retain these incentives and continue to coordinate with incumbents.[101] Regarding incumbents, Kuiper argues that while incumbents have incentives to minimize potential impacts of new entrants, an overly protective short-term threshold, like the O3b proposed formula, would incentivize incumbents to make unreasonable coordination demands and leverage those protections against new competition.[102]

26. O3b proposes the Commission use a formula, rather than a fixed percentage value, to determine the allowed increase in unavailability of an earlier-round system link. O3b proposes that the permitted increase in unavailability = -0.12 * baseline availability + 12.02.[103] O3b argues that its formula

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[93] *Id.*

[94] *Id. See also* Kuiper July 24, 2024 *ex parte* at 9 (stating "SpaceX's justification for a higher [0.4%] threshold has merit").

[95] *Id.*

[96] *Id.*; *see also id.* ("The zone of reasonableness found empirically, allowing up to 0.4% absolute change in link availability, also validates the principle that a well-designed, efficient earlier-round NGSO system should be able to withstand and adapt to short-term interference disruptions caused by inline events — even if simulated values for the absolute change are up to 0.4% at a C/N threshold of 0 dB.").

[97] Telesat Oct. 22, 2024 *ex parte* at 2.

[98] Kuiper July 24, 2024 *ex parte* at 7-9.

[99] *See id*. at 8-9; *see also* Kuiper Oct. 18, 2024 *ex parte* at 2-3.

[100] Kuiper Oct. 18, 2024 *ex parte* at 3.

[101] *Id*.

[102] *Id*.

[103] O3b Aug. 22, 2024 *ex parte* at 2.

appropriately adjusts protection levels to service requirements and reflects a broad range of technical characteristics and protection requirements.[104] OneWeb agrees and argues the SpaceX proposal would eliminate later round systems' incentive to coordinate, unacceptably undermine established operators' service quality, render it impossible for operators to guarantee a defined quality of service to their customers, and subvert the purpose of the processing round framework.[105] OneWeb further asserts that a 0.4% absolute increase is "overly-relaxed" and risks undermining U.S. credibility as a stable investment environment and deterring international coordination with U.S. systems.[106] Intelsat supports O3b's proposed formula approach and proposes the Commission adopt a slightly modified version of the formula, increasing the minimum unavailability degradation value.[107] Intelsat proposes that the permitted increase in unavailability = -0.12 * baseline availability + 12.05, modifying the minimum unavailability degradation factor from 12.02 to 12.05 which Intelsat argues allows for flexibility regarding the percent of link unavailability for high availability links.[108] OneWeb also supports adopting O3b's proposed formula, should the Commission decline to issue a further notice and comment.[109] SpaceX and Kuiper oppose this approach, arguing that O3b's formula is overly protective of earlier-round systems and would incentivize those incumbents to leverage strict limitations on later-round systems, thus discouraging market entry and innovation and leading to inefficient spectrum sharing.[110] Telesat also raises concerns, flagging that the O3b formula has not been previously considered by the Commission or "related forums such as the ITU" and involves granular details that are better addressed in coordination between parties than by the Commission.[111]

27. In the alternative, O3b and OneWeb suggest the Commission seek further comment on an appropriate short-term interference criterion and each of the corresponding proposals through a second further notice of proposed rulemaking.[112] O3b argues that the SpaceX and Kuiper proposals are both untimely and warrant additional inquiry.[113] SpaceX and Kuiper argue that the record is complete with

[104] *Id.* at 2-5.

[105] Letter from Kimberly M. Baum, Vice President, WorldVu Satellites Limited, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456, at 2 (filed Oct. 15, 2024) (OneWeb Oct. 15, 2024 *ex parte*) (arguing "established systems would be better off after the sunset than before it" because "O3b calculates that for a variety of its links, the maximum allowed level of interference without triggering spectrum sharing under Section 25.261[(c)] corresponds to an absolute reduction in availability to O3b of 0.01% to 0.04%[.]").

[106] Letter from Kimberly M. Baum, Vice President, WorldVu Satellites Limited, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456 at 1 (filed Oct. 31, 2024) (OneWeb Oct. 31, 2024 *ex parte*).

[107] Intelsat Oct. 18, 2024 *ex parte*, Attachment B at 4.

[108] *Id*.

[109] OneWeb Oct. 3, 2024 *ex parte* at 7-11; OneWeb Oct. 23, 2024 *ex parte*, Attachment B at 3.

[110] *See, e.g.*, Letter from Jayson L. Cohen, Director, Space Exploration Technologies Corp., to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456 at 2-3 (filed Oct. 24, 2024) (SpaceX Oct. 24, 2024 *ex parte*); Kuiper Oct. 18, 2024 *ex parte* at 3.

[111] Telesat Oct. 2, 2024 *ex parte* at 1.

[112] Letter from Suzanne Malloy, Vice President, O3b Limited, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456 at 1 (filed Oct. 9, 2024) (O3b Oct. 9, 2024 *ex parte*); OneWeb Oct. 15, 2024 *ex parte*, Attachment at 4; OneWeb Oct. 23, 2024 *ex parte*, Attachment B at 3; Letter from Suzanne Malloy, Vice President, O3b Limited, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456 at 2 (filed Oct. 29, 2024) (O3b Oct. 29, 2024 *ex parte*)(asking the Commission to seek comment on all four short-term interference metric proposals (O3b, Intelsat, SpaceX, and Kuiper) to develop a full record). *See also* Letter from Garrett Hill, Chief Executive Officer, X2nSat, Inc., to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456 (filed Nov. 5, 2024), at 1 (X2nSat *ex parte*); Letter from Alison Minea, Vice President, Regulatory Affairs, Hughes Network Systems, LLC, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456 (filed Nov. 1, 2024), at 2 (Hughes *ex parte*).

[113] *See* O3b Oct. 9, 2024 *ex parte*, at 1.

detailed analyses, and demonstrates that parties have moved toward a consensus on values and methodology, and encourage the Commission to move forward with a final order.[114] Telesat agrees, finding that the record is sufficiently complete to allow the Commission to finalize the rules for spectrum sharing and arguing that further delay will not lead to better rules, but rather, foster lingering uncertainty as to the framework in which NGSO operators coordinate their activities.[115] Telesat additionally notes that the record demonstrates that there may never be a perfect formula that optimally addresses all possible NGSO system interactions which all parties agree upon, given the nature of the complex analyses and systems involved in developing specific metrics, and thus the Commission is justified in moving forward with a final order.[116]

28. *Decision*. After review of the record, we adopt a 0.4% absolute increase in link unavailability at a C/N threshold of 0 dB as the short-term interference metric to be used in inter-round compatibility analyses. For the reasons discussed below, we conclude that this 0.4% value, more so than the 0.1% value, 0.01% or less values, or the formulas proposed by O3b or Intelsat on the record, most closely aligns with the Commission's goals of providing regulatory certainty for and ensuring adequate protection of earlier-round incumbents while offering the best opportunities for later-round new entrants and competition and encouraging coordination.

29. First, we find that this criterion will adequately protect earlier-round NGSO FSS systems. Like the long-term interference metric adopted above, this short-term interference metric will limit the increase in link unavailability at any analyzed location. Since the worst-case locations will likely drive operators' determinations of appropriate system parameters and any mitigation measures, the actual increase in unavailability will be less than 0.4% in many circumstances.[117] In addition, our use of a C/N threshold of 0 dB to assess changes in link availability is at the upper end of the -3 dB to 0 dB range for C/N thresholds supported on the record for compatibility analyses, and renders the 0.4% value more conservative.[118] Because the C/N threshold is intended to reflect the minimum carrier received signal, relative to noise, necessary to maintain a link, real values for the C/N threshold may be closer to -2 dB or -3 dB.[119] At these lower C/N thresholds, the absolute change in link availability is typically lower than at the 0 dB threshold.[120] Thus, using a 0 dB C/N threshold may overestimate the interference from a later-round system to an earlier-round system's link whose actual C/N threshold is lower. We further conclude this value will be sufficiently protective of earlier-round systems because of the decisions below to use simplifying assumptions in the analysis—such as modeling 50% or 100% deployment of an incumbent system even if it has not yet deployed in those numbers, or using an assumed satellite selection strategy when the actual satellite selection strategy is not provided by the incumbent—that may also tend to overestimate the actual interference caused to an incumbent system by the later round system.[121] These simplifying assumptions in the analysis itself tend to offer incumbents more protection. Therefore, we

[114] *See* Kuiper Oct. 18, 2024 *ex parte* at 5 (stating that "[w]ith a record of over 150 filings compiled over four years, there is little risk of a rush to judgment."); *see also* SpaceX Oct. 22, 2024 *ex parte* (asking the Commission to reject O3b's "11th-Hour efforts" and "complicated last-second proposal for a protection formula that would gut four years of Commission-led efforts to arrive at fair, sensible spectrum sharing rules.").

[115] Telesat Oct. 22, 2024 *ex parte* at 1-2.

[116] *Id*. at 2.

[117] *See* SpaceX Oct. 23, 2024 *ex parte* at 2 ("[U]nder this typical coordination process, all other interfered-with links everywhere will be protected to a much greater degree than the proposed 0.4% backstop value because the interferer system will have to employ operating parameters that protect the most vulnerable links.").

[118] *See* discussion of C/N objectives in Section III.A.4.b. *infra*.

[119] SpaceX Spectrum Sharing Study at S-6.

[120] *Id.*

[121] *See* Sections III.A.5., III.A.7., III.A.9 *infra*.

consider the totality of the analysis when deciding upon the likely real-world interference caused by a later-round system satisfying the 0.4% absolute increase in link unavailability metric at a C/N threshold of 0 dB.

30. Second, we conclude that adopting a 0.4% absolute increase in unavailability metric will simultaneously support competitive new entry because it will accommodate several modeled second-round systems, both uplinks and downlinks, per the 123 dynamic (Monte Carlo) simulations in the SpaceX study, which we note are a better representation of the dynamic nature of NGSO systems than a static analysis would reflect.[122] Further, we have reviewed the SpaceX study and find that the data, assumptions, and methodology employed are reasonable for purposes of adopting a 0.4% short-term interference metric to be used in inter-round compatibility analyses.[123] To be sure, O3b argues that the study is too limited in the operating metrics considered and is accordingly not reflective of real-world parameters.[124] Such individualized parameters will be considered in individual compatibility analyses.[125] In the event that other system combinations, or the use of different assumed parameters, result in exceedances of this short-term limit, this will require mitigation measures to be applied by the later-round operator or coordination with earlier round operators.[126]

31. Third, we conclude that adopting this short-term protection value will support competitive new entry while continuing to encourage good-faith coordination among both incumbents and new entrants, which offers the best avenue for efficient spectrum sharing among NGSO FSS systems. Unlike the requirement for later-round systems to protect earlier-round systems under the inter-round protection requirement prior to the sunset period, incumbents have no corresponding requirement to protect new entrants during this period, and therefore an overly conservative protection requirement for the benefit of incumbents may discourage incumbents from negotiating more lenient limits for new entrants. On the other hand, permitting new entrants to operate with an overly lenient limit may discourage them from negotiating with incumbents for more restrictive protections for the benefit of incumbents. The short-term interference metric we adopt here strikes the right balance to encourage coordination among earlier and later-round systems. We disagree with assertions that the 0.4% absolute increase will risk investment in U.S. systems by discouraging international systems from coordinating

[122] SpaceX Spectrum Sharing Study at S-6.

[123] Kuiper, which proposes a different 0.1% limit, nonetheless uses the SpaceX study as partial justification for its chosen interference limit and acknowledges that "SpaceX's justification for a higher [0.4%] threshold has merit." Kuiper July 24, 2024 *ex parte* at 9.

[124] *See, e.g.*, O3b Aug. 22, 2024 *ex parte* at 3, Attachment at 4 (arguing that O3b's analysis by comparison, considering the full range of antenna types and power levels as included in O3b's previous applications filed with the Commission, reflects significant variations from SpaceX's calculations); O3b Sept. 5, 2024 *ex parte,* Attachment at 4 (stating the SpaceX Study "considers for most systems only a single antenna size for GW and UT, along with a single power level for each – the maximum power requested" and that "SpaceX ignores the fact that O3b uses a broad range of antenna sizes and power levels, with a corresponding range of uplink baseline availability levels"); OneWeb Oct. 3, 2024 *ex parte* at 9.

[125] Thus, we reject O3B's assertion that "later round system could attempt to rely on SpaceX's interference calculations in lieu of making an actual compatibility showing reflecting real-world data." O3b Sept. 5, 2024 *ex parte*, Attachment at 7. Rather, in response to individual compatibility showings, first-round operators can challenge the assumptions and data used in such showings. *See* SpaceX Sept. 30, 2024 *ex parte* at 7-8 ("[N]othing in SpaceX's proposal prevents an earlier round system from opposing a compatibility study by using the type of analysis that O3b's submission suggests. In particular, under SpaceX's proposal, the Commission should expect oppositions that assume the earlier round system operates at power levels lower than its maximum levels while the later round system operates at its maximum power levels.").

[126] Thus, a 0.4% absolute increase in unavailability metric will not remove the incentive of later round systems to coordinate with earlier round systems. *See, e.g.*, O3b Aug. 22, 2024 *ex parte* at 6-8. *See also infra* para. 32 (discussing incentives of later round systems to coordinate).

with U.S. systems.[127] While it is unclear which specific circumstances are in reference, we remind both incumbents and new operators that coordination with the ITU is separate from coordination within the U.S. and is required of all international systems under the ITU Radio Regulations.[128] The Commission's rules require both parties to engage in good faith coordination. Providing an avenue for meaningful competition by both incumbents and new entrants will encourage both sides to agree upon any more specific, mutual protection measures during coordination.

32. We are not persuaded by alternative proposals. We disagree with the proposed 0.01% or lower threshold advocated by Viasat.[129] Unlike the 0.4% absolute increase in unavailability metric, which the SpaceX Monte Carlo study in the record indicates is achievable for several modeled second-round systems, there is no evidence in the record from proponents of a 0.01% or lower threshold showing that it is achievable and provides for competitive new entry. And while a 0.1% limit would accommodate most second-round system links analyzed in the SpaceX study, a 0.4% limit will provide greater opportunities for new entry while still providing adequate protection of incumbent systems due to the conservative assumptions incorporated into the standard and the calculation of increase in unavailability and at the same time providing incentives for good faith coordination. Stricter limits for particular links can, of course, be agreed in coordination. The SpaceX study indicates 0.4% to be the upper limit in the studied cases in both uplink and downlink, and accommodates user terminals and gateway earth stations.[130] Indeed, we note that Kuiper's initial study, which proposes the 0.1% limit, uses the SpaceX study as partial justification for its chosen interference limit and nonetheless acknowledges that "SpaceX's justification for a higher [0.4%] threshold has merit."[131] Further, Kuiper has since advocated for the Commission to adopt a threshold within the 0.1% and 0.4% range as proposed by Kuiper and SpaceX, respectively, noting that these proposals represent a reasonable range that balances competing interests and incentives.[132]

33. We also do not agree with O3b and Intelsat that their proposals to create a variable, sliding-scale metric for absolute increase in unavailability would better serve the Commission's goals than the adoption of a 0.4% absolute increase in link unavailability metric at a C/N threshold of 0 dB. As an initial matter, both the O3b and Intelsat formulae appear to be based on the protection of only a narrow

[127] *See* OneWeb Oct. 31, 2024 *ex parte* at 1 (arguing that a 0.4% metric risks "risks undermining U.S. credibility" and "raises concerns the international systems may similarly seek to avoid coordination with U.S. systems, leading to a less efficient spectrum sharing environment.").

[128] *See, e.g.*, *Space Norway AS, Petition for a Declaratory Ruling Granting Access to the U.S. Market for the Arctic Satellite Broadband Mission*, Order and Declaratory Ruling, 32 FCC Rcd 9649 at para. 6, n. 22, 24 (Nov. 3, 2017) (granting Space Norway system conditioned upon international coordination as a requirement of the grant, and stating, "Compliance with ITU coordination procedures is a requirement of the ITU Radio Regulations, which hold the force of treaty to which the United States is a party. Such compliance is a typical condition of both U.S. space station licenses and grants of U.S. market access." 47 CFR § 25.111(b) and ITU Radio Regulations, No. 9.12 (requiring coordination of certain NGSO Systems), No. 9.52 (requiring both parties in coordination to "make every possible mutual effort to overcome [coordination] difficulties, in a manner acceptable to the parties concerned"), No. 11.42 (requiring the immediate cessation of harmful interference actually caused to a recorded assignment with which coordination is required but has not been effected)."). *See also Space Exploration Holdings, LLC*, Memorandum Opinion, Order and Authorization, 33 FCC Rcd. 3391 at para. 8 (2018) (stating that "[o]utside the United States…the coexistence between SpaceX's operations and operations of a system that received a grant for access to the U.S. market are governed only by the ITU Radio Regulations as well as the regulations of the country where the earth station is located and are not subject to section 25.261.").

