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April 3, 2019

File Number: 48HH-246229

VIA IBFS

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Re: **Notice of Ex Parte Presentation**
Space Exploration Holdings, LLC; Application for Modification of Authorization for the SpaceX NGSO Satellite System; IBFS File No. SAT-MOD-201801108-00083
WorldVu Satellites Limited; Application for Modification; IBFS File No. SAT-MOD-20180319-00022

Dear Ms. Dortch:

On Monday, April 1, 2019, Mariah Shuman, Head of Regulatory Affairs, Americas and Mike Lindsay, Principal, Advanced Mission Design of WorldVu Satellites Limited ("OneWeb"), together with the undersigned, met with the following members of the Commission's International Bureau: Troy Tanner, Jose Albuquerque, Jay Whaley, Karl Kensinger, and Stephen Duall (present via telephone).[1] In the meeting, OneWeb responded to the recent response of Space Exploration Holdings ("SEH" or "SpaceX") to OneWeb's technical analysis demonstrating the increase in actual interference that other non-geostationary, fixed-satellite systems ("NGSO FSS") will experience as a result of SpaceX's proposed modifications to its licensed but unlaunched NGSO FSS system.[2] The Commission should reject SpaceX's specious mischaracterization of OneWeb's weighty analysis and require SpaceX to make the demonstration the Commission's precedent and processing rules require. So far, SpaceX has not made the required demonstration that "the proposed modifications to [SpaceX's] space

[1] OneWeb attempted to file this Notice of Ex Parte Presentation until midnight on April 3, 2019, but IBFS was down. Consequently, OneWeb filed the Notice of Ex Parte Presentation upon the resumption of the IBFS website's normal operations on April 4, 2019.

[2] *See* Reply of WorldVu Satellites Limited, IBFS File No. SAT-MOD-201801108-00083 (filed Mar. 5, 2019) ("OneWeb Reply"); Letter from William M. Wiltshire, Counsel to Space Exploration Holdings, LLC, to Marlene H. Dortch, Secretary, FCC at 2 (Mar. 18, 2019) ("March 18 Ex Parte"); Application for Modification of Authorization for the SpaceX NGSO Satellite System, IBFS File No. SAT-MOD-201801108-00083 (filed Nov. 8, 2018) ("SpaceX Modification Application").

segment do not . . . create any significant interference problems to other systems or make sharing [with] other NGSO FSS systems significantly more difficult."[3] Until SpaceX provides this demonstration, the Commission should not act on the SpaceX Modification Application.

During the meeting, OneWeb highlighted that OneWeb filed a similar modification application for its own authorized NGSO FSS system over one year ago.[4] Unlike the SpaceX Modification Application, the OneWeb Modification Application did not propose to change any frequency usage. The OneWeb Modification Application made one simple request: to increase the number of satellites in the OneWeb constellation as a direct response to changes in the Commission's NGSO milestone rule.[5] Even as modified, the OneWeb constellation will still only contain a fraction of the number of satellites proposed by SpaceX. Moreover, grant of the OneWeb Modification Application will permit OneWeb to employ satellite diversity, thus allowing OneWeb to further mitigate interference events and ease sharing.

OneWeb also noted that it successfully launched the first six satellites in the OneWeb constellation on February 27, 2019 and also announced on March 18, 2019 that OneWeb raised another $1.25B for a total of $3.4B in funding raised to date. Notwithstanding the progress OneWeb has made in building, launching, and financing its system, the OneWeb Modification Application remains pending at the Commission. OneWeb respectfully requested during the meeting that the Commission accord equal treatment for the OneWeb Modification Application and the SpaceX Modification Application. In other words, the OneWeb Modification Application and the SpaceX Modification Application should be processed in the same time frame and acted upon contemporaneously. This approach preserves regulatory parity among competing parties.

