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

In the Matter of	)	
O3B LIMITED	)	Call Sign: S2935
Amendment to Application to Modify U.S. Market Access Grant for the O3b Medium Earth Orbit Satellite System	)	File No. SAT-AMD-20170301-00026

COMMENTS OF SPACE EXPLORATION HOLDINGS, LLC

Space Exploration Holdings, LLC ("SpaceX") hereby comments on the amended application filed by O3b Limited ("O3b") to modify its authorization to serve the U.S. market with its non-geostationary satellite orbit ("NGSO") system providing Fixed-Satellite Service ("FSS"). O3b seeks to modify its existing authorization to, *inter alia*, add V-band operations for up to 24 new satellites in circular equatorial orbits.[1] While these satellites will use steerable beams, those beams can be placed anywhere within an extremely large footprint which, taking into account the significant spreading that would occur from O3b's relatively high operational altitudes in mid-Earth orbit ("MEO"), could each cover almost the entirety of North and South America.[2] The use of such a large coverage area, however, will greatly complicate spectrum sharing between NGSO systems in these bands and will reduce spectral efficiency.

In addition, due to O3b's proposed operational altitude, its uplink beams are likely to cause significant interference to low-Earth orbit ("LEO") systems whenever a LEO

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1 *See Amendment to Application to Modify U.S. Market Access Grant for the O3b Medium Earth Orbit Satellite System*, IBFS File No. SAT-AMD-20170301-00026, at 2 (Mar. 1, 2017) ("O3b Application").

2 *See id.*, Technical Annex at 5.

satellite passes through an O3b earth station's main beam or sidelobe. This would effectively prevent a LEO system with steerable beams (like SpaceX's) from working around the in-line event, forcing the default arrangement of band segmentation. The Commission should ensure that systems at all altitudes under consideration in this processing round will be able to coexist with one another while making efficient use of scarce spectral resources. And, if necessary, the Commission should impose license conditions to ensure that operators have the proper incentives to coordinate fairly and effectively with every other NGSO system.

I. THE COMMISSION SHOULD REQUIRE O3B TO SHARE BEAM POINTING INFORMATION WITH OTHER NGSO OPERATORS IN ORDER TO AVOID WASTING VALUABLE SPECTRUM

Under the Commission's avoidance of in-line events spectrum sharing regime, band splitting or other coordination measures would only be necessary to prevent harmful interference when the satellite of another NGSO system is in-line with an O3b satellite from the perspective of an earth station served by either system.[3] Because O3b's MEO footprint is considerably larger than the total area it will actively serve at any given time, other NGSO operators will have no way of knowing whether O3b is actually operating in a given portion of its footprint unless O3b supplies them the operational steering angles of its beams. Without this information, other operators may be required to take a conservative approach and employ spectrum splitting or other measures to ensure they do not cause or

[3] Although this regime currently applies only in certain portions of the Ku-band, the Commission has proposed to extend it to additional bands as well. *See Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, 31 FCC Rcd. 13651 (2016) ("*NGSO NPRM*").

experience presumed in-line interference that, unbeknownst to them, would never actually have occurred. Such an outcome would be extremely wasteful of valuable spectrum.

The potential improvement in spectrum usage achievable through information sharing is illustrated in Figures 1 and 2 below, which show the area potentially subject to in-line events with SpaceX across an O3b satellite's footprint as compared to such events determined using beam steering information.