[129] Viasat Comments, Technical Annex at A-2.

[130] *See* SpaceX Spectrum Sharing Study at S-4, S-6.

[131] Kuiper July 24, 2024 *ex parte* at 9 ("[P]er SpaceX's recent study, short-term interference would be under that [0.1%] threshold in 114 out of 123 interference scenarios between new entrants and incumbents.").

[132] Kuiper Oct. 18, 2024 *ex parte* at 3.

set of systems.[133] In addition, we disagree with O3b's claim that the proposed formula would not impose additional complications on operators compared to an established absolute threshold value. Incorporating a variable, sliding-scale short-term interference metric would be more burdensome for later round systems to implement considering that detailed information of the incumbent system, including the receiver characteristics, would be required in order to calculate the baseline availability required by the sliding-scale formula. Absent cooperation from the operator of the incumbent system, it would be difficult to obtain this information, particularly for new entrants. We do not find the alleged benefits of this approach as compared to a non-variable metric outweigh these burdens. Given the conservative assumptions in the analysis itself, we are also concerned that O3b and Intelsat's more stringent formulae may unnecessarily restrict competitive new entry. O3b and Intelsat's principal objection to the use of a single 0.4% absolute value is that it would create a more noticeable impact on customers served by higher availability links than on those served by lower availability links.[134] However, it is precisely a concern about the overprotection of high availability links that has driven the general consensus on the record towards using an absolute metric of increase in unavailability, rather than a relative metric.

34. Moreover, O3b's assumed baseline availability rates of the incumbent system may be higher on paper than in reality, to the extent O3b excludes from the baseline the effects of other existing sources of interference, such as interference from GSO networks, other NGSO systems, and intra-system noise.[135] Accordingly, the relative impact on high availability links may be overstated. In addition, while O3b argues that a 0.4% absolute increase in unavailability metric would "make it impossible for operators to guarantee a defined quality of service to their customers" because of the additive effect of short-term interference from multiple later-round systems, the potential for aggregate interference is not limited to the use of this value and would exist under O3b's formula as well.[136] Further, just as we expect the real-world impact of a later-round system complying with the 0.4% increase in unavailability limit to be less than 0.4% in many cases, given the conservative assumptions in the analysis noted above, we similarly expect that any cumulative, real-world effects of two or more later-round systems will likely be less than a simple multiplication of the 0.4% limit by the number of later-round interferers that O3b assumes because it fails to account for mitigation techniques or other spectrum-sharing measures that may be applied by the NGSO FSS systems and reduce their overall aggregate impact.[137]

35. While O3b also argues that a 0.4% increase in unavailability limit would "eliminate later round systems' incentive to coordinate" because all links in the SpaceX study can be accommodated under this short-term limit,[138] other links or parameters not included in the SpaceX study, some of which

[133] *See* O3b Aug. 22, 2024 *ex parte* at 3-4; Intelsat Oct. 24, 2024 *ex parte*, Attachment B at 4.

[134] O3b Aug. 22, 2024 *ex parte* at 7 ("[Allowing] a single later round system to increase unavailability by 0.4% would add roughly 35 outage hours per year across the board. For a link with a baseline availability of 99.9%, that would mean a jump in yearly outage from less than 9 hours to 44 hours, multiplying the total outage duration by almost five, while a link with a baseline availability of 99.0% would see its yearly outage increase from 88 hours to 123 hours, multiplying the total outage duration by 1.4."); *see also* OneWeb Oct. 3, 2024 *ex parte* at 10 (arguing the Commission "should ensure that the [short-term] limit adequately protects links that require higher availabilities, such as gateways and enterprise use cases"); X2nSat *ex parte* at 1; Hughes *ex parte* at 2.

[135] *See* Section III.A.4. *infra*.

[136] O3b Aug. 22, 2024 *ex parte* at 7-8; *see also* OneWeb Oct. 3, 2024 *ex parte* at 9-10. We consider the adoption of aggregate interference limits in Section III.A.4.c *infra*.

[137] O3b Aug. 22, 2024 *ex parte* at at 8; *see also, e.g.,* comments on aggregate interference summarized in para. 52, *infra*; SpaceX Sept. 30, 2024 *ex parte* at 9 (arguing the Commission should "ignore O3b's claim that SpaceX's proposal will lead to a cumulative short-term interference effect that O3b has not demonstrated or provided empirical evidence would actually take place").

[138] *See also* OneWeb Oct. 3, 2024 *ex parte* at 7-8.

O3b points out,[139] might exceed the 0.4% short-term limit.[140] In any event, O3b itself notes that not all links in the SpaceX study meet the 3% degraded throughput long-term limit we adopt above. Cases where a later-round system cannot meet either the short-term or long-term limit will encourage the later-round operator to complete coordination with the incumbent operator. Later-round operators will also be incentivized to coordinate in order to potentially *receive* some protection, or accommodation, from earlier-round operators. Further, the 10-year sunset period we adopted in the *Report and Order* ensures that earlier-round systems and later-round systems will be treated on an equal basis after the sunset period, and any compatibility analyses will no longer permit the later-round system to operate in cases where it would exceed the default spectrum-splitting mechanism in section 25.261(c).[141] Accordingly, later-round system operators will have several incentives to complete coordination with earlier-round operators. Moreover, section 25.261(b) of the Commission's rules requires NGSO FSS licensees and market access recipients to coordinate in good faith the use of commonly authorized frequencies regardless of their processing round status.[142]

36. To the extent an incumbent wishes to ensure the highest availability for particular use cases, such as when offering its services to government or enterprise customers, it may discuss such particular uses during coordination with new entrants and new entrants will have several incentives to complete the coordination.[143] The Commission has expressly recognized that the physical realities of interference in spectrum-based services should guide both system design and reasonable expectations of operation.[144] The likelihood of harmful interference should be assessed under a range of operating conditions. Further, the Commission has encouraged operators, and specifically NGSO FSS operators,[145] to design systems for a shared and dynamic operating environment and plan to manage potential interference in such dynamic environments.[146] Operators providing important communications with 99.5% or greater service availability require systems equipped with redundancy to compensate for potential short-term impacts caused by inline events. The Commission has detailed best practices for satellite operator emergency planning and preparedness with specific recommendations to determine system resiliency and redundancy.[147] To the extent operators have concerns about protecting particular types of links operating in the non-federal FSS, such as those they may be offering to government or enterprise customers, such concerns are best addressed in coordination agreements rather than in a non-federal spectrum sharing framework.

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[139] *See also id.* at 9.

[140] *See* O3b Aug. 22, 2024 *ex parte* at 3, 6.

[141] We further note that international coordination procedures offer an additional incentive for later-filed NGSO FSS systems to complete coordination with incumbent systems. *See, e.g.*, ITU Radio Regulations No. 9.12.

[142] 47 CFR § 25.261(b).

[143] *See supra* para. 32; *see also* OneWeb Oct. 3, 2024 *ex parte* at 8-9.

[144] *Commission Policy Statement* at paras. 5, 17; *see, e.g.*, Kuiper Oct. 18 *ex parte* at 5 (asserting that interference is an "ever-present reality for the satellite industry using commonly shared spectrum and one that every operator must address.").

[145] *See Report and Order* at para. 31 ("The nature of NGSO FSS systems, which must be designed to endure changing environment effects, also renders them more capable of sharing spectrum than other system designs.").

[146] *Commission Policy Statement* at paras. 18, 27-28 ("It is not the policy of the Commission to always provide interference protection to the worst (i.e., least selective) performing receivers, particularly when it is technically feasible and practical, over an appropriate amount of time, for receivers to perform their required functions with significantly more interference immunity. Indeed, the ITU and EU RED also emphasize that receivers should, as far as practical, be based on the most recent technological advances.") (citations omitted).

[147] *See* Emergency Planning for Satellite Carriers, FCC, https://www.fcc.gov/reports-research/guides/emergency-planning-satellite-carriers.

37. In addition, we do not agree with O3b that a 0.4% value "subvert[s] the purpose of the processing round framework" because it is higher than the spectrum-splitting trigger, which O3b calculates for its system would be between 0.01% and 0.04% absolute increase in unavailability.[148] Although it is possible for a very small number of links of the earlier-round systems in which the ΔT/T of 6% (I/N of -12.2 dB) (the trigger for coordination among systems in the same processing round) may be exceeded, such exceedance would be limited in terms of the number of links affected and the length of time. We are not convinced that such short-term impact would be significant on the earlier round systems.[149] The short-term protection criteria we adopt here is a unilateral protection of earlier-round systems by later-round systems and does not require any reduction in spectrum usage or other operational changes by the earlier-round system. In contrast, exceeding the more sensitive trigger for spectrum-splitting in section 25.261(c) for systems approved in the same processing round creates a mutual obligation for both systems to split their commonly authorized frequencies for the duration of the potential interference event. Nevertheless, for links of an earlier-round system in which the ΔT/T is 6% or greater, later-round systems are required to coordinate with the earlier-round systems of these links prior to commencing operation.

38. We are further not persuaded by calls to seek comment on the short-term interference metric through a second further notice of proposed rulemaking.[150] The *Further Notice* sought comment on setting a short-term interference metric.[151] In response to the *Further Notice*, interested parties have had ample opportunity to comment on all proposals, as illustrated by their record submissions.[152] Adopting a specific limit for increase in unavailability, rather than adopting no limit or deferring the issue to a later time as some commenters advocate, will result in a more complete set of required interference metrics applicable to an inter-round compatibility analysis and therefore will provide greater regulatory certainty to earlier-round operators and later-round operators. Conversely, not adopting any specific acceptable short-term interference threshold or deferring the issue to a later time would deprive new entrants of the certainty that they can provide some level of service without the agreement of an earlier-round operator. The SpaceX study indicates 0.4% to be the upper limit in the studied cases in both uplink and downlink, and accommodates user terminals and gateway earth stations.[153] Stricter limits for particular links can, of course, be agreed in coordination.

39. Therefore, we conclude an absolute increase in unavailability value of 0.4% at a C/N threshold of 0 dB will appropriately balance the Commission's goals of providing regulatory certainty for, and adequate protection of, incumbent systems while at the same time ensuring competitive new entry and encouraging coordination among NGSO FSS operators.

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[148] *See* O3b Oct. 11, 2024 *ex parte* at 3.

[149] *See, e.g.*, Kuiper Oct. 18, 2024 *ex parte* at 5 ("Further, as SpaceX points out, every operator should expect to address the short-term interference caused by in-line events, and a well-designed system is robust to a variety of sources of reasonable interference.") (citing SpaceX Sept. 30, 2024 *ex parte* at 5 ("But an earlier round system like O3b's or SpaceX's Gen 1 system should be able to absorb a much higher short-term impact to its operations caused by inline events with a later round system.")).

[150] *See*, *e.g.*, O3b Oct. 18, 2024 *ex parte* at 1.

[151] *Further Notice*, 38 FCC Rcd at 3718, para. 39. *See id*. at para. 40 (seeking comment on means to protect earlier-round systems from "potentially high levels of short term interference").

[152] *See*, *e.g.*, O3b Oct. 18, 2024 *ex parte*; OneWeb Oct. 23, 2024 *ex parte*, Attach. B; SES Oct. 21, 2024 *ex parte* at 2; SpaceX Sept. 30, 2024 *ex parte*; Amazon Oct. 18, 2024 *ex parte*; Intelsat Oct.18, 2024 *ex parte*, Attachment B; Telesat Oct. 22, 2024 *ex parte*.

[153] *See* SpaceX Spectrum Sharing Study at S-4, S-6.

### 3. Minimum Link Availability

40. *Further Notice and Comments*. In conjunction with the Commission's consideration of long-term and short-term interference criteria,[154] SpaceX, on the basis of its study of several 2016 processing-round and 2020 processing-round systems, proposes that the Commission adopt a 99.0% link availability without the interferer at a C/N threshold of 0 dB as a minimum benchmark for an earlier-round system to show it merits the backstop levels of short-term and long-term interference protection from a later-round system that the Commission is considering.[155] SpaceX states this minimum benchmark indicates a well-designed, efficient earlier-round NGSO system with a robust signal-to-noise ratio and that all first-round links studied by SpaceX achieved this minimum benchmark, except one link at 98.7%.[156] Requiring a minimum 99.0% link availability, SpaceX argues, would prevent an incumbent whose publicly-available information shows its link achieves a 99.9% link availability at a C/N threshold of 0 dB, for example, from claiming that it can actually achieve only a 90% link availability at that threshold. Such a claim would tend to exaggerate the extent to which the earlier round system is susceptible to interference from every second-round system.[157] SpaceX also contends that a rule requiring a first-round system to show a 99.0% link availability without the interferer at a C/N threshold of 0 dB incentivizes efficient spectrum sharing through coordination, since "a first-round system that cannot achieve this minimum benchmark level of performance on a given link — indicating its inefficient use of spectrum — would have to coordinate with the second-round system to determine a more efficient spectrum sharing arrangement."[158] O3b, in proposing its increase in unavailability threshold formula, supports protection of links with baseline availabilities as low as 97%,[159] and argues the SpaceX proposal would unfairly provide no protection for links with lower baseline availability levels that meet the needs of customers with a higher interference tolerance.[160]

41. *Decision*. We agree with SpaceX that an inefficient incumbent system design should not unreasonably hamper future entry. Further, we have reviewed the SpaceX study[161] and find that the data, assumptions, and methodology employed are reasonable and note that, although O3b has commented that the study could be expanded upon using different system parameters, no commenter objects to the data, assumptions, or methodology SpaceX used. While O3b's formula shows protection of links with baseline availabilities as low as 97%, its formula inherently recognizes that lower performing links should receive less protection and does not specifically justify or technically support requiring protection of links below 99.0% availability. Rather, we concur with SpaceX that a 99.0% link availability without the interferer at a C/N threshold of 0 dB is a reasonable minimum benchmark to guard against the risk of low-performing incumbent links. We therefore will require this benchmark as a minimum value to be incorporated into an inter-round compatibility showing to demonstrate compliance with the long-term and short-term interference metrics adopted above.

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[154] *See Further Notice*, 38 FCC Rcd at 3718-19, paras. 39-40. For example, the Commission inquired as to what the "appropriate baseline to consider for the earlier-round system" should be and how the analysis should "appropriately" protect the specific characteristics of an NGSO system's operations. *Id.* at 3718, para. 40.

[155] SpaceX Spectrum Sharing Study at S-9.

[156] *Id.*

[157] *Id.*

[158] *Id.* at S-10.

[159] O3b Aug. 22, 2024 *ex parte* at 5.

[160] O3b Oct. 17, 2024 *ex parte* at 2.

[161] SpaceX Spectrum Sharing Study at S-9 to S-10.

### 4. Additional Interference Metrics

#### a. Loss of Synchronization

42. *Further Notice*. The *Further Notice* also asked whether additional means are needed to protect earlier-round systems against loss of synchronization due to potentially high levels of short-term interference.[162]

43. *Comments*. Most commenters on this issue oppose including additional criteria to protect against loss of synchronization.[163] Telesat argues that doing so is unnecessary because in modern satellite systems the concept of link unavailability also protects against the loss of synchronization as long as an appropriate C/N objective is chosen.[164] Kuiper states that including such a protection criteria would undermine incentives for a resilient design of modems and receivers and result in a less efficient spectrum sharing framework.[165] Kuiper additionally maintains that any issues an incumbent may have regarding synchronization loss is best addressed in good-faith coordination with new entrants.[166] Commenters also note that information on the particular modems used by incumbents, which is required to determine a protection criteria necessary to prevent loss of synchronization for a particular system, is not typically disclosed in domestic or international filings.[167] Kuiper suggests the appropriate way to address particularized interference concerns of a given incumbent is not through systematic changes to the methodology but instead through operator-to-operator coordination.[168]

44. Two commenters support requiring later-round operators to specifically protect against an incumbent's loss of synchronization, arguing that consideration of loss of synchronization does not render analyses overly complex,[169] and that when information has been shared pursuant to good-faith coordination, the consideration of these additional metrics is straightforward and can ensure protection of a variety of NGSO system designs and service characteristics.[170] OneWeb also argues the Commission should account for short-term degraded throughput events where an operator may experience high levels of degradation causing a modem to lose synchronization or suffer other critical errors.[171] OneWeb argues

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[162] *Further Notice*, 38 FCC Rcd at 3718-19, para. 40.

[163] Telesat Comments at 9; Kuiper Comments at 12; SpaceX Comments at 14; Mangata Reply at 7.

[164] Telesat Comments at 9-10; Telesat July 5, 2024 *ex parte* at 2.