OneWeb also described the stark contrast between now and the last time large-scale NGSO FSS systems were proposed to the Commission approximately twenty years ago. Currently, it appears multiple NGSO FSS systems are moving from concept to reality. Indeed, as noted above, OneWeb has already launched the first six satellites in its constellation. OneWeb has also initiated the processes necessary to increase its launch cadence over the next 18 months. The exercise of ensuring the SpaceX Modification Application does not create

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[3] *See Teledesic LLC*, 14 FCC Rcd 2261, ¶ 7 (IB 1999) ("*Teledesic*"). SpaceX has cited to *Teledesic* as representative precedent. *See, e.g.* SpaceX Modification Application, Legal Narrative at 11. *See also Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters,* Report and Order and Further Notice of Proposed Rulemaking, 32 FCC Rcd 7809, ¶ 61 (2017) ("NGSO Order") ("The purpose of the recent processing rounds was to establish a sharing environment among NGSO systems, to provide a measure of certainty in lieu of adopting an open-ended requirement to accommodate all future applicants").

[4] *See* WorldVu Satellites Limited, Application for Modification, IBFS File No. SAT-MOD-20180319-00022 (filed Mar. 19, 2018) ("OneWeb Modification Application"). By contrast, the SpaceX Modification Application was filed just five months ago on November 8, 2018.

[5] *See* NGSO Order at ¶ 66.

any significant interference problems to other NGSO FSS systems is not merely theoretical. OneWeb stressed that failure to carefully scrutinize the impact of the SpaceX Modification Application will have real-world consequences, both on the ground and in space.[6]

In addition to the foregoing discussion, Mike Lindsay from OneWeb led a technical discussion utilizing the attached presentation. In this technical discussion, OneWeb discussed OneWeb's critique of the SpaceX interference analysis submitted as part of SpaceX's Further Opposition. OneWeb noted language in SpaceX's March 18 Ex Parte that mistakenly attempts to portray the "irony" of OneWeb's critique because OneWeb, according to SpaceX, allegedly "used precisely the same approach for the interference analysis it submitted to the International Telecommunication Union ("ITU") in May 2017 in support of its own system modification."[7]

As an initial matter, SpaceX strains credulity by claiming that its analysis—comprising only four sets of CDF curves, each analyzing only one victim antenna size, from only two NGSO systems, for a total of 4 comparisons—is even remotely close to analogous, let alone "precisely the same" as the approach OneWeb utilized in its comprehensive, 55-page submission to the ITU in May 2017 ("ITU Submission").[8] Far from supporting SpaceX's misguided determination that the SpaceX and OneWeb analyses share the same approach, the stark contrast between the two documents highlights the paucity of analysis provided by SpaceX. SpaceX must demonstrate that a grant of the SpaceX Modification Application will not cause an increase in interference to other NGSO FSS systems (a heavy burden that SpaceX bears).

Moreover, OneWeb is concerned by the constantly shifting nature of SpaceX's various technical analyses of the interference impact of the SpaceX Modification Application. For example, the first SpaceX technical analysis was critically flawed in that it only modelled a single Ku-band link, instead of four simultaneous Ku-band links as proposed.[9] In response, SpaceX addressed the link architecture concerns, but curiously changed its modelled tracking strategy

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[6] OneWeb utilized information from recent SpaceX earth station applications for purposes of analyzing the space station proposal in the SpaceX Modification Application. OneWeb did not discuss the merits of these earth station applications and took no position on the grant or denial of the earth station applications during the meeting with Commission staff.

[7] March 18 Ex Parte at 2. *See also* Further Consolidated Opposition to Petitions and Response to Comments of Space Exploration Holdings, LLC, Attachment A, IBFS File No. SAT-MOD-20181108-00083 (filed Feb. 21, 2019) ("Further Opposition").

[8] March 18 Ex Parte at 2.

[9] *See* Petition to Deny or Defer of WorldVu Satellites Limited, IBFS File No. SAT-MOD-201801108-00083 at 2-3 (filed Feb. 8, 2019). Multiple commenters also pointed out SpaceX's convenient decision to analyze such an esoteric, non-representative NGSO system. *See* Reply Comments of Kepler Communications, Inc., IBFS File No. SAT-MOD-20181108-00083 at 3 (filed Feb. 24, 2019); Comments of SES Americom, Inc. and O3b Limited, IBFS File No. SAT-MOD-20181108-00083 at 3 (filed Feb. 8, 2019).

to an unrealistic and unjustified "worst-case" selection.[10] SpaceX admits that it is "highly unlikely" that its earth stations would transmit to worst-case satellites at each time step, and in actual deployments this method of operation would be nearly impossible to sustain due to interference levels.[11] This "worst-case" selection—which also uses careful antenna and latitude selections to amplify I/N values—unjustifiably biases the results of any interference analysis in SpaceX's favor. This is simply not "precisely the same approach" that OneWeb utilized in the ITU Submission, which used a highest-elevation tracking strategy. SpaceX's statements to the contrary are erroneous.