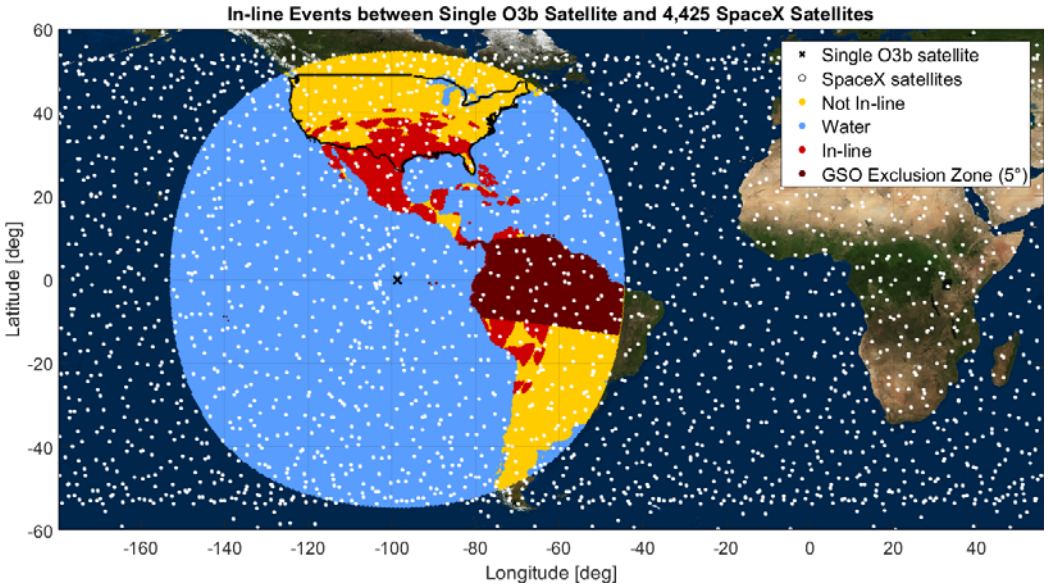

Figure 1. In-Line Events Without Shared Information

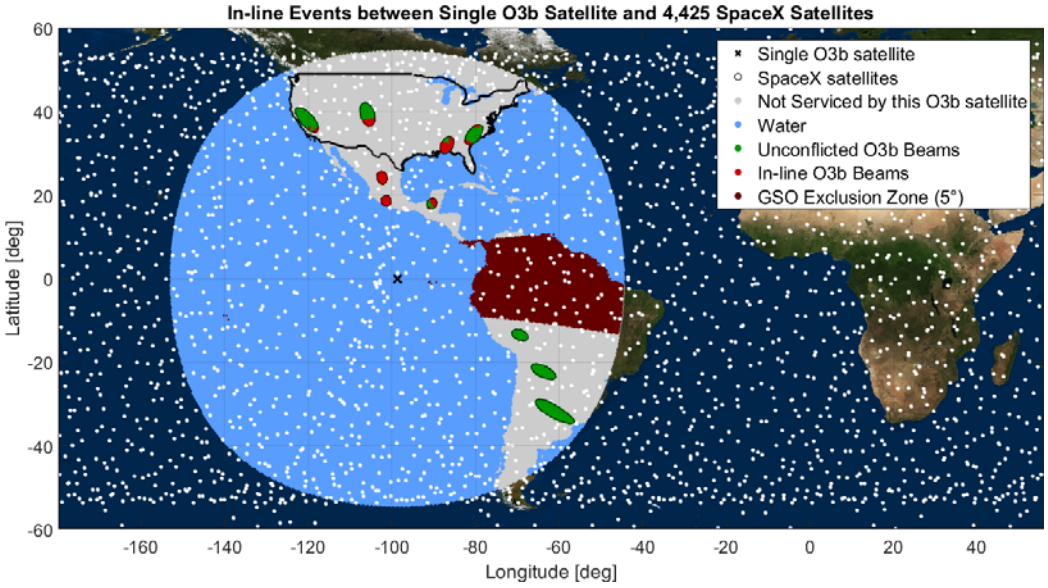

Figure 2. In-Line Events Using Shared Information, with Ten O3b V-band beams

Without beam pointing information (Figure 1), SpaceX must assume that its spacecraft are involved in an in-line event with an O3b MEO satellite in a large portion of its footprint. By sharing information on where its beams are actually operating (Figure 2), O3b would dramatically reduce the number of actual in-line events that must be managed. Information sharing means the difference between a multitude of false in-line events across most of North and South America and potential in-line events in a small number of very targeted areas. This dramatically reduces the number of instances in which *both* operators must reach agreement for spectrum sharing or default to band splitting.

Accordingly, the Commission should condition any authorization for the O3b V-band system with a requirement that O3b share beam pointing data with other NGSO system operators. Sharing such data just a few minutes in advance should present minimal technical challenges, given that each operator is aware of the steering angle of its own satellites' beams. Information on beam steering decisions could then be shared with other NGSO operators at the same time this information is determined by control facilities on Earth and then communicated to the satellite via TT&C links. To maximize the utility of this system, O3b should also transmit the length of time for which the operator anticipates maintaining that steering configuration. This information may be challenging to estimate with full precision, but even a significant overestimate of beam pointing duration would promote far more efficient use of spectrum by all satellite operators than no information sharing at all. However, O3b's MEO altitude will also make the necessary information sharing less challenging. Its MEO beams will move far more slowly relative to the surface of the Earth than will LEO beams, requiring pointing data to be updated at a manageable rate.