[165] Kuiper Comments at 14; *see also id.* ("Designing a system that cannot handle link loss or loss of synchronization is no different from designing a system that is otherwise unduly susceptible to interference (for example, through the use of low-quality receivers that are overly susceptible to interference). Accounting for such inefficient designs incentivizes their further deployment and shifts the cost of such decisions from the incumbent decisionmaker to new entrants."); SpaceX Comments at 14 ("Efficient satellite systems should be capable of rapidly establishing synchronization at a modem following in-line interference events, and having more than one reference value would penalize those systems investing in advanced capabilities that enhance the consumer experience.").

[166] *See* Kuiper July 24, 2024 *ex parte* at 10 (arguing that including a loss of synchronization metric would effectively create a new protection criterion that would only serve to protect poorly designed systems); *see also* Kuiper Oct. 18, 2024 *ex parte* at 6 (noting that OneWeb admits that additional protection criteria are "best addressed in the context of coordination") (citing OneWeb Oct. 3, 2024 *ex parte* at 10).

[167] Kuiper Comments at 14; Mangata Reply at 7.

[168] Kuiper Comments at 14-15, n.30.

[169] OneWeb Reply at 11.

[170] *See* O3b Comments at 8; O3b Reply at 10-11; OneWeb Reply at 11.

[171] OneWeb Reply at 11; *see also* OneWeb Comments at 16. Kuiper specifically opposes OneWeb's proposal to add an additional metric for short-term degraded throughput. Kuiper Reply at 6 ("Any degraded throughput metric will average interference highs and lows that an NGSO system experiences over a given time period. NGSO operators already typically simulate interference into other NGSO systems at one-second time steps over a significant time period, thereby averaging results over hundreds of thousands or millions of interference events. Therefore,

(continued….)

that loss of synchronization should be a required metric in any compatibility showing to ensure that operators have a complete picture of the interference environment if operators cannot achieve a coordination agreement.[172]

45. *Decision*. We decline to mandate new entrants protect incumbent systems against loss of synchronization, or incorporate a short-term degraded throughput metric, beyond the protections afforded by the long-term and short-term interference protection criteria we adopt above. We agree with commenters who argue that doing so would risk incentivizing inefficient system designs, including the choices of modems and receivers that are not capable of quickly re-establishing synchronization in a shared spectrum environment. We also agree with Telesat that doing so is unnecessary because a limit on the increase in link unavailability also protects against the loss of synchronization.[173] In addition, requiring new entrants to meet such protection criteria that are defined solely by incumbents, to address particular interference sensitivities of incumbent systems, outside of protections mutually agreed in coordination, would create uncertainty for new entrants and could unduly restrain new entry and competition.

### b. Carrier-to-Noise Objectives

46. *Further Notice*. The *Further Notice* sought specific comment on whether an earlier-round operator should be able to specify two C/N objectives – one relative to the C/N level below which the victim modem would lose signal lock with the satellite and another relative to the C/N level below which the victim link would become unavailable because it is not able to offer the minimum wanted throughput.[174]

47. *Comments*. Several commenters on this issue support the Commission adopting a single minimum C/N objective relative to link unavailability, rather than include multiple C/N objectives such as one below which the victim modem would lose lock. SpaceX proposes the Commission adopt a reference C/N threshold between -3 dB and 0 dB, because this range accounts for both real modem performance and the modulation and coding rates of broadband satellite waveforms within a reasonable margin.[175] O3b suggests the Commission specify 0 dB as the standard C/N level to account for the threshold performance that efficient modems should be capable of achieving.[176] Noting that the commonly used adaptive coding and modulation (ACM) standard DVB-S2X can demodulate signals with C/N levels as low as -3 dB, Intelsat recommends the required minimum C/N value should align with ACM standards and should accurately reflect the earlier NGSO system's requirements.[177]

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OneWeb's proposal, merely reducing the overall time period that interference is assessed to craft a separate metric, should only slightly vary the results, with no discernible spectrum sharing aim. To the extent that an NGSO system cannot accommodate these minor changes in long-term interference over different time horizons, this is a system inefficiency to address individually, not a spectrum sharing issue to foist on other NGSO operators.").

[172] OneWeb Oct. 23, 2024 *ex parte*, Attachment B at 5 (noting that "metrics like loss of synchronization, short-term degraded throughput, and fast changes in interference can all have significant impacts on the interference environment").

[173] Telesat Comments at 9-10.

[174] *Further Notice*, 38 FCC Rcd at 3718-19, para. 40.

[175] SpaceX Comments at 13-14; SpaceX Reply at 19.

[176] O3b Comments at 7.

[177] Intelsat Comments at 9. Intelsat observes that all known NGSO systems implement ACM techniques, which allow dynamic changes to account for link degradations from rain fade, interference, or other impairments while maximizing throughput. *Id.* Intelsat also notes that the minimum C/N required can vary significantly depending on the ACM technology implemented in an NGSO system, as well as between forward and return links. *Id.*

48. Several commenters also oppose allowing an incumbent to specify an additional C/N level below which its modem would lose lock, because doing so could invite gamesmanship,[178] or otherwise require information on all of the potential modems and receivers used by the incumbent system, details of which are not typically available through publicly available filings.[179] Kuiper argues that accounting for this factor in interference analyses could undermine incentives for a resilient design of modems and receivers, whereas rejecting proposals to account for link loss will require operators that choose designs ill-suited for a shared-spectrum environment to "internalize the costs of their decisions."[180]

49. O3b, however, argues the Commission should allow an earlier-round operator to justify a system-specific alternative minimum C/N threshold by identifying, subject to reasonable explanation and support, the required C/N level needed to maintain link usability.[181] O3b argues these C/N values would typically be incorporated into coordination discussions, so later-round systems should be aware of the earlier-authorized operators' protection requirements.[182]

50. *Decision*. We agree with the general consensus on the record that reference C/N threshold values of between -3 dB and 0 dB are appropriate to account for the performance of efficient, modern modems and receivers. We will adopt a C/N value of 0 dB that must be used in a compatibility showing with an earlier-round system as proposed by O3b and within the ranges supported by SpaceX and Intelsat as it reflects a reasonable, upper-limit for modern NGSO systems. We also conclude that allowing an incumbent to specify an additional C/N level below which the victim modem would lose lock, if it is more sensitive than this range, could reward inefficient system designs at the expense of more competitive new entry. We therefore decline O3b's proposal to require later-round grantees to demonstrate they will meet any alternative incumbent-specified C/N level needed to maintain lock. Nonetheless, operators in coordination will be free to discuss and agree upon the use of other C/N levels when concluding a coordination agreement that leaves both parties better off than would operating under any submitted compatibility showing.

### c. Aggregate Interference

51. *Further Notice*. The *Further Notice* also noted concerns about aggregate interference from multiple NGSO systems.[183] The Commission invited comment on whether to set a limit on permissible aggregate interference from later-round systems into earlier-round systems.[184] The Commission also asked whether we should expect that there will be a maximum number of NGSO FSS systems that can be accommodated in a given frequency band and if so, how that should affect any inter-round protection criteria and the opening of additional processing rounds.[185] Finally, the Commission inquired as to how the degraded throughput methodology should accommodate multiple NGSO systems that span multiple processing rounds.[186]

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[178] SpaceX Comments at 19; Intelsat Comments at 9.

[179] Kuiper Comments at 14; Mangata Reply at 7. Telesat also supports use of a single minimum C/N objective. Telesat Reply at 5.

[180] Kuiper Comments at 14.

[181] O3b Comments at 7; O3b Reply at 9.

[182] O3b Reply at 9.

[183] *Further Notice*, 38 FCC Rcd at 3719, para. 41.

[184] *Id.*

[185] *Id.*

[186] *Id.*

52. *Comments*. Most commenters on the issue of aggregate interference limits oppose them as unworkable and unnecessary.[187] Commenters argue that setting aggregate interference limits is unnecessary for several reasons. As an initial matter, Mangata argues that the primary concern with respect to interference between NGSO systems is the occurrence of inline interference events, and the probability of an inline event involving multiple NGSO systems, with all the varying constellation designs and the resulting look angles, is very low.[188] As such, Mangata contends that per-system limits established in this proceeding will be sufficient to mitigate any such concerns.[189] Second, commenters argue that both advances in technology and the use of increasingly higher-frequency bands should make it possible for more operators to coexist within a band than is otherwise possible today.[190] Third, commenters argue that required coordination or spectrum-splitting among later-round operators should further reduce the expected aggregate interference.[191]

53. Commenters also argue there is no demonstrated need on the record to adopt aggregate interference threshold for now.[192] Kuiper notes that, given the long deployment timelines of NGSO FSS systems, such aggregate interference would not manifest for years—giving the Commission ample time to address this issue should it actually arise.[193] Some commenters therefore recommend the Commission defer consideration of aggregate interference levels for protecting earlier round systems until there is more real-world data that can be evaluated to determine the effect of aggregate interference on individual system operations.[194]

54. Commenters further state that numerous implementation questions remain unsettled which would also make it difficult to enforce aggregate interference criteria,[195] and this uncertainty raises the question of whether and how the Commission would administer an aggregate framework for NGSO sharing when the number of potential systems is perpetually in flux.[196] Indeed, commenters state there is currently no known basis for any later-round applicant even to measure aggregate interference that might result from the combined operations of multiple systems.[197]

55. Commenters also dispute that establishing aggregate interference limits is a prerequisite to establishing per-system limits, and further dispute that per-system limits should be derived by simply dividing the aggregate limit among the number of later-round systems, because doing so assumes that

[187] Kuiper Comments at 19-21; Intelsat Comments at 12-13; Telesat Comments at 11; SpaceX Reply at 7-8; Mangata Reply at 8-9; *see also generally* Kepler Comments at 2 (arguing that prior to establishing an acceptable aggregate interference threshold, further studies should be carried to mitigate the potential of any future risks).

[188] Mangata Reply at 8.

[189] *Id.*

[190] SpaceX Reply at 7; *see also* Intelsat Comments at 12, n.28 (arguing there is "a theoretical limit on the number of NGSO systems that can share a band given that orbital resources are not infinite" but that "[t]his limit is contingent on standards and technology (both of which evolve over time) and, most importantly, information sharing between NGSO operators"); Intelsat Reply at 6 ("Adopting a[n aggregate interference] cap now presumes there will be no further technological development to enhance spectrum sharing.").

[191] Kuiper Comments at 18; Intelsat Reply at 16; Kuiper July 24, 2024 *ex parte* at 11.

[192] Intelsat Reply at 6; *see also* Telesat Comments at 11; Telesat Reply at 9; Kuiper Comments at 18-19.

[193] Kuiper Comments at 16-17; Kuiper July 24, 2024 *ex parte* at 11.

[194] Telesat Comments at 11; Telesat Reply at 9; Intelsat Reply at 6; Kuiper Comments at 18-19.

[195] *See, e.g.*, Kuiper Comments at 20-21 and n.44; Kuiper Reply at 11.

[196] SpaceX Reply at 8; Intelsat Reply at 6.

[197] Telesat Reply at 9; Kuiper Comments at 20-21.

each system contributes equally to aggregate interference.[198] They argue such an assumption "defies reality" and "would significantly overstate actual interference"[199] because "cumulative interference could only result where multiple satellites communicate with earth stations at the same location, with the same frequency, and at the same time."[200] Commenters further note that some authorized systems may not deploy.[201]

56. Commenters also raise concerns with adopting an aggregate interference limit in the context of the Commission's licensing regime for NGSO FSS systems. SpaceX argues the Commission cannot adopt an aggregate interference cap under its current processing round framework because the number of NGSO systems that will deploy in a given processing round and spectrum band is uncertain and highly variable.[202] Kuiper contends that, given the Commission has adopted a framework designed to promote coordination and efficient coexistence, it would be irrational to adopt an aggregate limit on the assumption that parties neither coordinate nor take measures to efficiently share spectrum.[203] Kuiper also suggests that the same arguments raised in favor of an aggregate cap on interference could be made to cap the number of applicants in a single processing round, where more applicants in a processing round can mean reduced spectrum access for any given licensee required to share spectrum on equal terms with contemporaneously licensed systems.[204] Intelsat warns that adopting an aggregate interference cap would be an end-run around the purposes of the sunset framework the Commission just adopted, which are to promote competition and to encourage NGSO operators to innovate and use spectrum more efficiently.[205]

57. Importantly, SpaceX warns that "an aggregate cap on interference would involve arbitrary line-drawing that risks stifling new NGSO system entry,"[206] and numerous other commenters make similar statements.[207] Instead, these commenters argue that NGSO systems can account for the total interference environment within their private negotiations, and that the Commission has determined in other contexts that operators themselves could account for aggregate interference concerns as a part of good-faith coordination.[208]

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[198] Telesat Reply at 8-9.

[199] *Id.*

[200] Kuiper Comments at 17-18.

[201] Intelsat Reply at 6; Kuiper Comments at 16 (stating "later-licensed NGSO systems may never deploy in the numbers and manner necessary to cause an unmanageable level of aggregate interference").

[202] SpaceX Reply at 7.

[203] Kuiper Comments at 18.

[204] *Id*. at 20.

[205] Intelsat Comments at 12-13.

[206] SpaceX Reply at 7.

[207] *See, e.g.,* Mangata Reply at ("An aggregate limit among all NGSO systems is both unnecessary and serves only to limit the total actual or theoretical competitors in the market, which is contrary to the Commission's goals of promoting robust competition."); Telesat Reply at 8 (arguing that "imposing an aggregate limit at this time, when information is limited, coupled with an arbitrary form of allocation, as suggested by its proponents, could place unnecessary restrictions on later-round applicants"); Intelsat Reply at 6 ("Adopting a cap now for a currently hypothetical problem would only stymie innovation and competition."); Kuiper Comments at 19 ("[T]he prospect of unmanageable aggregate interference caused by later-licensed NGSO FSS systems is both remote and hypothetical. At the same time, the effect of an aggregate limit on competition and innovation from new systems would be immediate and profound."); *see also* Kuiper Reply at 10-11; Kepler Comments at 2.

[208] *See, e.g.,* Kuiper Comments at 18 (citing *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services et al.*, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014, paras. 293-95 (2016); *Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands*, Report and Order, 29 FCC Rcd 4610, para. 92 (2014); and *Amendment of Part*

(continued….)

58. A minority of commenters do express support for the adoption of aggregate interference limits. OneWeb argues the establishment of aggregate limits on interference into NGSO FSS systems is a prerequisite to establishing per-system limits,[209] and that failing to adopt aggregate limits could result in more systems being authorized than can reasonably be accommodated.[210] OneWeb suggests the Commission could accept operators in an initial processing round "up to" the established aggregate limit and, once those systems deploy, or fail to do so, the Commission could determine the number of additional systems that can be supported in later processing rounds.[211] Considering degradation due to rain fade and other sources of interference, OneWeb argues that an aggregate limit of 2.5% to 3.85% time-weighted average degraded throughput should be given to all NGSO FSS systems.[212]

59. Viasat suggests the Commission develop aggregate interference limits by defining the total amount of interference that any individual NGSO system should be expected to tolerate, then allocating this amount between different NGSO FSS systems and processing rounds, while ensuring adequate opportunities for additional market entry.[213] Viasat argues an acceptable aggregate interference limit, including all interference sources (NGSO, GSO, and terrestrial), would be less than 0.05%.[214] ViaSat notes that aggregate interference limits on NGSO FSS systems have been adopted to protect GSO networks, though there remains no mechanism for allocating the overall interference budget between different NGSO operators.[215]

60. ITIF suggests the Commission could apply an aggregate limit to later-round systems, which would be divided equally among the later-round systems that actually deploy.[216] TechFreedom also argues the Commission should consider how many NGSO systems a given frequency band support, but states it is premature to do so based on the current record.[217]

61. *Decision*. We decline to adopt limits on aggregate interference into an NGSO FSS system. First, there has been no demonstration of a need for such limits at this time. No second-round system is required to deploy its full constellation until 2029 at the earliest.[218] Indeed, some proposed

(Continued from previous page)
*101 of the Commission's Rules to Modify Antenna Requirements for the 10.7–11.7 GHz Band et al.*, Report and Order, 22 FCC Rcd 17153, paras. 48-49 (2007)); Kuiper Reply at 10; SpaceX Reply at 7; *see also* Intelsat Comments at 12; Intelsat Reply at 6 (arguing aggregate "[i]nterference risks can be minimized through good-faith coordination and information sharing among NGSO operators, as well as through the default band-splitting requirement.").

[209] *See* OneWeb Comments at 9.

[210] *Id*. at 10.

[211] OneWeb Reply at 4-5.

[212] *Id.* at 8, n.28.

[213] Viasat Comments at 6. Viasat states that it is ""not advocating an *ex ante* cap on the number of NGSO systems that can be authorized in a particular spectrum band" and that "[t]o the contrary, any aggregate limit should be designed and implemented to try to avoid creating any *de facto* cap of this nature." *Id.* at n.9.

[214] *Id.* at 4.

[215] *Id.*; *see also* OneWeb Comments at 10-11.