SpaceX's new approach also appears to be directly at odds with the views on regulatory modelling expressed by Working Party 4A, to which SpaceX provided input.[12] In Document 4A/779-E to ITU-R Working Party 4A, the United States recognizes that worst-case link modelling "becomes unreasonably pessimistic when applied to recently proposed advanced non-GSO systems with steerable beams," and results in statistics that illustrate "a significant dichotomy between realistic operations, where in fact additional routing options could be used to mitigate interference, and regulatory modelling."[13] To remedy this, the authors of the document suggest that a "potential solution would be to allow the non-GSO operator to specify a beam routing policy that will match the behavior of their system," clearly indicating that worst-case link modelling is not a valid representation of operational realities.[14]

Despite multiple submissions purporting to address these issues, to date SpaceX has produced no analysis that accurately portrays the interference other NGSO FSS systems will experience if the Commission grants the SpaceX Modification Application.[15] The notable absence of meaningful analysis is even more surprising given that there are at least two analytical models SpaceX could have chosen to utilize that would have generated an accurate depiction of the interference that will be caused by its proposed modifications:

- ***System Agnostic Model***. One method of modelling SpaceX could have chosen would include a satellite tracking strategy that is agnostic of other NGSO systems. Examples of such an analysis could include highest elevation selection, longest track selection,

[10] *See* Further Opposition at A-1.

[11] OneWeb Reply at 4.

[12] ITU-R Working Party 4A, *List of participants - Working Party 4A (Geneva, 3-14 July 2018)* at 11, *available at* https://www.itu.int/dms_ties/itu-r/md/15/wp4a/c/R15-WP4A-C-0825!!PDF-E.pdf (TIES account required for access).

[13] ITU-R Working Party 4A, Document 4A/779-E at 2, *available at* https://www.itu.int/md/R15-WP4A-C-0779/en (TIES account required for access) ("ITU WP4A Revisions").

[14] *Id*. at 4.

[15] *See* Further Opposition; SpaceX Modification Application.

randomized selection, or any other strategy devised by SpaceX. This method would also be consistent with WP4A's regulatory modelling recommendations.[16]

- ***System Specific Model***. Another method of modelling SpaceX could have chosen to provide would involve taking into consideration other NGSO FSS systems. Under this model, SpaceX would have also accounted for the Commission's requirement that NGSO FSS operators coordinate in good faith to minimize the potential for harmful interference.[17]

In neither of these two realistic modelling scenarios is choosing worst-case I/N links at each time step defensible, as this necessarily would involve SpaceX choosing links which maximize interference into other systems at every timestep, as the SpaceX analysis provided in the Further Opposition does.[18] This kind of analysis is not merely unrepresentative of the interference that would be experienced by other NGSO FSS systems; it also constitutes an operating scenario in which SpaceX's proposed service would be degraded as a result of the interference environment. Unsurprisingly, the ITU WP4A Revisions suggested modelling in this way would be inaccurate.[19]

Instead, a far more plausible scenario is that SpaceX and other NGSO operators will coordinate in good faith to minimize interference. Therefore, an interference analysis which considers best-case I/N links at each time step would be a much more authentic representation of the SpaceX Modification Application's impact to other NGSO FSS systems. The authors of the ITU WP4A Revisions presented results from an interference simulation using the "best-possible NGSO satellite selection at each time step."[20]

The interference analysis provided by OneWeb in the ITU Submission is entirely consistent with a methodology that WP4A—to which SpaceX was a party—supports. SpaceX's characterization of OneWeb's technical analysis methodology as "cynical" is, at best, self-contradictory and at worst, a thinly-veiled attempt to distract from an inescapable and unrefuted

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[16] This approach would be consistent with "Proposed Option #2" in the ITU WP4A Revisions. *See* ITU WP 4A Revisions at 4.

[17] *See* 47 C.F.R. § 25.261(b) (requiring NGSO operators to "coordinate in good faith the use of commonly authorized frequencies."). OneWeb notes that SpaceX's interference modelling for the OneWeb and O3b NGSO FSS systems included in the Further Opposition did not account for such coordination considerations.