II. O3B SHOULD PROVIDE ADDITIONAL INFORMATION REGARDING UPLINK POWER

As SpaceX has explained in its Comments on O3b's and other operators' Ku/Ka-band systems, MEO uplink transmissions may present a significant risk of harmful interference to LEO satellites.[4] They are likely to cause interference to LEO systems due to the very high EIRP of these systems' earth station uplink beams. For example, in order to communicate with MEO satellites at altitudes of 8,000 km, O3b's uplink beams will likely transmit at EIRP levels much higher than SpaceX's.[5] With such an extreme power disparity, the O3b uplink beam would likely degrade SpaceX's or any other LEO satellite's ability to receive any uplink signal in the affected band from *any* location on the Earth, whether or not it is near the transmitting O3b earth station. This would essentially prevent a LEO satellite with steerable beams from using that steering capability to avoid an in-line event, forcing both operators to default to band segmentation.

Without effective coordination, such pervasive interference will significantly reduce the overall utility of NGSO operations throughout the band. Yet if O3b earth stations operate at high EIRP, equitable and efficient spectrum sharing will be difficult or impossible. O3b's V-band application does not appear to disclose the intended transmit power of its user terminals, making it impossible to judge the precise interference risk of O3b's V-band uplinks. O3b should provide this information to facilitate a complete interference analysis before the Commission acts on its application. The Commission

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[4] *See, e.g.*, Comments of Space Exploration Technologies Corp., IBFS File No. SAT-AMD-20161115-00116, at 3-7 (June 26, 2017).

[5] The G/T of O3b's satellite receive antennas 13.3 dB/K, compared to values of 12.8 dB/K and 14.3 dB/K for SpaceX, which are all fairly comparable. However, because O3b will have to compensate for a path loss disadvantage of approximately 28 dB as compared to SpaceX's much lower altitude VLEO satellites, O3b's earth stations would apparently have to operate at approximately 30 dB higher EIRP than SpaceX's.

would then be in a position to consider whether it would be appropriate to impose conditions to address this potential interference and enhance the potential for efficient spectrum sharing.

III. THE COMMISSION SHOULD GRANT VARIOUS WAIVERS REQUESTED BY O3B

In its application, O3b has requested a variety of waivers for operation of its V-band system. For the reasons discussed below, SpaceX supports the following requests.

- *Request for waiver to operate in the 50.4-51.4 GHz band.* O3b has requested a waiver of Section 25.202(a)(1) of the Commission's rules so that it would be able to operate its system using the 50.4-51.4 GHz band.[6] The situation with respect to this band is a bit unusual. The Commission's domestic table of allocations identifies this band as available for FSS (Earth-to-space) use on a co-primary basis, but the Commission has not made a corresponding entry in Section 25.202(a)(1). A waiver may not be required under these circumstances, but it clearly should be granted to the extent deemed necessary.[7] In addition, O3b has shown that its proposed operations would not cause interference to future GSO or terrestrial operations in this band, further justifying the requested relief.[8]
- *Request for waiver of the geographic service requirements.* O3b requests a waiver of Section 25.143(b)(2),[9] which sets the default geographic coverage requirements

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6 O3b Application at 7-8. The Commission has deferred consideration of O3b's request to operate in the 42.0-42.5 GHz band. SpaceX supports these requests as well and will address them at the appropriate time.

7 The Commission recently proposed to eliminate the list of FSS frequencies in Section 25.202(a)(1) and rely solely on the spectrum identified in the allocation tables in order to avoid just this sort of confusion. *See NGSO NPRM* ¶ 14.

8 *See* O3b Application, Technical Annex at 13.

9 O3b Application at 8.

for all NGSO systems where band-specific rules do not apply.[10] That provision includes both an international and a domestic requirement. First, the system must have at least one satellite that would be visible above the horizon at an elevation angle of at least 5 degrees for at least 18 hours each day, for any location between 70º North Latitude and 55º South Latitude. Second, the system must have at least one satellite that would be visible above the horizon at an elevation angle of at least 5 degrees at all times throughout the fifty states, Puerto Rico, and the U.S. Virgin Islands. The Commission previously granted O3b a waiver of a similar geographic coverage requirement for its existing system, in recognition of the limitations of an equatorial orbit.[11] The addition of up to 24 more satellites in that same orbit will not change the situation. Here again, the Commission should recognize the practical and logistical limitations of NGSO operations and grant the requested waiver.