[216] ITIF Comments at 4. Kuiper characterizes this proposal as "replacing an aggregate limit with a variable single-entry limit that would be reduced as each later-round system became operational." Kuiper Reply at 11.

[217] *See* TechFreedom Comments at 2-3, 6.

[218] Kuiper and SpaceX have been granted NGSO FSS system licenses in the second Ku-/Ka-band processing round. *Kuiper Systems, LLC Application for Authority to Deploy and Operate a Ka-band Non-Geostationary Satellite Orbit System*, Order and Authorization, 35 FCC Rcd 8324 (2020); *Space Exploration Holdings, LLC Request for Orbital Deployment and Operating Authority for the SpaceX Gen2 NGSO Satellite System*, Order and Authorization, 37 FCC Rcd 14882 (2022).

systems may never deploy their authorized number of satellites, or deploy any satellites at all. Even if we felt it appropriate to adopt aggregate interference limits from later-round systems at this time, we agree with Kuiper, among others, that unresolved questions remain as to the derivation of any aggregate limits.[219] We also disagree with OneWeb that a simplistic, worst-case assumption of multiplying the single-entry limit by six operational NGSO FSS systems reflects a realistic assessment of the interference environment because it fails to account for mitigation techniques or other spectrum-sharing measures that may be applied by the NGSO FSS systems and reduce their overall aggregate impact.[220] Nor do we agree with OneWeb that the Commission should adopt aggregate interference limits to prevent "more operators being granted authorizations to operate in a given band than can reasonably be accommodated."[221] Our experience has shown that not all authorized systems deploy their fully planned constellations, if they deploy at all. The recent generation of NGSO FSS systems has shown to be iterative in nature, with companies filing for systems in the first and second processing rounds, and using techniques like adaptive coding and modulation to adapt to changing spectrum environments. Blocking new entry while we wait and see which NGSO FSS systems will deploy, out of a fear of future aggregate interference that may never arise, would artificially and unreasonably inhibit competition to the benefit of some incumbents but contrary to the public interest. Should a demonstrated need arise in the future, we may revisit the question of aggregate limits. And, of course, operators are free to discuss and agree upon ways to account for any aggregate interference effects during their good-faith coordination discussions.

#### 5. Other Sources of Interference in Baseline

62. *Further Notice*. The *Further Notice* invited specific comment on how to determine the appropriate baseline for the earlier-round system, and whether it should include existing sources of interference, such as interference from GSO networks or intra-system interference.[222] The Commission also inquired whether a degraded throughput methodology should compare an incumbent's baseline level of performance given only natural degradation to that same incumbent's expected performance given only a single new entrant's operations, or whether the comparison should include the operations of multiple new entrants.[223]

##### a. GSO Interference

63. *Comments*. Most commenters on this issue oppose including GSO interference in the baseline calculation. Commenters argue that including additional degradations in the baseline from interference due to GSO networks could overly complicate the analysis because there is no standardized model for such interference[224] and no clear way to impute such interference across all systems given the different approaches NGSO systems employ to address GSO interference.[225] Commenters also note that the Commission has set aside certain portions of the Ka-band in which GSO networks must protect

[219] *See, e.g.,* Kuiper Comments at 20.

[220] *See* OneWeb Comments at 3.

[221] OneWeb Comments at 10.

[222] *Further Notice*, 38 FCC Rcd at 3718-19, para. 40.

[223] *Id.*

[224] Telesat Comments at 9-10; Kuiper Comments at 9, n.18; Mangata Reply at 9.

[225] Kuiper Comments at 9 n.18; Mangata Reply at 9; *see also* SpaceX Reply at 17 (arguing that the potential for interference will also largely vary by frequency band and operating location, where a select number of GSO satellites with CONUS coverage may be irrelevant due to link geometries and frequency diversity). Both Telesat and Kuiper point to ITU models such as Recommendation ITU-R P.618 to establish the baseline calculation. *See* Telesat Comments at 9; Kuiper Comments at 11-14.

NGSO systems,[226] and argue that "[e]xisting NGSO operators should not be penalized for being subject to interference from secondary GSO networks."[227]

64. Intelsat, however, supports including GSO interference in the baseline calculation. Intelsat argues that failing to account for all noise sources that contribute to the overall noise an NGSO system experiences will ultimately lead to the overprotection of earlier-round systems and, as a result, artificially reduce competition among NGSO satellite services.[228] Intelsat argues the specific level of existing noise to be accounted for in each frequency range should be as accurate as possible and based on services deployed in that frequency range,[229] which will vary depending both on the Commission's rules that apply in the bands and on the intensity with which the bands are used.[230] While conceding that GSO noise still needs to be modeled and developed to ensure that it is accurately represented,[231] Intelsat argues there are likely baseline metrics that can be used in all or most scenarios to simulate GSO interference for which NGSO operators must account.[232] Intelsat suggests the Commission need not define the metric for inter-system interference from existing GSO systems because the party conducting the analysis can determine whether to include this element and provide any necessary justification for that choice.[233]

65. *Decision*. We decline to incorporate GSO interference into the baseline. We acknowledge that omitting existing sources of interference in the baseline, such as GSO interference, will tend to underestimate the interference experienced by an incumbent. However, we disagree with Intelsat that parties should be able to create and use their own metric for GSO interference affecting the incumbent's baseline in order to ease their burden of demonstrating compliance with the required interference limits. We are concerned that Intelsat's proposal, in the absence of an agreed model or clear way to impute such interference across all NGSO FSS systems, and the need to carefully consider GSO deployments and regulatory frameworks in different frequency bands, would create unnecessary disputes that would be time-consuming for Commission staff to assess and strain the Commission's limited resources. Accordingly, we conclude that any alleged benefit of incorporating GSO interference into the baseline does not outweigh the burdens on parties and Commission staff in determining the appropriate way to incorporate such interference at this time. Parties are free to explore such interference effects during the detailed information sharing and discussions that accompany good-faith coordination among NGSO FSS operators, and which, we find, ultimately lead to the most efficient use of spectrum by the concerned operators.

### b. Intra-System Interference

66. *Comments*. Most commenters on this issue also oppose including intra-system interference in the baseline. These commenters state that satellite operators do not routinely disclose how they mitigate intra-system interference because such mitigation techniques have little to no impact on the operations of other constellations, may be competitively sensitive, and change with user needs.[234] Kuiper argues that requiring consideration of intra-system interference would either leave new entrants to guess

[226] *See* 47 CFR § 2.106, NG165.

[227] O3b Comments at 11; *see also* O3b Reply at 6, n.21; SpaceX Reply at 17.

[228] Intelsat Comments at 5-6; Intelsat Reply at 9. SpaceX argues later-round systems may incorporate reference values for GSO interference that "warrant further discussion and development in the record." SpaceX Reply at 18.

[229] Intelsat Comments at 6.

[230] *Id.* at 5.

[231] *Id.* at 6.

[232] Intelsat Reply at 10.

[233] Intelsat Comments at 6.

[234] Kuiper Comments at 12-13; *see also* SpaceX Reply at 17; Mangata Reply at 9.

how each incumbent addresses intra-system interference, inviting inaccuracy and dispute, or necessitate an unnecessary and potentially intrusive mandate to share such information.[235] Kuiper suggests that an administrable degraded throughput methodology is likely to omit several existing noise sources, such as intra-system interference and interference from other NGSO FSS operators, given the practical difficulties of faithfully incorporating such factors into the analysis.[236]

67. Intelsat, however, again argues that the earlier-round system's performance baseline should consider all realistic sources of noise degradation, including intra-system degradations.[237] Intelsat contends that intra-system interference and non-time-varying sources could be standardized to a single value, and notes that ITU Resolution 770 uses 1 dB of margin to account for these cases.[238] Intelsat asserts that intra-system noise is a critical factor that should be included in compatibility analyses and argues there is no technical reason not to account for intra-system noise as a realistic assumption that would improve sharing among NGSOs.[239]

68. *Decision*. We decline to incorporate intra-system interference into the baseline. Given that information on intra-system interference changes with user needs, we are concerned that incorporating such interference into the baseline would create additional disputes between parties, and burdens on the Commission's limited staff resources in resolving those disputes, in the absence of a clear way to incorporate such interference into the baseline. Further, the record is not sufficiently developed to determine whether the 1 dB margin used to account for intra-system interference and non-time-varying sources with respect to interference into GSO networks in V-band under ITU Resolution 770 would be appropriate to systems in other frequency bands. Accordingly, we conclude that any alleged benefit of incorporating intra-system interference into the baseline does not outweigh the burdens on parties and Commission staff in determining the appropriate way to incorporate such interference at this time. Parties in coordination are free to explore such interference effects during their detailed information sharing and discussions.

### c. Interference from Other NGSO FSS Systems

69. *Comments*. The only specific comments on this issue supported comparing an incumbent's baseline against its expected performance given the operations of a single (rather than multiple) new entrant.[240] In particular, Kuiper argues that, while accounting for the noise environment an incumbent faces because of other incumbent NGSO FSS operators may make the analysis more accurate, the burden of increased complexity outweighs any benefit of this accuracy.[241] Rather, Kuiper argues the Commission should follow the path taken by satellite operators in coordination – to model only the incumbent and new entrant's systems.[242] Kuiper states that instead of ignoring interference from other

[235] Kuiper Comments at 12-13.

[236] Kuiper Reply at 5.

[237] Intelsat Comments at 3. SpaceX argues later-round systems may incorporate reference values for intra-system interference that "warrant further discussion and development in the record." SpaceX Reply at 18.

[238] Intelsat Comments at 6.

[239] *See* Intelsat Oct. 24, 2024 *ex parte*, Attachment at 5 (noting that in WP4A of the ITU failing to account for intra-system noise leads to significant overprotection in the long term and that ITU Res. 770 and Rec. ITU-R S.1323 both account for intra-system noise).

[240] Kuiper Comments at 13; Telesat Comments at 9.

[241] Kuiper Comments at 13 ("Modeling three, four, or more constellations with varying orbits, geometries, and power levels will dramatically complicate the analysis. Indeed, it may be impossible to accurately model additional constellations given the wide-ranging coordination and mitigation techniques that each pair of constellations may employ.").

[242] *Id*.

NGSO FSS systems, the Commission can account for it when establishing an interference threshold and recognize that excluding this interference makes any threshold that it adopts more conservative and protective than it appears.[243]

70. *Decision*. We decline to require compatibility analyses to include effects of multiple NGSO FSS systems in the baseline interference of the incumbent system because doing so could create uncertainty and disputes, with accompanying strain on the Commission's limited staff resources to assess those disputes, as to which additional NGSO FSS systems should be considered in a given analysis and how their effects should be incorporated in the analysis. Accordingly, we conclude that any alleged benefit of incorporating interference from multiple NGSO FSS systems into the baseline does not outweigh the burdens on parties and Commission staff in determining the appropriate way to incorporate such interference at this time. Although including this interference is not common in operator's own coordination discussions, parties in coordination are free to explore such interference effects during their detailed information sharing and discussions.

### 6. Rain Attenuation

71. *Further Notice*. The Commission also asked how rain fade conditions in different locations should be incorporated into the degraded throughput analysis, how many locations should be evaluated, and whether any locations should include sites outside the United States.[244]

72. *Comments*. Most commenters on this issue support using three geographically diverse locations within the United States for application of a rain attenuation standard, one for each of low, medium and high rain rates.[245] These commenters assert that using three data points will provide sufficient scope for an interference assessment, while at the same time not demanding an analysis that could become unwieldly with an excessive number of data points.[246] SpaceX contends that these locations should reflect the actual deployments of earlier-round systems and, where possible, rely on locations that operators jointly establish in good-faith coordination.[247]

73. Intelsat argues that four to five sites located within the United States in representative geographic areas with different rain rates "should suffice."[248] O3b proposes that the Commission require parties to employ at least four different latitudes between 10 degrees and 70 degrees North Latitude as test points in the analysis and consider a range of rain conditions at each latitude.[249]

74. Additionally, several commenters recommend that the Commission require operators to use a common rain-attenuation model that references attenuation characteristics from the latest versions of Recommendations ITU-R P.618 and P.676.[250]

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[243] *Id.*

[244] *Further Notice*, 38 FCC Rcd at 3718-19, para. 40.

[245] SpaceX Comments at 12; Kuiper Comments at 10; Telesat Comments at 10. Kuiper specifically argues that the chosen sites should vary by latitude to account for the fact that the link geometries of NGSO FSS systems vary by latitude, influencing the incumbent's link performance. Kuiper Comments at 10. No commenter argues that locations outside the United States should be required.

[246] Telesat Comments at 10; *see also* Kuiper Comments at 10; SpaceX Reply at 18.

[247] SpaceX Reply at 18. SpaceX states, for example, that O3b requests that NGSO systems assess interference at an array of latitudes and rain conditions, yet many of those latitudes exceed the service coverage that its operational first-round system can provide. *Id.*

[248] Intelsat Comments at 10.

[249] O3b Comments at 6.

[250] *See* Intelsat Comments at 10; Telesat Comments at 9; Kuiper Comments at 10; SpaceX Reply at 19.

75. SpaceX also argues that the Commission should standardize the rain fade conditions that represent the low, medium, and high rain attenuation conditions for NGSO system deployments, and proposes to define low rain areas as having ≤ 30 mm/hr, moderate rain areas as having 40–50 mm/hr, and high rain areas as having ≥ 80 mm/hr.[251] O3b similarly suggests rain rates for 0.01% of an average year that vary between dry (20-30 millimeters/hour) to wet (up to 80 millimeters/hour).[252]

76. Finally, Intelsat argues that, to account for other link losses, the Commission should either calculate the non-precipitation impairment values using the methodology specified in Recommendation ITU-R P.618 or use a standardized approach to these additional degradations.[253]

77. *Decision*. We decline to mandate specific rain fade assumptions to be used in an inter-round compatibility analysis. Rather, we will assess rain fade assumptions on a case-by-case basis as to whether they are reliable and representative. While we conclude based upon review of the record that inter-round compatibility analyses with three geographically diverse locations at various latitudes within the United States may be sufficient in many cases for application of a rain attenuation standard (one for each of low, medium and high rain rates), we will assess rain fade assumptions, including the number of locations, on a case-by-case basis to determine whether they are reliable and representative.

78. We agree with the majority of commenters on this issue that three locations would typically provide sufficient scope for the analysis without overburdening it because three locations will allow for the selection of sites with each of low, medium, and high rain rates. But regardless of the number of locations assumed (whether three or more or less than three), the operator submitting an inter-round compatibility analysis must demonstrate that the number of locations assumed is reliable and representative given the assumed operations of the earlier-round system. For example, if an earlier-round system operated only in a geographically limited area, such as at high latitudes, then a later-round operator might reasonably use location and rain fade assumptions that reflect the actual service area of the earlier-round system even if less than three locations. Similarly, to ensure the most accurate modeling, these locations can reflect the actual coverage of earlier-round systems and, where possible, rely on locations that operators jointly establish in good-faith coordination discussions.

79. We will also assess the rain attenuation model used in an inter-round compatibility analysis on a case-by-case basis as to whether it is reliable and representative. As an illustrative example, a party preparing an inter-round protection showing may model rain attenuation as per the current versions of ITU-R Recommendations P.618-14 and P.676-13, as recommended by commenters, and specify the rain fade conditions that represent the low, medium, and high rain attenuation conditions for NGSO system deployments, with rain rates for 0.01% of an average year in low rain areas as ≤ 30 mm/hr, in moderate rain areas as 40–50 mm/hr, and in high rain areas as ≥ 80 mm/hr. We will assess such rain fade assumptions on a case-by-case basis as to whether they are reliable and representative. Finally, as an illustrative example, a party might use Recommendation ITU-R P.618 to account for other link losses and will assess its appropriateness on a case-by-case basis, considering how these other link losses are treated in coordination and similar contexts and their particular applicability to the cases studied.

[251] SpaceX Reply at 19.

[252] O3b Comments at 6.

[253] Intelsat Comments at 10. Intelsat states it does not have a view on which option is more appropriate but notes that the first option will require a more complex compatibility demonstration, while the difficulty of the second option lies in defining an appropriate standard degradation value, noting the degradation will vary by frequency bands. *Id.* at 10-11.

### 7. Standardized Parameters

80. *Further Notice*. The *Further Notice* inquired as to whether we should use standardized antenna patterns and noise temperatures for the computation of C/(I+N) in a degraded throughput method.[254]

81. *Comments*. Commenters supporting standardized parameters argue that the Commission should allow later-round applicants to use certain default system parameters for earlier-round applicants that reflect a baseline of accepted system performance, below which the earlier-round applicant should not be entitled to protection.[255]

82. SpaceX argues that establishing default parameter values will ensure that compatibility showings uniformly implement the best practices of efficient NGSO systems when the parties and the Commission lack access to operational information.[256] SpaceX also argues that default parameter values will give notice to operators that any sharing framework will not accommodate filings or system designs that are based on inefficiencies intended to block competition.[257]

83. Intelsat also argues the Commission should also adopt or clarify the nominal or standard earth station parameters that should be used where the information is not provided in the operator's authorization and not already provided for in the Commission's rules.[258]

84. Commenters propose specific operational assumptions the Commission could standardize, including: assuming earth stations from the victim and the interfering systems are collocated for both uplink and downlink cases;[259] considering satellite beams of the selected satellites as pointing toward the earth station location in both uplink and downlink cases;[260] for uplink cases, considering only one interferer location at each time step;[261] and implementing one-second time step durations in the

[254] *Further Notice*, 38 FCC Rcd at 3718-19, para. 40.