[18] *See* Further Opposition at A-1.

[19] ITU WP4A Revisions at 2 (noting the "significant dichotomy between realistic operations, where in fact additional routing options could be used to mitigate interference, and regulatory modelling").

[20] *Id*. at 4.

conclusion based on the record in this proceeding: SpaceX's proposed modifications will result in an increase in actual interference to other NGSO FSS systems.

To be clear, OneWeb is not suggesting SpaceX must *only* perform its interference analyses using a best-case tracking strategy. However, as OneWeb has demonstrated, doing so would definitively demonstrate an increase in interference to other NGSO FSS systems.[21] Therefore, the Commission should require SpaceX to at least demonstrate how a different, realistic, and defensible tracking strategy would not do the same. SpaceX's continued reliance on worst-case tracking is both technically inappropriate and highly misleading. Nothing SpaceX has submitted to the Commission demonstrates otherwise.

Therefore, OneWeb reiterates its request that the Commission deny the SpaceX Modification Application, or, at a minimum, process the OneWeb Modification Application and the SpaceX Modification Application contemporaneously.

Kindly contact the undersigned with any questions regarding this submission.

Very truly yours,

/s/ Brian D. Weimer

Brian D. Weimer
for SHEPPARD, MULLIN, RICHTER & HAMPTON LLP

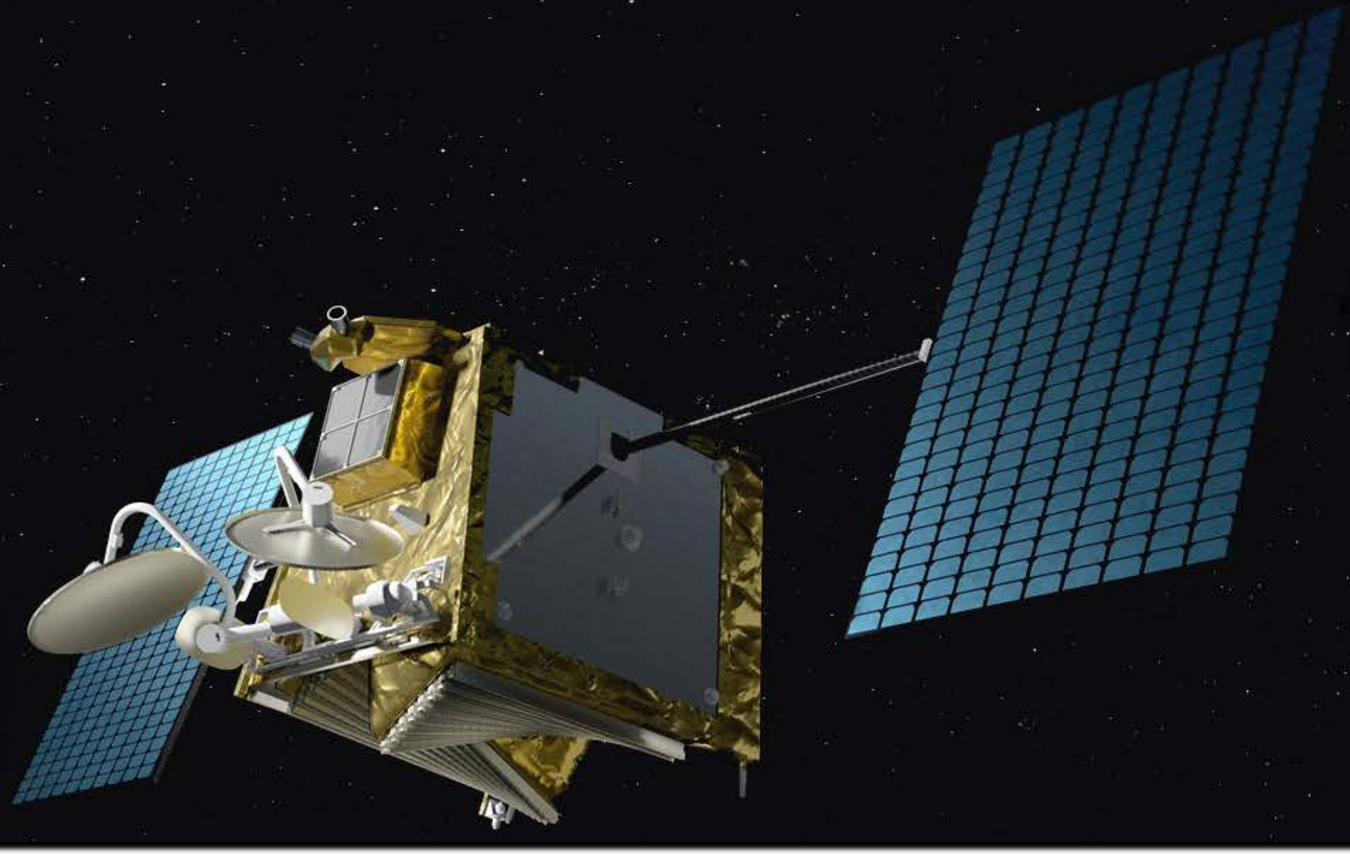
Attachment

cc: Troy Tanner, Deputy Bureau Chief, International Bureau
Jose Albuquerque, Chief, Satellite Division
Karl Kensinger, Deputy Division Chief, Satellite Division
Stephen Duall, Satellite Division
Jay Whaley, Satellite Division

[21] OneWeb Reply at 5.

OneWeb

ACCESS FOR EVERYONE



Meeting with Satellite Division of the FCC's International Bureau