- *Request for waiver to access spectrum previously licensed to GSO systems.* O3b requests a waiver of Section 25.156(d)(5),[12] which provides that the Commission will not consider NGSO-like applications after it has granted a GSO-like application unless and until the Commission establishes NGSO/GSO sharing criteria for that frequency band. This provision may be interpreted to be applicable to the V-band because the Commission has not adopted specific

[10] *See* 47 C.F.R. § 25.217 (identifying default rules for NGSO operations in frequencies without band-specific rules, including Section 25.143(b)(2)(ii) and (iii)).

[11] *See* Grant Stamp, IBFS File Nos. SAT-LOI-20141029-00118 and SAT-AMD-20150115-00004, ¶ 14 (Jan. 22, 2015).

[12] O3b Application at 9-10.

service rules or GSO/NGSO sharing criteria for this band, and it has issued two prior authorizations for systems operating in portions of this band. The first such authorization was issued to a hybrid GSO/NGSO system,[13] while the second was issued to a single-satellite GSO system.[14] Neither system was ever deployed, however, and both licensees have since surrendered their authorizations. When the Commission adopted Section 25.156(d)(5), it specifically stated that it would treat a hybrid GSO/NGSO system "as an NGSO-like system, with the GSO portion of the system as additional satellites" for purposes of this rule.[15] Thus, because the first application granted in this band meets the NGSO-like application grant requirement, this rule should be no bar to further NGSO-like applications.

- *Request for waiver of band segmentation rule.* O3b has requested a waiver of Section 25.157(e),[16] which establishes certain band segmentation procedures if there is not sufficient spectrum available to accommodate all qualified applicants in a processing round. In considering various approaches for intra-service sharing among NGSO FSS applicants in other bands, the Commission has rejected approaches that applied band segmentation, finding that they "are overly restrictive, and could result in insufficient spectrum for commercially viable

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13 *Northrop Grumman Space & Mission Systems Corp.*, 24 FCC Rcd. 2330 (IB 2009).

14 Stamp Grant, Hughes Network Systems, LLC, IBFS File No. SAT-LOA-20111223-00248 (Aug. 3, 2012).

15 *See Amendment of the Commission's Space Station Licensing Rules and Policies*, 18 FCC Rcd. 10760, ¶ 58 (2003).

16 O3b Application at 10.

operations."[17] The Commission preferred the Avoidance of In-line Interference Events approach, under which all NGSO FSS licensees could use the entire band at issue, except in situations where two or more NGSO systems experience in-line interference, when they would have to coordinate.[18] The Commission found that this approach would best meet its goals of allowing equal access to the available spectrum, avoiding spectrum warehousing, and encouraging system flexibility to promote spectrum coordination.[19] The Commission should not now revert to imposing the automatic band segmentation approach upon the participants in this NGSO processing round. Rather, the Commission should waive the band segmentation requirements of Section 25.157(e) to the extent necessary. Successful coordination among NGSO systems will yield much more productive use of valuable spectrum and orbital resources than would a rigid band segmentation approach.

IV. CONCLUSION

V-band spectrum holds the promise of providing much-needed capacity for satellite broadband services from NGSO systems. However, that promise will only be realized if systems operate in ways that maximize spectral efficiency. O3b's MEO system, which operates at a relatively high altitude and with a large coverage area, appears to create a significant number of in-line events. Moreover, the system compounds this challenge by posing an asymmetric interference risk to lower-altitude operators whenever they pass

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17 *See Establishment of Policies and Service Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ku-Band*, 17 FCC Rcd. 7841, ¶ 37 (2002).

18 *Id.* ¶¶ 39-52. For those NGSO systems operators that are unable to reach a coordination agreement, the Commission adopted a default sharing approach based on frequency isolation. *Id.* ¶¶ 53-55.

19 *Id.* ¶¶ 27-38.

through the high-EIRP O3b uplink transmissions. The Commission should carefully consider whether the public interest would be served by conditioning operations of such systems to foster spectrally efficient coexistence between systems of widely differing altitudes.

Respectfully submitted,

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September 25, 2017

ENGINEERING CERTIFICATION

The undersigned hereby certifies to the Federal Communications Commission as follows:

(i) I am the technically qualified person responsible for the engineering information contained in the foregoing Comments,

(ii) I am familiar with Part 25 of the Commission's Rules, and

(iii) I have either prepared or reviewed the engineering information contained in the foregoing Comments, and it is complete and accurate to the best of my knowledge and belief.

Signed:

/s/ Mihai Albulet

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September 25, 2017

Date

CERTIFICATE OF SERVICE

I hereby certify that, on this 25th day of September, 2017, a copy of the foregoing Comments was served by U.S. mail upon:

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/s/ *Abigail Hylton*
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