[255] Intelsat Comments at 8-11; SpaceX Reply at 20-21; Telesat Reply at 7; SpaceX Comments at 15-16; *see also* ITIF Comments at 2-3 ("The degraded throughput methodology comes with the inherent risk of low-performing receivers experiencing degradation that receivers in better-designed systems would not. This dynamic could perversely incentivize satellite spectrum users not to invest in the resilience of their receivers because they can reduce costs and block future competitors by making their throughput unreasonably degradable. … The Commission should, therefore, adopt standardized antenna patterns that will receive Commission protection in order not to let unreasonably low-performing receivers be a basis for claiming high degraded throughput."); *see also generally* Viasat Comments at 5 ("Although the Commission should not dictate overall system design decisions to NGSO operators, it also should not reward operators for making inefficient design decisions. The Commission can achieve both objectives by establishing baseline antenna off-axis gain and/or power limits, and antenna receive protection criteria, beyond which NGSO operators will not be entitled to cause interference to other NGSOs, or claim interference protection, as the Commission has done in the GSO context to facilitate coexistence.").

[256] SpaceX Comments at 16.

[257] *Id.*

[258] Intelsat Comments at 8 (stating, for example, that most NGSO systems specify ITU Radio Regulations Appendix 8 for their earth station user receive antenna pattern and that earth station noise temperatures are often standardized (but band-specific), but that other parameters, such as uplink effective isotropic radiated power do not lend themselves to be standardized and will vary depending on NGSO orbit and for other reasons). Conversely, Intelsat notes that some information, such as satellite transmit EIRP density and satellite gain-to-noise-temperature ratio, are unlikely to be easily standardized. *Id.*

[259] Intelsat Comments at 9; SpaceX Reply at 21.

[260] *Id*.

[261] *Id*.

analysis.[262]

85. Intelsat further proposes that, absent information on an incumbent's tracking strategy, later-round grantees should default to using random selection as the tracking strategy to determine the available satellites that meet other operational parameters such as minimum elevation angle, GSO exclusion angle, and Nco (the maximum number of beams which can be illuminated simultaneously in the polarization considered).[263]

86. SpaceX recommends reference parameters for downlinks and uplinks that operators should use when operational information is missing or incomplete.[264] As standardized downlink parameters, SpaceX proposes an earth station receive noise temperature of 200K and satellite antenna patterns contained in Recommendation ITU-R S.1528.[265] As standardized uplink parameters, SpaceX proposes a satellite receive noise temperature of 500K, earth station antenna diameters of 2.4m (gateway) and 1.0m (user terminal), and earth station antenna patterns contained in the ITU Radio Regulations Appendix 8, Annex 3.[266]

87. Intelsat also suggests the Commission should standardize the method and waveform used for the conversion from C/N values to spectral efficiency, and suggests using the method defined in Section 2.3 of the Annex of Recommendation ITU-R S.2131-1, which considers a DVB-S2X waveform and is widely used in the satellite industry.[267]

88. OneWeb, however, opposes making use of standardized parameters, arguing that the parameters for NGSO FSS systems vary widely and default NGSO system or earth station parameters are unlikely to effectively protect incumbent operators.[268] In particular, OneWeb disagrees with considering only collocated earth stations.[269] OneWeb asserts that this is an oversimplification and that aggregate interference of multiple stations within the same interfering system also needs to be addressed.[270] Additionally, OneWeb opposes a standardized practice of considering only one interferer location at each time step, claiming that the interference potential could be underestimated if multiple earth stations are

[262] Intelsat Comments at 11; SpaceX Reply at 21.

[263] Intelsat Comments at 8.

[264] SpaceX Reply at 20-21.

[265] SpaceX states that although the S.1528 antenna patterns, for example, S.1528 LN = -20 dB, are effectively the only reference standard antenna patterns available to model NGSO satellite transmissions, these patterns are dated, overly conservative, and tend to overestimate interference. SpaceX Reply at 21. SpaceX suggests the Commission consider seeking comment on and adoption of updated standard satellite antenna pattern(s) that are developed either through this proceeding or at the ITU. *Id.*; *see also* Kuiper Comments at 9, n.18 (arguing that antenna patterns are critical in assessing interference to and from NGSO FSS systems—and yet the use of overly conservative reference antenna patterns (even standardized patterns) may cause drastic overestimates of potential interference).

[266] SpaceX states that the antenna patterns included in ITU Appendix 8, Annex 3, may be overly conservative due to their assumed sidelobe profiles and may overestimate interference caused by earth station sidelobe emissions. SpaceX Reply at 21. SpaceX recommends the Commission consider seeking comments on and adoption of updated standard earth station antenna pattern(s) either through this proceeding or at the ITU. *Id.*; *see also* Kuiper Comments at 9, n.18.

[267] Intelsat Comments at 9-10; *see also generally* Kepler Comments at 2 (arguing the Commission "should require that operators continue to rely on existing published standards such as ITU-R S.2131.5").

[268] OneWeb Reply at 3.

[269] *Id.* at 8.

[270] *Id.*

not accounted for and that earth station deployment models can be addressed in detailed coordination.[271]

89. *Decision*. We decline to mandate specific parameters and assumptions to be used in an inter-round compatibility analysis. Rather, we will assess these parameters and assumptions on a case-by-case basis as to whether they are reliable and representative. To facilitate the work of new entrants in preparing the showings and Commission staff and incumbents in reviewing them, we list below illustrative examples of parameters and assumptions that operators might consider using in any necessary compatibility showings:

*1)* assume earth stations from the victim and the interfering systems are collocated for both uplink and downlink cases;[272]

*2)* consider satellite beams of the selected satellites as pointing toward the earth station location in both uplink and downlink cases;[273]

*3)* for uplink cases, consider only one interferer location at each time step;[274]

*4)* implement one-second time step durations in the analysis;[275]

*5)* use of the method and waveform for the conversion from C/N values to spectral efficiency method defined in Section 2.3 of the Annex of Recommendation ITU-R S.2131-1;[276]

*6)* assume earth station antenna diameters of 2.4m (gateway) and 1.0m (user terminal);[277]

*7)* use the earth station antenna patterns contained in the ITU Radio Regulations Appendix 8, Annex 3;[278]

*8)* assume an earth station receive noise temperature of 200K;[279]

*9)* use the satellite antenna patterns contained in Recommendation ITU-R S.1528;[280]

*10)* assume a satellite receive noise temperature of 500K;[281] and

*11)* assume random selection as the tracking strategy to determine the available satellites that meet other operational parameters such as minimum elevation angle, GSO exclusion angle, and Nco.[282]

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[271] *Id.*

[272] Intelsat Comments at 9; SpaceX Reply at 21.

[273] *Id*.

[274] *Id*.

[275] Intelsat Comments at 11; SpaceX Reply at 21.

[276] Intelsat Comments at 9-10.

[277] SpaceX Reply at 21.

[278] *Id.* While we decline to seek comment on updates to these antenna patterns at this time as suggested by SpaceX, we note that these patterns could be updated through ITU processes. We may seek comment on updates, including any updates adopted through ITU processes, or alternative patterns at a later date.

[279] *Id.*

[280] *Id.* While we decline to seek comment on updates to these antenna patterns at this time as suggested by SpaceX, we note that these patterns could be updated through ITU processes. We may seek comment on updates, including any updates adopted through ITU processes, or alternative patterns at a later date.

[281] *Id.*

[282] Intelsat Comments at 8.

90. We conclude that providing these illustrative examples of parameters and methodological approaches could make the preparation and review of compatibility analyses less burdensome and could avert unnecessary disputes among operators. We emphasize, however, that we will assess these parameters and assumptions on a case-by-case basis as to whether they are reliable and representative, including by considering any alternative publicly available information or information that the incumbent provides during operator-to-operator coordination and any justifications raised by the parties. For example, we will assess on a case-by-case basis whether it is appropriate for parties to assume that earth stations are collocated and to consider only one interferer location at each time step, including as it may be necessary due to the absence of detailed earth station deployment models and satellite receiving beams layout.[283] We believe that a case-by-case approach, in combination with the list of illustrative example parameters above taken from the record, will provide parties appropriate flexibility in tailoring their analyses while facilitating the preparation of these analyses by new entrants.

### 8. Use of Information Gained through Coordination

91. *Further Notice*. The *Further Notice* sought comment on what other technical data is needed to appropriately evaluate degraded throughput effects, and how the Commission can ensure that any degraded throughput analysis appropriately protects the specific characteristics of an NGSO system's operations, including what role Schedule S information should play in the analysis.[284]

92. *Comments*. Commenters agree that as part of the good faith coordination among NGSO FSS operators required by the Commission, operators share technical and operational information about their systems,[285] which is a better reflection of their actual or planned operations than can be drawn solely from information in the public record.[286] Commenters therefore support the Commission allowing later-round operators to use operational information gained during coordination to enhance the accuracy of their compatibility showings with an earlier-round system, and to submit such showings to the Commission on a confidential basis, allowing the earlier-round operator to review the showing to ensure the information exchanged in good-faith coordination is properly represented and analyzed while preventing competing operators from viewing potentially commercially sensitive operational data.[287]

93. Commenters disagree, however, on whether later-round operators should be required to use more realistic operational information gained during coordination in their compatibility showings whenever possible,[288] or whether later-round operators should have the choice of using either public or private data on the earlier-round system.[289] Both sides raise the prospect of gamesmanship – if there is a requirement to use private data, the earlier-round operator could selectively provide system details that

[283] *See* OneWeb Reply at 8.

[284] *Further Notice*, 38 FCC Rcd at 3718-19, para. 40.

[285] *See, e.g.*, SpaceX Comments at 7 ("As an industry practice, NGSO operators already share actual operational parameters with each other during good-faith coordination because publicly accessible information often does not reflect true operations.").

[286] *See, e.g.*, O3b Comments at 5-6 ("Analyzing the interference potential using service-specific operating data is far superior to relying on data from public sources such as the Schedule S or network filings made with the International Telecommunication Union ("ITU"). Schedule S information, for example, typically represents a system's broad operating envelope but does not reflect the range of links that can be provided or supply significant information regarding uplink transmissions. As a result, a compatibility study using only public data will not enable an accurate assessment of the real-world effect of the later-round system's entry on existing services."); *see also* Intelsat Comments at 7.

[287] *See* SpaceX Comments at 7-8; OneWeb Reply at 4; O3b Comments at 6; O3b Reply at 6; Telesat Reply at 7; Kuiper Reply at 13; Intelsat Oct. 24, 2024 *ex parte*, Attachment at 2.

[288] SpaceX Comments at 6-7; O3b Comments at 5-6; Telesat Reply at 6.

[289] Kuiper Comments at 11; Mangata Reply at 2.

make it appear more sensitive to interference while omitting details that could facilitate sharing;[290] while if there is the option, but no requirement, a later-round could choose any combination of public or private information to ease its compatibility showing, even public information that, commenters agree, may not reflect actual operations.[291] Kuiper argues that, if later-round systems are given the option of using public or private information, the earlier-round operator will still have the opportunity to review the showing and comment on the appropriateness of the parameters used.[292] SpaceX also notes that later-round operators may need to disclose confidential parameters in any compatibility studies before the Commission to show compliance with backstop interference values, supporting the disclosure of parameters as needed to maximize efficient spectrum sharing.[293]

94. *Decision*. We agree with commenters that the use of operational information shared during coordination should enhance the accuracy of compatibility showings, and will allow later-round operators to base their analyses on such information to the extent it is available and permitted by the incumbent operator to be reflected in a compatibility analysis submitted to the Commission. Analyses based on operational information shared during coordination may be submitted on a confidential basis when satisfying the requirements of the Commission's confidentiality rules (assuming the incumbent operator has permitted this information to be reflected in a compatibility analysis).[294] However, we agree with Kuiper that later-round operators should have the flexibility to use publicly available parameters of the earlier-round system, even if alternative parameters are provided in coordination, and to justify that decision when submitting a compatibility analysis. We will assess the use of publicly available information in these instances on a case-by-case basis to determine if the analysis is adequately representative of the earlier-round system, considering as well any arguments that the later-round operator has selectively used publicly available information to its advantage to ease its protection showing. In addition, because the incumbent's privately shared operational data may be used in a compatibility analysis submitted to the Commission only if it consents to such use, we do not believe that allowing use of such data will disincentivize information sharing during coordination, especially where the incumbent's consent may be contingent upon sharing the information on a confidential basis.

### 9. Incorporation of Deployment Milestones into Compatibility Analyses

95. *Comments*. Several commenters note that when the operator of a later-round NGSO FSS system is preparing a compatibility showing for an earlier-round system, the earlier-round system may not yet be fully deployed and, indeed, may never fully deploy or deploy at all.[295] Commenters argue that later-round operators should be given the flexibility to provide compatibility analyses based either on the number of satellites at the 50% or 100% deployment milestones of the earlier-round system, whichever has yet to be achieved,[296] or on the "number of satellites actually deployed" and operating.[297]

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[290] Kuiper Reply at 14.

[291] SpaceX Comments at 6-7; *see also* SpaceX Comments at 8-9 ("The public filings of an NGSO system often assume an envelope of potential operating parameters, which is important and entirely proper to promote flexibility and innovation. In practice, however, an NGSO system will use specific operational parameters that fall within that envelope. If allowed, an NGSO operator may improperly leverage this distinction between envelope and actual operational parameters to assert that the most advantageous values from its public filings must be used for analyzing compatibility even if these values deviate from its own operational parameters. These inaccurate input assumptions reduce the fidelity of interference showings, thereby reducing efficient spectrum sharing and thereby harming consumers and competition.").

[292] Kuiper Reply at 14.

[293] SpaceX Spectrum Sharing Study at S-5.

[294] 47 CFR § 0.459.

[295] *See, e.g.*, Kuiper Comments at 16.

[296] SpaceX Comments at 9-10. For example, SpaceX suggests that when an earlier-round NGSO system has not yet satisfied its first deployment milestone, a later-round NGSO system should only be required to demonstrate

(continued….)

Commenters suggest that later-round operators should not be held to the parameters of such showings before the actual deployment of the earlier-round system,[298] and that later-round operators should be able to update their showings to account for later deployments, if not accounted for in the initial analysis.[299]

96. SpaceX, for example, argues that accounting for milestone requirements in compatibility analyses would better reflect the operational realities of NGSO systems and better calibrate the need for regulatory certainty with opportunities for new entry.[300] SpaceX also argues that accounting for deployment milestones in compatibility showings better accommodates the interference risk to earlier-round systems as they grow and change, given that NGSO operators frequently file modifications as they build out systems that differ from those initially authorized.[301] SpaceX further asserts that by emphasizing the deployment milestone requirements, the Commission can encourage earlier-round systems to share higher-fidelity information about their near-term deployment plans for new satellite launches to ensure protection for those satellites.[302]

97. *Decision*. We agree that later-round NGSO FSS operators should not be restrained by a requirement to protect not yet deployed earlier-round systems. At the same time, we are cautious about permitting compatibility analyses considering solely the number of deployed satellites at a given time, which may need to be updated with each subsequent launch of an earlier-round system and consume unnecessary resources for the earlier-round operator, and Commission staff to review. Therefore, we will permit compatibility analyses to consider only the deployment configuration of the earlier-round system at the six-year, 50% milestone if this milestone has not yet been met.[303] If the 50% deployment milestone has been met, compatibility analyses must consider the fully deployed system. In the event the earlier-round system misses a milestone and its authorization is automatically reduced to the number of satellites deployed on the date of the missed milestone, compatibility analyses need only consider the number of actually deployed satellites.

### 10. Mitigation Techniques

98. *Further Notice*. The *Further Notice* also asked what mitigation techniques would be appropriate for a later-round system to implement in the event that any protection criteria were not otherwise satisfied in a compatibility showing.[304]

99. *Comments.* Commenters on this issue agree that the Commission should not limit the mitigation techniques available to a new entrant where its constellation would otherwise exceed the

(Continued from previous page)
compatibility with the sub-constellation that conforms with that first milestone. If the earlier-round system eventually meets its first milestone and the parties still have not completed coordination, SpaceX suggests the later-round NGSO system should provide an updated showing for the fully authorized earlier-round system, consistent with that system's second deployment milestone. *Id.*

[297] Intelsat Reply at 4-5.