April 1, 2019

SEH Modification – Unfulfilled Obligations

- **The SEH proposed modification is distinct from a simple change to orbital configuration or number of satellites**
  - Changing the spectrum-use architecture has real impacts on both the NGSO and GSO sharing environments

- **SEH must demonstrate that the proposed modification will not result in increased interference to other NGSO systems, which requires SEH to:**
  - Assess all of the potentially affected systems
  - Assess the entire range of affected antenna sizes
  - Justify how the selected analysis parameters ensure that the worst-case difference in interference is characterized (not absolute interference)

- **EPFD compliance must be confirmed by a third-party prior to operation**

NGSO Interference Comparison Analysis

The SEH analysis falls short of the L5 analysis in every regard, lacks necessary rigor and completeness, and biases results.

	L5 Filing	SEH
NGSO Systems Analyzed	11 ✓	2 ✗
Victim Antennas Considered	4 per system ✓	1 per system ✗
Latitudes Considered	0°, 40°, 60°, 65° ✓	Only 50° ✗
Satellite Selection Strategy	Highest elevation ✓	Worst-case I/N ✗

SEH worst-case selection strategy for NGSO interference analysis is not defensible

- **SEH admits it is "highly unlikely"[1] its earth stations would transmit to worst-case satellites at each time step.**
  - To do so would require intentional tracking and interference to other NGSO systems.
- **This "unreasonably pessimistic"[2] method of operation would be nearly impossible to sustain due to I/N levels.**
  - I/N > 0 for 50% of the time
  - The results of such a method highlight a "dichotomy between realistic operations, where in fact additional routing options could be used to mitigate interference, and regulatory modelling."[3]

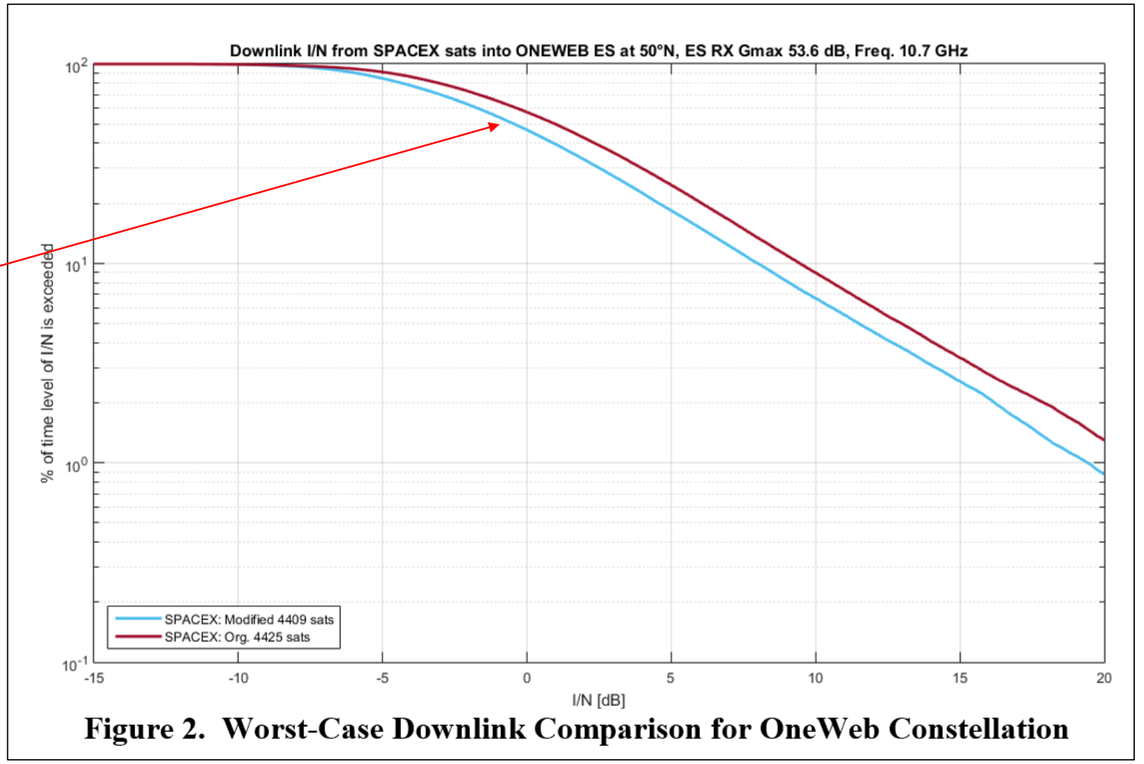
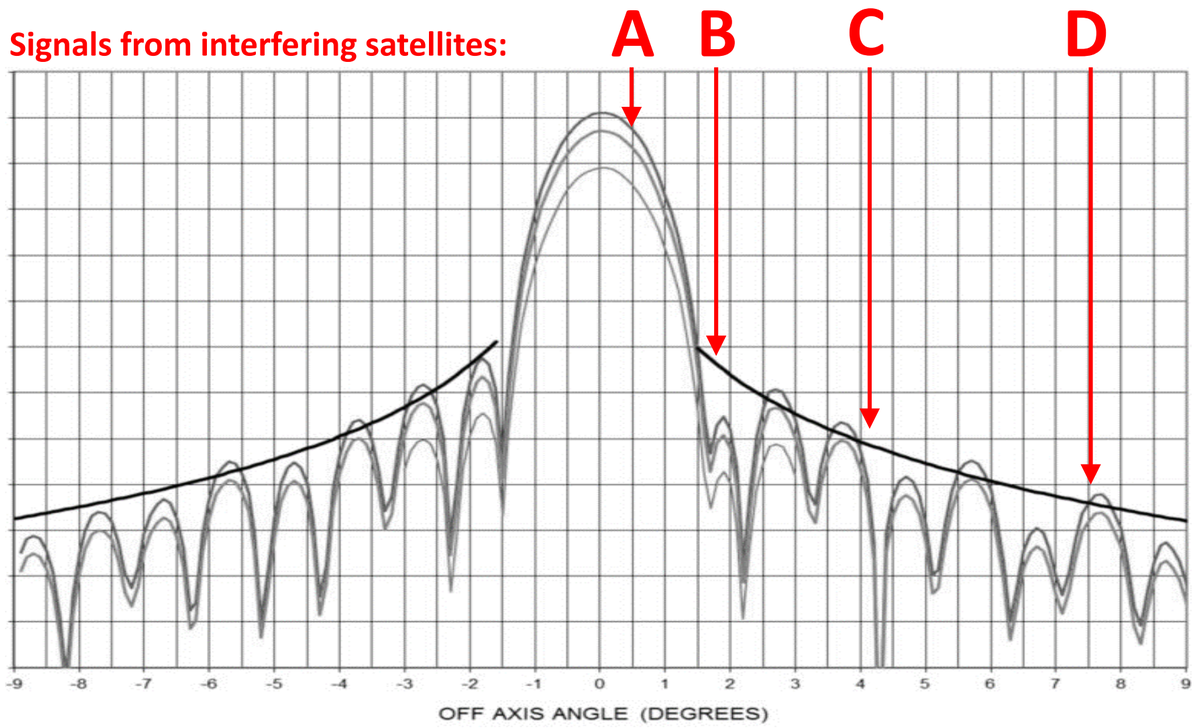


Figure 2. Worst-Case Downlink Comparison for OneWeb Constellation

1. Space Exploration Holdings, LLC, Further Consolidated Opposition to Petitions and Response to Comments of Space Exploration Holdings, LLC, IBFS File No. SAT-MOD-20181108-00083 at A-3 (filed Feb. 21, 2019).
2. ITU-R Working Party 4A, *Document 4A/779-E* at 2, *available at* https://www.itu.int/md/R15-WP4A-C-0779/en (TIES account required for access).
3. *Id*.