[298] Mangata Reply at 6-7.

[299] SpaceX Comments at 9-10; Mangata Reply at 6-7.

[300] SpaceX Comments at 10.

[301] *Id.* at 11-12.

[302] *Id.* at 11.

[303] Therefore, for example, while a later-round licensee would have to demonstrate how it would protect an earlier-round system at 50% deployment even if the earlier-round system had yet to launch any satellites, in practice, the later-round licensee would not have to implement such protection unless and until the earlier-round system began deploying, and then only to the extent of the actual deployment of the earlier-round system.

[304] *See Further Notice*, 38 FCC Rcd at 3718-19, para. 40.

interference thresholds,[305] though some commenters specifically note that, once an operator commits to using certain mitigation techniques, it should be held to that commitment through licensing conditions.[306]

100. *Decision.* We concur that elaborating a list of appropriate mitigation techniques could unnecessarily restrict operator flexibility and spectral efficiency, and therefore will not limit the potential mitigation techniques that can be employed. Further, we agree that, when mitigation techniques are used as a basis for demonstrating compatibility with an earlier-round system, the later-round system will be required to employ those mitigation techniques to the extent necessary to protect the earlier-round system's actual operations.[307]

### 11. Timing of Acceptance of Compatibility Showings

101. *Comments*. Some commenters argue that the Commission should refuse to accept a compatibility showing from a later-round operator until the operator makes a "valid prior coordination attempt" with the earlier-round operator,[308] or until "after coordination has failed."[309] Mangata notes that the Commission's rules already require good faith coordination among all NGSO FSS grantees and argues the Commission "need not exclude valid degraded throughput analyses to enforce coordination since engaging in such coordination efforts is already required."[310]

102. *Decision*. We decline to adopt any limit on when a later-round NGSO FSS grantee may submit an inter-round compatibility analysis based on the state of its coordination with an earlier-round operator. Later-round grantees are under an obligation to coordinate in good faith with other NGSO FSS operators, before and after submission of any compatibility showings.[311] We do not believe it would be productive to codify, and potentially adjudicate, a requirement that later-round operators coordinate "enough" before we will review a demonstration that their operations will be compatible with an earlier-round operator. Rather, to the extent earlier-round operators may be concerned that its operational data will not be used in the compatibility showing, they may affirmatively reach out to provide such information and, a later-round grantee may not refuse such an offer consistent with its obligation to coordinate in good faith.

### 12. Post-Sunset Sharing Regime

103. *Further Notice*. When adopting a sunset period to accompany the new inter-round protection requirement in the *Report and Order*, the Commission determined that, after sunset, new entrants will be subject to co-equal spectrum sharing with incumbents.[312] In the absence of a coordination

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[305] Kuiper Comments at 15; O3b Comments at 11; O3b Reply at 12-13; OneWeb Reply at 11-12; Mangata Reply at 7-8. Commenters list numerous potential mitigation techniques. *See, e.g.*, Kuiper Comments at 15 (listing mitigation techniques to include "increasing its angular avoidance with the incumbent, changing its satellite selection algorithm, increasing geographical separation with the incumbent's earth stations, reducing its uplink or downlink power levels, decreasing its duty cycle, changing the polarization of its beams, or reducing or eliminating the use of co-channel frequencies during in-line events").

[306] O3b Comments at 12; OneWeb Reply at 11-12.

[307] This requirement is incorporated in the requirement we adopt in section 25.261(d)(4) that a later-round NGSO FSS system will be required to conform its operations to its compatibility showing submitted for the protection of an earlier-round system only to the extent necessary to protect the actual number of deployed and operating space stations of the earlier-round system.

[308] O3b Comments at 4-5.

[309] OneWeb Reply at 2.

[310] Mangata Reply at 6.

[311] *See* 47 CFR § 25.261(b).

[312] *Report and Order*, 38 FCC Rcd at 3714, para. 31.

agreement, this is accomplished through spectrum-splitting when the ΔT/T of 6% threshold is exceeded.[313] Nonetheless, the *Further Notice* sought additional comment on what criteria should be applied among NGSO systems after the sunset period.[314]

104. *Comments*. Most commenters on this issue support the Commission's initial decision in the *Report and Order* to apply the default spectrum-splitting procedure between earlier and later-round systems after sunsetting occurs.[315] They argue that placing parties on an equal footing under the Commission's default spectrum-splitting rules represents the simplest and most reasonable approach to sunsetting,[316] that alternatives to spectrum splitting do not have a similar ability to incentivize both sides to reach a coordination agreement,[317] and that not applying the spectrum-splitting rules equally after sunset would perpetuate a stratified spectrum-sharing regime that gives incumbents a permanent advantage over later-round grantees.[318]

105. SpaceX, which supports applying the Commission's default spectrum-splitting procedure after the sunset date, nonetheless argues that the Commission should ensure that systems with deployment milestones after the sunset date do not avoid good-faith coordination simply because their deployment commitments extend into the post-sunset regime.[319] While SpaceX supports applying the Commission's default spectrum-splitting procedure after the sunset date, it proposes a revision to the procedure to reward the more efficient system with the first choice in a spectrum split, and to apply this backstop both to systems within the same processing round and to different-round systems after protections sunset.[320]

106. Telesat asks the Commission to defer consideration of any revisions of the current regime until a later date, when the Commission has gained more experience in understanding how NGSO systems can coexist.[321]

107. ViaSat, SpaceX, and OneWeb reiterate earlier arguments that the Commission should revise the default spectrum-splitting mechanism as it applies to systems authorized in the same processing round, but do not argue that a different sharing regime should apply between earlier and later-round systems following sunset.[322] OneWeb also argues the Commission should lengthen the sunset period for later-round operators until they have deployed their full systems, and only after consider applying the same metrics between prior-round operators and later-round operators.[323]

108. *Decision*. We reaffirm the decision in the *Report and Order* to place earlier and later-round operators on an equal footing after the sunset date by applying the default, spectrum-splitting mechanism to both sets of operators at that time. Doing so ensures that earlier-round advantages do not continue indefinitely, and simplifies the regulatory framework when systems authorized through multiple

[313] *Id.*; 47 CFR § 25.261(d).

[314] *Further Notice*, 38 FCC Rcd at 3719, para. 42.

[315] Kuiper Comments at 21-22; Kuiper Reply at 15-17; Intelsat Comments at 13-15; Intelsat Reply at 7-8; O3b Comments at 12-13; O3b Reply at 13-14; SpaceX Reply at 22; Kuiper July 18, 2024 *ex parte* at 15.

[316] Kuiper Reply at 15.

[317] O3b Comments at 13.

[318] Intelsat Comments at 13.

[319] SpaceX Reply at 22.

[320] *Id.* at 22-23.

[321] Telesat Comments at 11-12; Telesat Reply at 6.

[322] *See* Viasat Comments at 7-8; Viasat Reply at 6; SpaceX Comments at 17; SpaceX Reply at 22-23; OneWeb Reply at 13; OneWeb Oct. 3, 2024 *ex parte* at 17.

[323] *See* OneWeb Comments at 17; OneWeb Oct. 3, 2024 *ex parte* at 16-17.

processing rounds may be operating. However, we decline to adopt proposed changes to the default, spectrum-splitting mechanism itself, as applied to systems within a processing round,[324] because such changes are beyond the scope of this proceeding. Further, we note that no commenter advocates different treatment of later-round operators post-sunset than among earlier-round operators. Indeed, the equality of treatment of later-round operators after the sunset date is a key component of the sunset provision.[325] And while the proposal to lengthen the sunset period for certain operators is also beyond the scope of the *Further Notice's* inquiry, the Commission retains the authority to enforce its good-faith coordination requirement in cases where a later-round operator with deployment milestones after the sunset date is alleged to be avoiding good-faith coordination.[326] We expect any such cases to be rare, however, because operators receive benefits of reaching stable coordination agreements not only in operation but in securing the necessary funding for constellation deployments.

### 13. Digital Equity and Inclusion

109. The Commission, as part of its continuing effort to advance digital equity for all,[327] including people of color, persons with disabilities, persons who live in rural or Tribal areas, and others who are or have been historically underserved, marginalized, or adversely affected by persistent poverty or inequality, invited comment on any equity-related considerations[328] and benefits (if any) that may be associated with the proposals and issues discussed in the *Further Notice*.[329]

110. The Commission did not receive specific comment on this topic. Nonetheless, we find that the rule changes in this Second Report and Order will continue to encourage a more stable and competitive environment for the development of NGSO FSS systems well suited to reaching underserved areas with new broadband capacity, and therefore that this rulemaking will enhance digital equity and inclusion.

## B. Order on Reconsideration

111. *Petition*. OneWeb petitions for reconsideration of the sunset period[330] adopted with the inter-round protection requirement in the *Report and Order*.[331] OneWeb specifically requests that the Commission partially reconsider the sunset period for first round operators because it believes that the

[324] *See* SpaceX Reply at 22-23 (requesting that more efficient systems have the first choice in a spectrum split, and to apply this backstop to systems within the same processing round).

[325] *Report and Order*, 38 FCC Rcd at 3713-14, para 30.

[326] *See* 47 CFR § 25.261(b).

[327] Section 1 of the Communications Act of 1934 as amended provides that the FCC "regulat[es] interstate and foreign commerce in communication by wire and radio so as to make [such service] available, so far as possible, to all the people of the United States, without discrimination on the basis of race, color, religion, national origin, or sex." 47 U.S.C. § 151.

[328] The term "equity" is used here consistent with Executive Order 13985 as the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality. *See* Exec. Order No. 13985, 86 Fed. Reg. 7009, Executive Order on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government (January 20, 2021).

[329] *NPRM*, 36 FCC Rcd at 17880, para. 27.

[330] *See* 47 CFR § 25.261(e).

[331] OneWeb Petition; *see also* OneWeb Oct. 3, 2024 *ex parte* at 4-6.

Commission failed to consider the evidence in the record and applied an unjustifiable sunset period to them.[332] In support of its petition, OneWeb makes three principal arguments.

112. First, OneWeb argues that the Commission effectively reduced the sunset period for first-round operators "by 30%" compared to operators in later processing rounds because the 10-year sunset period began on the date of the first authorization in a subsequent processing round, which occurred in 2020, leading to a sunset period ending in 2030, whereas the *Report and Order* that established the sunset date was not adopted and released until 2023.[333] OneWeb states this creates an "effectively seven-year sunset period for interference protections" for first-round operators.[334] OneWeb argues that such treatment undermines the benefit first-round operators should receive for their pioneering efforts and that, given the time required to implement technical changes in constellation designs and operations, the sunset period impairs first-round operators' ability to develop appropriate mechanisms to co-exist with later-arriving operators, potentially subjecting first-round operators to harmful interference.[335] OneWeb further contends that, although the Commission stated in 2017 that it would consider NGSO FSS applications filed after the first processing round on a "case-by-case" basis, OneWeb had no prior reasonable expectation that all later-round operators would be entitled to operate on a co-equal basis with first-round systems eventually.[336] OneWeb claims that the Commission's decision here is contrary to past precedent, where it denied Kuiper's waiver request to be treated on an equal basis with systems that filed applications within a previous processing round.[337] OneWeb also argues that the Commission failed to consider relevant information in the record and failed to provide a sufficient explanation for its decision.[338]

113. Second, OneWeb argues that the consideration of several questions in the *Further Notice* on the technical rules surrounding interference protections that affect the sunset period "further cuts into the already shorter sunset period for First Round operators."[339] OneWeb states these questions include: what protection levels should be imposed during and after the sunset period;[340] whether there is a maximum number of NGSO systems that can be accommodated in a given frequency band;[341] how the number of NGSO systems accommodated should affect inter-round protection criteria and the opening of

[332] OneWeb Petition at 10; OneWeb July 18, 2024 *ex parte*, Attachment B at 2; OneWeb Oct. 3, 2024 *ex parte* at 4-6; OneWeb Oct. 23, 2024 *ex parte*, Attachment B at 6.

[333] OneWeb Petition at 7-9 ("The Commission's justification for the application of its sunset period ignores that the Order erases three years out of the Commission's ten-year sunset period for First Round NGSO FSS grantees by 'backdating' the sunset period's start to 2020"); *see also Report and Order*, 38 FCC Rcd at 3712, para 29.

[334] OneWeb Petition at 3; OneWeb Oct. 23, 2024 *ex parte*, Attachment B at 6.

[335] Petition at 6; OneWeb Oct. 3, 2024 *ex parte* at 4.

[336] *See id.* at 8.

[337] *See id.* at 8, nn.28-29 (citing *Kuiper Systems, LLC*, Order and Authorization, 35 FCC Rcd 8324, 8337-38, para. 42 (2020)).

[338] *Id.* at 5.

[339] *Id.* at 9.

[340] OneWeb asked the Commission to include this question in the *Further Notice*. *Id.* at 4 ("OneWeb requested that the Commission seek further comment in the FNPRM on how coordination would be conducted among systems post-sunset in the combined first-second processing round.").

[341] OneWeb argues that, should the Commission determine that a maximum number of NGSO systems can be accommodated in a given frequency band, the sunset period may be superfluous. *Id.* at 9-10.

different rounds; and what "co-equal" means when established operators are to operate a co-equal basis with newer entrants.[342]

114. Finally, OneWeb notes that several second-round applications from the 2020 processing round remain pending. If granted, the operators would have up to nine years to deploy their full constellations under the Commission's milestone rules. Therefore, OneWeb argues, the sunset of the inter-round protection requirement in 2030 will mean that "first-round operators would be protected from interference for little or no time after second-round grantees are fully deployed,"[343] "effectively placing the later-arriving operators in the first processing round in the context of interference protections"[344] and "remov[ing] any meaningful incentive for second-round operators to coordinate with First Round operators."[345] OneWeb now requests that the Commission specifically establish the sunset for first-round protections at ten years from adoption of the *Report and Order* consistent with the notice for subsequent rounds, or at ten years from final adoption of the spectrum sharing framework metrics under this Further Notice.[346]

115. *Comments*. Kuiper opposed the OneWeb Petition.[347] Kuiper contends that it fails to identify any material error in the *Report and Order* warranting reconsideration, and otherwise relies on arguments that the Commission has fully considered and rejected or that OneWeb could have but did not present earlier in this proceeding.[348]

116. Kuiper argues the Commission specifically addressed the question of whether the sunset should apply to first-round operators and concluded that, as applied, it gave "incumbent NGSO FSS grantees sufficient time to evaluate and adapt to the eventual, equal sharing environment" and that not applying the sunset in this way "would substantially frustrate the purpose of sunsetting by locking in incumbent protections that are not assured under the current, case-by-case regime."[349] Kuiper also states that OneWeb has offered no evidence—either now or before the *Report and Order* was adopted—that a seven-year period would afford insufficient time to prepare for co-equal spectrum sharing with second-round systems, or evidence that the thirteen years OneWeb will have had between its market access grant in 2017 and the end of the sunset period in 2030 would be insufficient.[350]

117. Kuiper states that OneWeb appears to misread the Commission's reason for discussing the full deployment milestone, stating that at no point does the Commission suggest that it is choosing that milestone as a means to protect incumbents—instead, the Commission chose it in recognition that once a new entrant has fully deployed its constellation, it should generally have the right to co-equal

[342] *Id.* at 9. OneWeb argues that the Commission's resolution of questions regarding the meaning of "co-equal" operations between first and second round operators, the levels of interference protection during and after the sunset period, and other issues raised in the *Further Notice* affect how operators will redesign their systems, which in turn affects the time necessary for first-round operators to accommodate new entrants. *Id*. at 10.

[343] *Id.* at 4.

[344] *Id.* at 5.

[345] *Id.* at 6.

[346] OneWeb Oct. 3, 2024 *ex parte* at 4-6.

[347] Kuiper Opposition; Kuiper July 24, 2024 *ex parte* at 16-17.

[348] *See* Kuiper Opposition at 2; Kuiper Oct. 18, 2024 *ex parte* at 5, 7; Kuiper Oct. 30, 2023 *ex parte* (contending that OneWeb untimely raised for the first time the argument that Commission's decision to ask further questions regarding the post-sunset regime prejudiced first-round operators by creating uncertainty).

[349] Kuiper Opposition at 4.