SEH worst-case selection strategy unjustifiably biases results



Method	Original License	Proposed Modified Operations	Comparison Result
SEH “worst-case”	Use I/N from A only	Use average I/N from A, B, C, and D	I/N(Average) < I/N(A) Interference appears to **decrease**
More realistic best-case	Use I/N from D only	Use average I/N from A, B, C, and D	I/N(Average) < I/N(D) Interference **increases**

Comparison of Simulated Satellite Selection Strategies

The SEH analysis method is not valid for comparing relative interference impacts

	Representative	Best-Case I/N	Worst-Case I/N
Selection Strategy	Based on actual operations (e.g. highest elevation, longest hold, random)	Based on lowest I/N link available	Based on highest I/N link available
Simulation Usefulness	Realistic modeling, independent from other NGSO system parameters	Captures the best result of successful, good-faith coordination	Captures theoretical absolute worst-case I/N environment
Simulation Drawbacks	Does not consider results of successful coordinations	May be overly optimistic	Does not represent a defensible/possible operation mode
Interference Comparison Analysis Results	Finds realistic difference (**L5 filing**) ✓	Finds worst-case difference ✓	Finds best-case difference (**SEH**) ✗

SEH should be required to use a valid method to assess the interference change it will cause to other NGSOs

- The best-case selection strategy is neither “cynical” nor does it fabricate “additional interference”[4] – rather, it would capture the results of good faith coordination between operators to minimize interference.

- As such, an analysis that considers best-case I/N links at each time step would enable a much more authentic interference comparison between SEH’s Modification Application and its licensed operations.

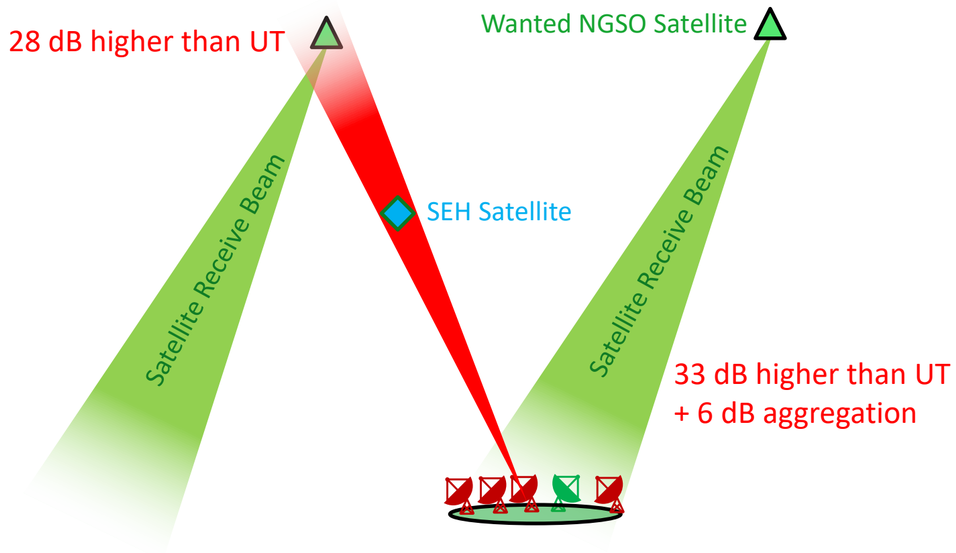
- Consistent with this selection strategy, the authors of a USA input to ITU WP4A regarding regulatory modelling[5] presented results from an interference simulation using the “best-possible NGSO satellite selection at each time step.”[6]