[350] *Id.* at 5-6; Kuiper July 24, 2024 *ex parte* at 16.

treatment.[351] And Kuiper notes that, as the Commission explained in direct response to OneWeb's argument, the fact that the full deployment milestone for some (or even many) later-round operators will not occur until after the 2030 sunset is irrelevant because "'the speed of deployment of the later-round systems would not affect the overall time that the incumbents will be protected by systems approved in the later processing round.'"[352]

118. Kuiper further states that the *Report and Order* did not premise the adoption of the sunset period on providing inter-round protections after second-round systems have fully deployed and are providing service, instead reasoning that first-round operators would need some "period of time" after an application had been granted in a new processing round to plan for co-equal sharing, and that the ten-year period, which would run from the grant of the first license in the next processing round, "appropriately balance[d] the need for stability for incumbent operations and the possibility for new entrants to compete on an equal footing once they have built out their systems."[353]

119. Kuiper also argues that OneWeb incorrectly assumes that second-round operators will delay offering any service until they are fully deployed, but that even if later-licensed systems did delay offering service in this manner, such delay would have no impact on the time given to OneWeb to operate with special protections.[354]

120. Kuiper further asserts that OneWeb's claim that the decision removes "any meaningful incentive for second-round operators to coordinate" ignores the Commission's thorough treatment of such incentives and record evidence that a sunset is likely to enhance the incentives for all parties to coordinate.[355] And Kuiper argues that OneWeb's argument that it has invested "billions of dollars" and "made significant financial investments in their next generation satellites based on the Commission's framework existing prior to the adoption of a sunset period" ignores the billions of dollars that second-round operators have invested in their own systems.[356]

121. Kuiper finally argues that none of the questions in the *Further Notice* implicate the length or application of the sunset period to first-round operators, and notes that OneWeb itself explicitly told the Commission that the "proposed sunset schedule" — that is, a 2030 sunset for second-round operators — "affords the Commission time to further consider these issues."[357]

122. OneWeb replied to Kuiper's opposition, arguing that the opposition fails to counter the issues raised in its petition and reiterating arguments in the petition.[358] OneWeb maintains that neither the *Report and Order* nor Kuiper have addressed the disparate treatment of first-round operators who have insufficient time to prepare for co-equal spectrum sharing.[359] OneWeb contends that Kuiper ignores that

[351] Kuiper Opposition at 7.

[352] *Id.* (citing *Report and Order*, 38 FCC Rcd at 3713, para. 34, n.97).

[353] *Id.*

[354] *Id.* at 8; *see also* Kuiper July 24, 2024 *ex parte* at 17 (noting that processing delays only harm second-round applicants with pending applications by delaying market entry while earlier-round systems enjoy extended period without any interference).

[355] Kuiper Opposition at 8.

[356] *Id.*

[357] *Id.* at 9.

[358] OneWeb Reply to Kuiper Opposition.

[359] *Id.* at 1-2.

the outcome of the *Further Notice* further diminishes first-round operators' time to prepare for the "fully defined regulatory framework" given that they will have to comply with the new rules.[360]

123. SpaceX also responded to the OneWeb Petition, arguing that the ten-year sunset period adopted by the Commission "strikes the appropriate balance" between incumbents and new entrants but stating that careful consideration should be given when incorporating deployment milestones for later-round systems to minimize any advantages for operators that refuse to coordinate.[361]

124. *Decision*. We dismiss in part and, on alternative and independent grounds, deny the OneWeb Petition in full on the merits. Under section 1.429(l)(3) of the Commission rules, the Commission may dismiss a petition for reconsideration that presents arguments previously considered and rejected.[362] OneWeb previously raised the issue that the 10-year sunset period would effectively eliminate advantages of first-round operators because of the timing of second-round grants, since first-round operators would be protected from interference for little or no time after some second-round grantees are fully deployed.[363] The Commission fully considered and rejected this argument in the *Report and Order* in this proceeding, finding that while the sunset may occur before some later-round systems have reached the full deployment milestone at nine years, contrary to OneWeb's argument, this would not "effectively eliminate" advantages for first-round operators, since the speed of deployment of the later-round systems would not affect the overall time that the incumbents will be protected by systems approved in the later processing round.[364] Accordingly, we dismiss this part of the OneWeb Petition pursuant to section 1.429(l)(3).

125. On alternative and independent grounds, we deny the OneWeb Petition on the merits. The *Report and Order* for the first time adopted an inter-round protection requirement to replace the Commission's explicit policy of case-by-case licensing of NGSO FSS systems after the cutoff date in an initial processing round.[365] In doing so, the Commission considered numerous sunsetting proposals on the record, ranging from 6 years after the application cut-off date in a processing round to 15 years commencing from release of the *Report and Order* for the current Ku-/Ka-band processing rounds and 15 years from the first authorization or market access grant in a subsequent processing round for future processing rounds.[366]

126. First, the *Report and Order* ensured all NGSO FSS operators authorized through a processing round the same 10-year period of time, following the first authorization in a subsequent processing round, during which they are protected by systems approved in that subsequent processing round under the newly adopted inter-round protection requirement.[367] The 10-year period, tied to the first authorization in a later round, balances the Commission's goals to afford later-round systems equal spectrum sharing opportunities under the spectrum-splitting procedure once their full service constellations are operational, while providing earlier-round systems time to adjust to the constellations ultimately deployed by later-round grantees, with simplicity and regulatory clarity.[368] While it is true that

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[360] *Id*. at 7-8.

[361] SpaceX Response to OneWeb Petition at 2. SpaceX also argues the Commission should take additional action to revisit its spectrum-splitting procedure so that, where NGSO FSS systems are unable to reach a coordination agreement, the more spectrally efficient system gets first choice of spectrum. *Id.* at 2-3.

[362] *See* 47 CFR § 1.429(l)(3).

[363] *See* Letter from Kimberly M. Baum, Vice President, Spectrum Engineering & Strategy, OneWeb to Marlene H. Dortch, Secretary, FCC, IB Docket No. 21-456 at 2 (filed Apr. 14, 2023).

[364] *See Report and Order*, 38 FCC Rcd at 3713, n.97.

[365] *Id*. at 3712-14, paras. 29-31.

[366] *Id.* at 3712, para. 28.

[367] *Id.* at 3713-14, para. 30.

first-round operators effectively had notice of seven years of protection from all second-round grantees under the new inter-round protection requirement, applying a 10-year sunset provision from the date of the release of the *Report and Order* would result in an effective 13-year sunset period for the first system authorized in the second processing round, contrary to the Commission's rationales for adopting the 10-year inter-round protection period and its goal of promoting new entry.

127. Indeed, the basis for the adoption of a 10-year period was not because it was the minimum necessary period for earlier-round systems to adjust to new entrants.[369] Rather, the Commission concentrated on the deployment timelines of *later*-round systems and reasoned that sunset period should "relieve earlier-round grantees of the uncertainty of near-term, equal sharing with new entrants" while giving later-round systems an equal opportunity to operate with their full service constellations, which may be completed at the nine-year final deployment milestone.[370] For OneWeb's first-round system approved in 2017, and for other first-round systems, we continue to find that a sunset date in 2030 (ten years after the first grant in the subsequent processing round, which occurred in 2020) relieves them of the uncertainty of near-term, equal sharing with new entrants intended by the sunset period. The *Report and Order* further noted the iterative development of NGSO FSS systems and the fact that many earlier-round grantees, like OneWeb,[371] have proposed updated, second-generation systems filed in a later processing round that will benefit from the sunsetting period applied to second-round systems.[372] As Kuiper notes, OneWeb provided no specific evidence to support its assertion that the sunset period as adopted is in fact insufficient.

128. The *Report and Order* also determined that sunsetting will not upset existing expectations of interference protection because, under Commission policy in effect prior to the *Report and Order*, later-round applicants were considered on a case-by-case basis as to whether they will be entitled to share spectrum on an equal basis with earlier-round systems – as such there was never a guarantee that earlier-round grantees would be entitled to protection from later-round systems.[373] OneWeb's citation to a grant condition in which a later-round licensee was required to protect NGSO FSS systems authorized through an earlier processing round does not create a reasonable expectation that OneWeb would be protected indefinitely from all later-round applicants.[374] The *Report and Order* acknowledged the Commission's then-existing policy of case-by-case licensing of NGSO FSS systems filed after a processing round, including licensing conditions,[375] and based on the record in the proceeding decided to adopt a generally applicable inter-round protection requirement with an accompanying sunset provision.[376] While OneWeb argues the Commission "provided no notice that all such later-round operators would be entitled to co-equal operations,"[377] the policy of case-by-case licensing meant that any future applicant – or all future applicants – could be afforded co-equal status with earlier-round systems. The sunset period also does not effectively create an open-ended processing round because the sunset guarantees a period of time of unequal protection for earlier-round systems, during which earlier-round

(Continued from previous page)

[368] *Id.*

[369] *See, e.g., id.* at 3713, para. 30.

[370] *See id.* at 3713, para. 30.

[371] *See* ICFS File Nos. SAT-LOI-20160428-00041, SAT-MPL-20200526-00062 and SAT-APL-20210112-00007.

[372] *See Report and Order*, 38 FCC Rcd at 3714, para. 31.

[373] *Id*.

[374] OneWeb Petition at 8 (citing *Kuiper Systems, LLC, Application for Authority to Deploy and Operate a Ka-band Non-Geostationary Satellite Orbit System*, Order and Authorization, 35 FCC Rcd 8324, 8344, para. 59 (2020)).

[375] *See Report and Order*, 38 FCC Rcd at 3704, para. 13, n.35.

[376] *Id.* at 3712, para. 29.

[377] OneWeb Petition at 8.

systems are not required to protect later-round systems, while an open-ended processing round would immediately treat all NGSO FSS systems on an equal basis.

129. Second, the *Report and Order* tied the 10-year sunset date to the date of the first authorization in a later processing round. In doing so, the Commission acknowledged that "the sunset may occur before some later-round systems have reached the full deployment milestone at nine years" but reasoned, contrary to OneWeb's argument, this would not "effectively eliminate" advantages for first-round operators, since the speed of deployment of the later-round systems would not affect the overall time that the incumbents will be protected by systems approved in the later processing round.[378] Similarly, we do not share OneWeb's concern that some "second-round operators' fully-deployed systems would never have to protect First Round operators, effectively placing the later-arriving operators in the first processing round," "contrary to the Commission's acknowledgement that First Round operators should have some benefits, and remov[ing] any meaningful incentive for second-round operators to coordinate with First Round operators."[379] The basis for the 10-year sunset period was not to lock in coordination advantages for earlier-round systems. Rather, the Commission determined that fully deployed later-round systems *should* be able to operate on an equal basis with earlier-round systems; not that they must protect earlier-round systems for a specific period of time after full deployment.[380] Further, the benefit to earlier-round operators is that they are entitled to a 10-year period after the initial grant in a later processing round in which later-round systems must protect the earlier-round system while accepting any interference caused by the earlier-round system, unless a coordination agreement has been reached. And as explained in the *Report and Order*, we do not expect the sunset period to introduce significant coordination delays because the period is long enough that a later-round grantee would not wish to operate for years without an agreement with earlier-round grantees.[381]

130. Finally, we disagree that the exploration of issues in the *Further Notice*, some of which OneWeb itself requested, justifies changing the sunset provision. Specifically, OneWeb argues that having as open issues "what protection levels should be imposed during and after the sunset period" and "what 'co-equal' means when established operators are to operate a co-equal basis with newer entrants" shortens the time period for it to prepare for new entrants at the end of the sunset period.[382] In the Second Report and Order above, we reaffirm the decision in the *Report and Order* to apply the default, spectrum-splitting mechanism between earlier and later-round systems after sunset. Therefore, there is no change in the post-sunset regime from what was adopted in the *Report and Order*. In addition, the Second Report and Order declines to adopt any cap on the number of NGSO FSS systems that can operate in a given frequency band, negating OneWeb's concern that doing so may render the sunset period superfluous. Similarly, the Second Report and Order does not place any restrictions on "the opening of different processing rounds," nor limit "the number of NGSO systems accommodated."[383] The changes the Commission has adopted in the Second Report and Order to the inter-round protection requirement also do not "shorten" the sunset period for first-round systems because, while they will apply immediately

[378] *Report and Order*, 38 FCC Rcd. at 3713-14, para. 30, n.97.

[379] OneWeb Petition at 5-6.

[380] *See Report and Order*, 38 FCC Rcd at 3713, para. 30 ("We believe that the protection afforded to an earlier-round system by a later-round system should work in concert with our deployment milestones for NGSO systems to relieve earlier-round grantees of the uncertainty of near-term, equal sharing with new entrants while also giving later-round systems an equal opportunity after they have demonstrated their commitment to provide service and completed their final deployment milestone."); *id.* at 3713-14, para. 30 ("We believe this period appropriately balances the need for stability for incumbent operations and the possibility for new entrants to compete on an equal footing once they have built out their systems.").

[381] *Id.* at 3714, para. 31.

[382] OneWeb Petition at 9-10.

[383] *See id*. at 9.

upon the effective date of the rule changes, they will not apply between first and second-round systems after the sunset period.

## IV. PROCEDURAL MATTERS

131. *Regulatory Flexibility Act.* The Regulatory Flexibility Act of 1980, as amended (RFA),[384] requires that an agency prepare a regulatory flexibility analysis for notice and comment rulemakings, unless the agency certifies that "the rule will not, if promulgated, have a significant economic impact on a substantial number of small entities."[385] Accordingly, we have prepared a Final Regulatory Flexibility Analysis (FRFA) concerning the possible impact of the rule changes contained in this Second Report and Order on small entities. The FRFA is set forth in Appendix B.

132. *Paperwork Reduction Act*. The Second Report and Order contains modified information collection requirements subject to the Paperwork Reduction Act of 1995 (PRA), Public Law 104-13. It will be submitted to the Office of Management and Budget (OMB) for review under Section 3507(d) of the PRA. OMB, other Federal agencies, and the general public are invited to comment on the modified information collection requirements contained in this document.

133. In this document, we have assessed the effects of requiring later-round NGSO FSS grantees to submit compatibility showings with respect to earlier-round grantees with whom coordination has not yet been reached. We find that doing so will serve the public interest and is unlikely to directly affect businesses with fewer than 25 employees.

134. *Congressional Review Act.* The Commission has determined, and the Administrator of the Office of Information and Regulatory Affairs, Office of Management and Budget, concurs that this rule is non-major under the Congressional Review Act, 5 U.S.C. § 804(2). The Commission will send a copy of this Second Report and Order and Order on Reconsideration to Congress and the Government Accountability Office pursuant to the Congressional Review Act, see 5 U.S.C. § 801(a)(1)(A).

## V. ORDERING CLAUSES

135. IT IS ORDERED, pursuant to Sections 4(i), 7(a), 10, 303, 308(b), and 316 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 154(i), 157(a), 160, 303, 308(b), 316, that this Second Report and Order and Order on Reconsideration IS ADOPTED, the policies, rules, and requirements discussed herein ARE ADOPTED, and Part 25 of the Commission's rules IS AMENDED as set forth in Appendix A.

136. IT IS FURTHER ORDERED that, pursuant to sections 1, 4(i), 4(j), and 405 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 151, 154(i), 154(j), 405, and section 1.429(b) and 1.429(l)(3) of the Commission's rules, 47 CFR § 1.429(b), (l)(3), that the petition for reconsideration filed by WorldVu Satellites Limited in IB Docket No. 21-456, is DISMISSED IN PART and, on alternative and independent grounds, DENIED.

137. IT IS FURTHER ORDERED that this Second Report and Order and Order on Reconsideration SHALL BE effective 30 days after publication in the Federal Register, except that section 25.261(d), which may contain new or modified information collection requirements, will not become effective until the Office of Management and Budget completes review of any information collection requirements that the Space Bureau determines is required under the Paperwork Reduction Act. The Commission directs the Space Bureau to announce the effective date of section 25.261(d) by subsequent Public Notice.

138. IT IS FURTHER ORDERED that the Commission's Office of Secretary SHALL SEND

[384] 5 U.S.C. §§ 601–612. The RFA has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996).

[385] 5 U.S.C. § 605(b).

a copy of this Second Report and Order and Order on Reconsideration, including the Final Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

139. IT IS FURTHER ORDERED that the Commission's Office of the Managing Director, Performance Program Management, SHALL SEND a copy of this Second Report and Order and Order on Reconsideration in a report to be sent to Congress and the Government Accountability Office pursuant to the Congressional Review Act, *see* 5 U.S.C. § 801(a)(1)(A).

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

## APPENDIX A

## Final Rules

The Federal Communications Commission amends title 47 of the Code of Federal Regulations, part 25, as follows:

PART 25 – SATELLITE COMMUNICATIONS

1. The authority citation for part 25 continues to read as follows:

Authority: 47 U.S.C. 154, 301, 302, 303, 307, 309, 310, 319, 332, 605, and 721, unless otherwise noted.

2. Amend § 25.261 by revising paragraphs (d) and (e) to read as follows:

§ 25.261 Sharing among NGSO FSS space stations.

* * * * *

(d) *Protection of earlier-round systems*. Prior to commencing operations, an NGSO FSS licensee or market access recipient must either certify that it has completed a coordination agreement with any operational NGSO FSS system licensed or granted U.S. market access in an earlier processing round, or submit for Commission approval a compatibility showing which demonstrates by use of a degraded throughput methodology that it will not cause harmful interference to any such system with which coordination has not been completed. If an earlier-round system becomes operational after a later-round system has commenced operations, the later-round licensee or market access recipient must submit a certification of coordination or a compatibility showing with respect to the earlier-round system no later than 60 days after the earlier-round system commences operations as notified pursuant to § 25.121(b) or otherwise.

(1) Compatibility showings must contain the following elements:

(A) A demonstration that the later-round system will cause no more than 3% time-weighted average degraded throughput of the link to the earlier-round system, for links with a baseline link availability of 99.0% or higher at a C/N threshold of 0 dB;

(B) A demonstration that the later-round system will cause no more than 0.4% absolute change in link availability to the earlier-round system using a C/N threshold value of 0 dB, for links with a baseline link availability of 99.0% link availability or higher; and

(C) With respect to an earlier-round system that has not yet satisfied its 50% deployment milestone pursuant to section 25.164(b)(1) of this part, the compatibility showing may consider only 50% deployment of the earlier-round system; if the 50% deployment milestone has been satisfied, the showing must consider 100% deployment of the authorized system.

(2) Compatibility showings will be placed on public notice pursuant to § 25.151(a)(13).

(3) While a compatibility showing remains pending before the Commission, the submitting NGSO FSS licensee or market access recipient may commence operations on an unprotected, non-interference basis with respect to the operations of the system that is the subject of the showing.

(4) A later-round NGSO FSS system will be required to conform its operations to its compatibility showing submitted for the protection of an earlier-round system to the extent necessary to protect the actual number of deployed and operating space stations of the earlier-round system.

(e) *Sunsetting*. Ten years after the first authorization or grant of market access in a processing round, the systems approved in that processing round will no longer be required to protect earlier-rounds systems under paragraph (d) of this section, and instead will be required to share spectrum with earlier-round systems under paragraph (c) of this section.

## APPENDIX B

## Final Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act of 1980, as amended (RFA),[1] an Initial Regulatory Flexibility Analysis (IRFA) was incorporated in the *Revising Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems*, Further Notice of Proposed Rulemaking (*Further Notice*) released in April 2023.[2] The Federal Communications Commission (Commission) sought written public comment on the proposals in the *Further Notice*, including comment on the IRFA. No comments were filed addressing the IRFA. This Final Regulatory Flexibility Analysis (FRFA) conforms to the RFA.[3]

### A. Need for, and Objectives of, the Second Report and Order

2. The Second Report and Order continues to facilitate the deployment of non-geostationary satellite orbit, fixed-satellite service (NGSO FSS) systems capable of providing broadband and other services on a global basis, by refining the Commission's rules governing spectrum sharing among a new generation of broadband satellite constellations to promote market entry, regulatory certainty, and spectrum efficiency through good-faith coordination. The Commission amends its rules governing the treatment of NGSO FSS systems filed in different processing rounds clarifying certain details of the degraded throughput methodology that, in the absence of a coordination agreement, must be used in compatibility analyses by NGSO FSS system licensees authorized through later processing rounds to show they can operate compatibly with, and protect, NGSO FSS systems authorized through earlier processing rounds.

3. Specifically, the Second Report and Order clarifies details regarding the implementation of a degraded throughput methodology by adopting a 3% throughput degradation as a long-term interference protection criterion, a 0.4% absolute increase in link unavailability as a short-term interference protection criterion, and declining to adopt additional protection metrics or to adopt an aggregate limit on interference from later-round NGSO FSS systems into earlier-round NGSO FSS systems. It also affirms that the default, spectrum-splitting mechanism will be applied among NGSO systems in different processing rounds after the sunset period. The actions the Commission takes in this proceeding further its efforts to promote development, and competition among broadband NGSO FSS system proponents, including the market entry of new competitors.[4]

### B. Summary of Significant Issues Raised by Public Comments in Response to the IRFA

4. There were no comments filed that specifically addressed the proposed rules and policies presented in the IRFA.

[1] 5 U.S.C. § 603. The RFA, 5 U.S.C. §§ 601-612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996, (SBREFA) Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996).

[2] *Revising Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems*, Report and Order and Further Notice of Proposed Rulemaking, 38 FCC Rcd 3699, 3729-32, Appendix C (2023) (*Report and Order*).

[3] 5 U.S.C. § 604.

[4] *See generally* Executive Order No. 14036, Promoting Competition in the American Economy, 86 FR 36987 (July 9, 2021) ("The heads of all agencies shall consider using their authorities to further the policies set forth in section 1 of this order, with particular attention to: (i) the influence of their respective regulations, particularly any licensing regulations, on concentration and competition in the industries under their jurisdiction; and…"). Executive Order at 86 FR 36991.

### C. Response to Comments by the Chief Counsel for Advocacy of the Small Business Administration

5. Pursuant to the Small Business Jobs Act of 2010, which amended the RFA, the Commission is required to respond to any comments filed by the Chief Counsel for Advocacy of the Small Business Administration (SBA), and to provide a detailed statement of any change made to the proposed rules as a result of those comments.[5] The Chief Counsel did not file any comments in response to the proposed rules in this proceeding.

### D. Description and Estimate of the Number of Small Entities to Which the Rules Will Apply

6. The RFA directs agencies to provide a description of, and where feasible, an estimate of the number of small entities that may be affected by the rules adopted herein.[6] The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."[7] In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act.[8] A "small business concern" is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the SBA.[9]

7. *Satellite Telecommunications*. This industry comprises firms "primarily engaged in providing telecommunications services to other establishments in the telecommunications and broadcasting industries by forwarding and receiving communications signals via a system of satellites or reselling satellite telecommunications."[10] Satellite telecommunications service providers include satellite and earth station operators. The SBA small business size standard for this industry classifies a business with $44 million or less in annual receipts as small.[11] U.S. Census Bureau data for 2017 show that 275 firms in this industry operated for the entire year.[12] Of this number, 242 firms had revenue of less than $25 million.[13] Consequently, using the SBA's small business size standard most satellite telecommunications service providers can be considered small entities. The Commission notes however, that the SBA's revenue small business size standard is applicable to a broad scope of satellite telecommunications providers included in the U.S. Census Bureau's Satellite Telecommunications

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[5] 5 U.S.C. § 604(a)(3).

[6] *Id*. § 604(a)(4).

[7] *Id*. § 601(6).

[8] *Id*. § 601(3) (incorporating by reference the definition of "small-business concern" in the Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies "unless an agency, after consultation with the Office of Advocacy of the Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register."

[9] 15 U.S.C. § 632.

[10] *See* U.S. Census Bureau, *2017 NAICS Definition*, "*517410 Satellite Telecommunications*," https://www.census.gov/naics/?input=517410&year=2017&details=517410.

[11] *See* 13 CFR § 121.201, NAICS Code 517410.

[12] *See* U.S. Census Bureau, *2017 Economic Census of the United States*, *Selected Sectors: Sales, Value of Shipments, or Revenue Size of Firms for the U.S.: 2017*, Table ID: EC1700SIZEREVFIRM, NAICS Code 517410, https://data.census.gov/cedsci/table?y=2017&n=517410&tid=ECNSIZE2017.EC1700SIZEREVFIRM&hidePreview=false. At this time, the 2022 Economic Census data is not available.

13 *Id*. The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard. We also note that according to the U.S. Census Bureau glossary, the terms receipts and revenues are used interchangeably, *see* https://www.census.gov/glossary/#term_ReceiptsRevenueServices.

industry definition. Additionally, the Commission neither requests nor collects annual revenue information from satellite telecommunications providers, and is therefore unable to more accurately estimate the number of satellite telecommunications providers that would be classified as a small business under the SBA size standard. For purposes of this proceeding it is likely that there are very few entities meeting the SBA's definition of small satellite telecommunications providers that are small satellite system operators involved in designing, manufacturing, and launching a satellite due to the generally a high fixed cost of these activities.[14]

8. *All Other Telecommunications.* This industry comprises firms "primarily engaged in providing specialized telecommunications services, such as satellite tracking, communications telemetry, and radar station operation.[15] This industry also includes establishments primarily engaged in providing satellite terminal stations and associated facilities connected with one or more terrestrial systems and capable of transmitting telecommunications to, and receiving telecommunications from, satellite systems.[16] Providers of Internet services (e.g. dial-up ISPs) or Voice over Internet Protocol (VoIP) services, via client-supplied telecommunications connections are also included in this industry.[17] The SBA small business size standard for this industry classifies firms with annual receipts of $40 million or less as small.[18] U.S. Census Bureau data for 2017 show that there were 1,079 firms in this industry that operated for the entire year.[19] Of those firms, 1,039 had revenue of less than $25 million.[20] Based on this data, the Commission estimates that the majority of "All Other Telecommunications" firms can be considered small.

### E. Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements for Small Entities

9. The Second Report and Order amends rules that are applicable to space station operators requesting a license or grant of U.S. market access from the Commission. Specifically, the Second Report and Order adopts changes to the spectrum sharing requirements among NGSO FSS satellite systems approved in different processing rounds, and specifies details of the technical demonstration that space station licensees and market access grantees that were authorized through a later processing round must submit to show that they will not cause harmful interference to space station licensees and market access grantees that were authorized through an earlier processing round, prior to the sunsetting period, if the later-round grantees have not certified that they have reached a coordination agreement with the earlier-round grantees. The technical demonstration of compatibility between the later-round system and the earlier-round system is based on a degraded throughput methodology and assessing absolute increase in link unavailability.

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[14] *See Communications Marketplace Report*, GN Docket No. 22-203, 2022 WL 18110553 at 138, para, 206. (2022) (*2022 Communications Marketplace Report*).

[15] *See* U.S. Census Bureau, *2017 NAICS Definition*, "*517919 All Other Telecommunications*," https://www.census.gov/naics/?input=517919&year=2017&details=517919.

[16] *Id.*

[17] *Id*.

[18] *See* 13 CFR § 121.201, NAICS Code 517919 (as of 10/1/22, NAICS Code 517810).

[19] *See* U.S. Census Bureau, *2017 Economic Census of the United States*, *Selected Sectors: Sales, Value of Shipments, or Revenue Size of Firms for the U.S.: 2017,* Table ID: EC1700SIZEREVFIRM, NAICS Code 517919, https://data.census.gov/cedsci/table?y=2017&n=517919&tid=ECNSIZE2017.EC1700SIZEREVFIRM&hidePreview=false. At this time, the 2022 Economic Census data is not available.

[20] *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard. We also note that according to the U.S. Census Bureau glossary, the terms receipts and revenues are used interchangeably, *see* https://www.census.gov/glossary/#term_ReceiptsRevenueServices.

10. The adopted metrics, values, and assumptions to finalize degraded throughput methodology will impact information later-round NGSO FSS system operators are required to report in compatibility analysis submissions. However, because of the costs involved in developing and deploying an NGSO FSS satellite constellation, the Commission anticipates that few NGSO FSS operators affected by this rulemaking would qualify under the SBA definition of "small entity," and therefore small entities are not likely to have to hire professionals, or incur any compliance costs as a result of the Second Report and Order.

### F. Steps Taken to Minimize the Significant Economic Impact on Small Entities, and Significant Alternatives Considered

11. The RFA requires an agency to provide, "a description of the steps the agency has taken to minimize the significant economic impact on small entities…including a statement of the factual, policy, and legal reasons for selecting the alternative adopted in the final rule and why each one of the other significant alternatives to the rule considered by the agency which affect the impact on small entities was rejected."[21]

12. The Second Report and Order defines specific metrics for long-term interference and short-term interference that must be used in compatibility analyses demonstrating that a later-round NGSO FSS system will adequately protect an earlier-round system. Agreeing with the general consensus of commenters, the Second Report and Order adopts a 3% degraded throughput threshold as the long-term interference metric for inter-round compatibility analyses and a 0.4% absolute increase in link unavailability as the short-term interference metric based on the technical record developed in this proceeding. The Commission concludes that establishing a specific long-term interference protection metric consistent with the technical evidence in the record provides the benefit of a clear standard for new entrants, and a benchmark that parties can use to negotiate any alternative long-term protections mutually agreed to in coordination.

13. The Commission specifically considered, and declined, adopting additional protection metrics for loss of synchronization, multiple carrier-to-noise (C/N) objectives, or aggregate interference limits in part because of the additional complexities and costs that complying with such additional metrics could entail. Similarly, the Commission considered, and rejected, incorporating interference from additional sources in the baseline calculation, such as from GSO networks, other NGSO FSS systems, and intra-system noise, in part to simplify the analysis required of new entrants in the absence of a coordination agreement. Moreover, to lower burdens on later-round operators, the Commission provides illustrative examples of parameters that may be used when preparing compatibility analyses and which will be considered on a case-by-case basis as to whether they are reliable and representative. The Commission also considered and reaffirmed its decision from the *Report and Order* to apply the default, spectrum-splitting mechanism to earlier and later-round operators after the sunset date to place them on equal footing, noting that facilitating equal treatment of later-round operators after the sunset date was a key component of the sunset provision.[22] Additionally, by reaffirming this decision the Commission ensures that earlier-round advantages do not continue indefinitely, and simplifies the regulatory framework when systems authorized through multiple processing rounds may be operating.

### G. Report to Congress

14. The Commission will send a copy of the *Second Report and Order*, including this FRFA, in a report to be sent to Congress pursuant to the Congressional Review Act.[23] In addition, the Commission will send a copy of the Second Report and Order, including this FRFA, to the Chief Counsel

[21] 5 U.S.C. § 604(a)(6).

[22] *Report and Order*, 38 FCC Rcd at 3713-14, para. 30.

[23] 5 U.S.C. § 801(a)(1)(A).

for Advocacy of the SBA. A copy of the Second Report and Order and FRFA (or summaries thereof) will also be published in the Federal Register.[24]

[24] *Id*. § 604(b).

## APPENDIX C

## List of Commenters

**Comments on the *Further Notice* in IB Docket No. 21-456**

Information Technology and Innovation Foundation (ITIF)
Intelsat License LLC (Intelsat)
Kepler Communications Inc. (Kepler)
Kuiper Systems LLC (Kuiper)
O3b Limited (O3b)
Space Exploration Holdings, LLC (SpaceX)
TechFreedom
Telesat Canada (Telesat)
Viasat, Inc. (Viasat)
WorldVu Satellites Limited (OneWeb)

**Reply Comments on the *Further Notice* in IB Docket No. 21-456**

Intelsat
Kuiper
Mangata
O3b
OneWeb
SpaceX
Telesat
ViaSat

**Comments on the Petition for Reconsideration in IB Docket No. 21-456**

Kuiper
SpaceX

**Reply Comments on the Petition for Reconsideration in IB Docket No. 21-456**

OneWeb

***Ex Parte* Filings in IB Docket No. 21-456 after Release of the *Further Notice***

Kuiper June 20, 2023 *ex parte*
Kuiper Oct. 30, 2023 *ex parte*
OneWeb Apr. 3, 2024 *ex parte*
OneWeb Apr. 15, 2024 *ex parte*
OneWeb and Eutelsat S.A. May 6, 2024 *ex parte*
Kuiper May 7, 2024 *ex parte*
Kuiper May 10, 2024 *ex parte*
Kuiper May 10, 2024 *ex parte*
SpaceX May 24, 2024 *ex parte*
Telesat July 5, 2024 *ex parte*
Telesat July 11, 2024 *ex parte*
OneWeb July 18, 2024 *ex parte*
SpaceX July 21, 2024 *ex parte*
Kuiper July 24, 2024 *ex parte*

SpaceX July 25, 2024 *ex parte*
Kuiper August 1, 2024 *ex parte*
SpaceX August 1, 2024 *ex parte*
Kuiper August 5, 2024 *ex parte*
Kuiper August 12, 2024 *ex parte*
SpaceX August 14, 2024 *ex parte*
O3b August 22, 2024 *ex parte*
SpaceX August 26, 2024 *ex parte*
SpaceX August 29, 2024 *ex parte*
O3b August 30, 2024 *ex parte*
O3b September 5, 2024 *ex parte*
SpaceX September 30, 2024 *ex parte*
Telesat October 2, 2024 *ex parte*
O3b October 2, 2024 *ex parte*
O3b October 3, 2024 *ex parte*
OneWeb October 3, 2024 *ex parte*
O3b October 7, 2024 *ex parte*
O3b October 9, 2024 *ex parte*
O3b October 11, 2024 *ex parte*
OneWeb October 15, 2024 *ex parte*
O3b October 17, 2024 *ex parte*
O3b October 18, 2024 *ex parte*
Intelsat October 18, 2024 *ex parte*
Kuiper October 18, 2024 *ex parte*
O3b October 21, 2024 *ex parte*
Telesat October 22, 2024 *ex parte*
OneWeb October 31, 2024 *ex parte*
Open Technology at New America, Public Knowledge November 1, 2024 *ex parte*
Hughes Network Systems November 4, 2024 *ex parte*
X2nSat, Inc. November 5, 2024 *ex parte*
OneWeb November 7, 2024 *ex parte*