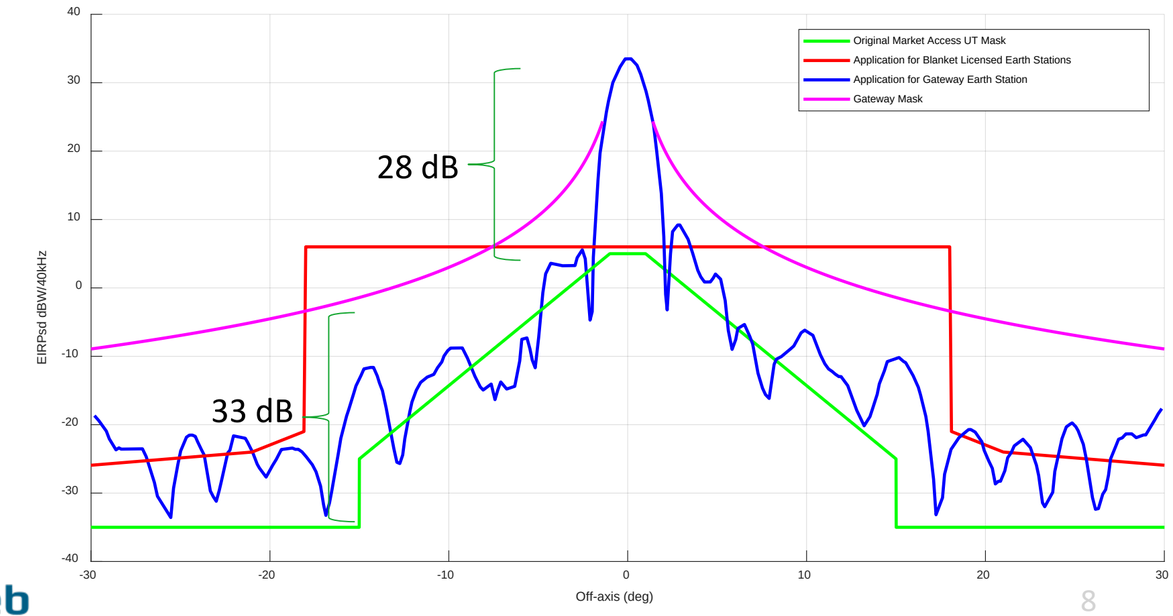
4. Letter from William M. Wiltshire, Counsel to Space Exploration Holdings, LLC, to Marlene H. Dortch, Secretary, FCC at 2 (Mar. 18, 2019).
5. This input was in regards to GSO interference, but the principles are equally applicable to NGSO interference.
6. ITU WP4A Revisions at 4.

SEH use of Ku-band for gateways significantly increases the interference environment

- All prior SEH showings and OneWeb replies were based on the assumption that SEH gateway earth stations would operate with the same maximum EIRP spectral density as SEH user terminals
  - While interference would likely increase in this assumed scenario, recent filings by SEH[7] indicate a reality which is immensely worse than what has been presented in models thus far
  - SEH proposes EIRP spectral densities that are 28 dB higher than before the modification[8]

The SEH Modification will make sharing substantially more difficult





7. *See* SES-LIC-INTR2019-00877, SES-LIC-INTR2019-00878, SES-LIC-INTR2019-00879, SES-LIC-INTR2019-00880, SES-LIC-INTR2019-00881, and SES-LIC-INTR2019-00882.

8. *See, e.g.* SpaceX Services, Application for Gateway Earth Station, SES-LIC-INTR2019-0082, Narrative at A-2—A-4, (filed Mar. 28, 2019).

Comparison of EPFD Compliance Demonstrations

	L5 Filing	SEH
Modified constellation and operation parameters are publicly available	Yes ✓	No ✗
$EPFD_{up}$ considers aggregate of user terminals and gateways operating simultaneously[9]	N/A	No ✗
EPFD compliance validated prior to launch	Yes ✓	Waiver request ✗

9. *See* Space Exploration Holdings, LLC, Application for Modification of Authorization for the SpaceX NGSO Satellite System, IBFS File No. SAT-MOD-20181108-00083, Attachment A (filed Nov. 8, 2018). Attachment A shows user terminal EPFDup of -161.9 dBW/m2/40 kHz and a gateway EPFDup of -162.2 dBW/m2/40 kHz. When aggregated this is -159.0 dBW/m2/40 kHz, exceeding the limit.

Conclusion

The SEH Modification Application Presents Serious, Unresolved Interference Concerns That Must be Addressed Before Further Processing by the Commission

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